

See discussions, stats, and author profiles for this publication at: <https://www.researchgate.net/publication/235335567>

Keys to the lichens of Italy I. Terricolous species

Book · January 2004

CITATIONS

21

READS

715

2 authors:



Pier Luigi Nimis

University of Trieste

296 PUBLICATIONS 4,727 CITATIONS

[SEE PROFILE](#)



Martellos Stefano

University of Trieste

83 PUBLICATIONS 903 CITATIONS

[SEE PROFILE](#)

Some of the authors of this publication are also working on these related projects:



KeyToNature [View project](#)



Create new project "Organism Identification for Citizen Science" [View project](#)

Le guide di Dryades 1 - Serie Licheni 1 (L-I)

KEYS TO THE LICHENS OF ITALY

I. TERRICOLOUS SPECIES

Pier Luigi Nimis & Stefano Martellos



Edizioni Goliardiche

Le guide di *Dryades* 1 – Serie Licheni I (L-I)

KEYS TO
THE LICHENS OF ITALY
I. TERRICOLOUS SPECIES

Pier Luigi NIMIS & Stefano MARTELLOS

TRIESTE 2004

INDEX

Abstract	7
Riassunto	7
Acknowledgments	7
INTRODUCTION	
The term “terricolous”	9
The terricolous lichen vegetation of Italy	12
Identification and classification	17
Program FRIDA	19
The distributional-ecological filter: ITALIC	22
The rank of characters	31
The keys	34
Tips and limitatons	35
GENERAL KEY	37
Subkey 1 - Fruticose lichens	37
Subkey 2 – Foliose lichens	83
Subkey 3 – Squamulose lichens	111
Subkey 4 – Crustose lichens	159
Subkey 5 – Leprose lichens	243
SIMPLIFIED KEYS	253
Key A: subalpine-alpine, on acid to subacid substrata	253
Fruticose lichens: subkey A1	253
Foliose lichens: subkey A2	259
Squamulose lichens: subkey A3	261
Crustose lichens: subkey A4	262
Key B: subalpine-alpine, on subneutral to basic (calcareous) substrata	269
Fruticose lichens: subkey B1	269
Foliose lichens: subkey B2	271
Squamulose lichens: subkey B3	274
Crustose lichens: subkey B4	277
Key C: mediterranean to montane, on acid to subacid substrata	283
Fruticose lichens: subkey C1	283
Foliose lichens: subkey C2	287
Squamulose lichens: subkey C3	289
Crustose lichens: subkey C4	290
Key D: mediterranean to montane, on subneutral to basic (calcareous) substrata	295
Fruticose lichens: subkey D1	295
Foliose lichens: subkey D2	297
Squamulose lichens: subkey D3	299
Crustose lichens: subkey D4	304
GLOSSARY	309
REFERENCES	329
INDEX TO TAXA	333

Abstract: This book contains keys to all terricolous ascolichens hitherto known from Italy (439 species). The introduction includes a critical discussion of the term “terricolous”. The general key, provided with descriptions and maps which show the hitherto known distribution in Italy, is followed by four smaller keys for beginners, limited to species found on acid-siliceous and calciferous substrata, below and above treeline. A glossary of 300 technical terms is included. The basic outline of the keys was produced by program FRIDA, patented by the University of Trieste.

Riassunto: chiavi per l'identificazione di tutti i licheni terricoli italiani (439 specie, escludendo i basidiolicheni). Introduzione: discussione del termine “terricolo”. Chiave generale, con descrizioni e carte di distribuzione. Quattro chiavi semplificate per i licheni di substrati silicei e calcarei, al di sotto ed al di sopra della fascia montana. Glossario di 300 termini tecnici. Le chiavi sono state generate da un programma originale (FRIDA), brevettato dall'Università di Trieste.

Acknowledgements: we thank Dr. Guido Incerti (Trieste) for technical assistance in the preparation of the maps, and Prof. Mauro Tretiach (Trieste) for critical comments to the keys. The publication of this book was partially funded by a MIUR grant to the senior author.

INTRODUCTION

This book, dedicated to “terricolous” species, is the first in a series of practical guides to the lichens of Italy, conceived as a baseline for a forthcoming flora of the country. The outline of the keys was produced by program FRIDA, written by the junior author (see later), while data input and descriptions are by the senior author.

The instruments which led to the production of this book originate from two projects co-financed by the Italian Ministry for Education in the period 2000-2004, under the direction of the senior author. The first project has created ecological-distributional and nomenclatural databases searchable on-line for most of the terrestrial “plants” of Italy. These are:

- 1) Macrobasidiomycetes <http://dbiodbs.univ.trieste.it/global/mush>
- 2) Lichens <http://dbiodbs.univ.trieste.it/>
- 3) Mosses <http://dbiodbs.univ.trieste.it/global/mosses1>
- 4) Liverworts <http://dbiodbs.univ.trieste.it/global/epat1>
- 5) Vascular plants <http://dbiodbs.univ.trieste.it/global/flora1>

The second project (2003-2004) is presently implementing morphological databases and interactive identification keys. It aims at making easier the identification of organisms by joining ecological-distributional information and morpho-anatomical data into a program for producing identification tools available on-line.

The term “terricolous”

The term “terricolous” is ambiguous. It well deserves to be discussed in an introduction.

“Terricolous” derives from the Latin “*terra*”, which originally referred to land as opposed to water and air (e.g. *coelum et terra* = the sky and the earth, *terra marique* = the land and the seas, *terrestreae navalesquae pugnae* = battles on land and sea, *terram attingere* = getting to the harbour). Later, it was used for solid ground in general, and even for what we now call “soil” (*terrae solum* = the soil; *ea qua gignuntur a terra* = those things which arouse from soil; *terram subigere*: working the soil; *gleba terrae* = a heap of soil).

The term “soil”, as well, derives from Latin. *Solum* is something we can trample on by the sole (Italian = *suola*) of our feet or shoes [*nullius ante trita solo* = a ground never trampled by anybody

(Cicero); *sederunt medio terra fretumque solo* = they were sitting on bare ground (Ovidium); *terrae solum* = the real soil (Lucretius!)]

The Greek counterpart for *terra* is Γη. In earlier times Γη was a primeval Goddess, the Mother Earth (the Goddess *Tellus* of Romans). The term Γη evolved like *terra*: it was used for anything which is different from sea and the atmosphere, for something solid under our feet, sometimes for what we call “soil” (as early as Omerus, we find the expression *τεν γην εραξεσται* = working the soil).

The Greek counterpart of *solum* is *πεδον*. Like *solum*, *πεδον* has to do with the German-(English) concept of “ground” (from the Barbarian root “*grnd*”), e.g., *εσ πεδον χεο* = I let it fall to ground, Aeschilus. *Πεδον* was often used as the Latin *solum* in the widest sense, e.g. *Ευρωπησ πεδον* = the territory of Europe. (Aeschilus). The Latin term for feet is *pedes* (Italian: *piedi*). For Greeks and Romans the “ground” (*πεδον*, *solum*) is something we trample with feet.

Solum and *πεδον* are perhaps nearer to the modern concept of “soil” (see later) than the almost mythological terms *Terra* and Γη. However, the term “solophilous” was never applied to lichens, being a bad mixture of Latin and Greek, while the more correct, completely Greek term *pedophilous* is not good for lichens. The fully Greek term “epigaeous” (sometimes spelled *epigaeic*) can be used instead of “terricolous”, with the same meaning, i.e. “growing on the ground”. In this book we use the term “terricolous”, because is more familiar to Italians (*terricolo*) than the Greek “epigaeous”.

Apart from etymological matters, most lichenologists agree that “terricolous” (“epigaeous”) lichens are those growing on the ground, or on “soil”. In modern science, however, the term “soil” enjoys a plethora of widely different definitions by pedologists, the systematics of soil being even more complex and confused than that of organisms. Definitions such as “*material in the top layer of the surface of the earth in which plants can grow*”, or “*a variable mixture of organic and inorganic materials, which contains life and constitutes a complex biochemical system of solids, liquids and air*” are of no great help for defining the guild of “terricolous” lichens.

Soils can be mainly organic, mainly mineral, or a mixture of these two components. On the organic side, can a half-rotten, half-living leaf of *Saxifraga* colonised by *Caloplaca saxifragarum* be considered as a “soil”? The border between living-dead plant material

and a “soil” is a faint one: the degree of decomposition of organic material in order for it to be considered as real “soil” is controversial. However, a layer of recently fallen leaves in a forest is an integral component of the soil profile according to most pedologists. On the mineral side, things become even more confuse: lichens are cited in many textbooks as the pioneers in the processes of pedogenesis. Thin layers of strongly weathered rocks can act as a “soil” for several lichens, but no phanerogamist would ever consider them as a “real soil”.

Like organisms, soils have had a long evolution on Earth. According to Barreno (1998): “*Terrestrial habitats in the Palaeozoic consisted only of siliceous rocks and mineral soil: the first adaptive radiation is likely to have occurred on these substrata...we should distinguish between lichens of mineral siliceous soil and those occurring on organic soil, the latter habitat certainly being much younger....A relatively young genus, like Cladonia, finds its maximum diversity on such substrata*”. This sentence is worthy of consideration, as a trigger for further research.

The present book deals with “terricolous” lichens. How do we define this ecological guild?

Some “terricolous” lichens exclusively grow on predominantly mineral soil (e.g. *Solorinella asteriscus*), others are found on living or half-dead plant debris on the ground (e.g. *Caloplaca tirolensis*), still others only occur only on humic, organic soil (e.g. *Cladonia macroceras*). In their checklist of Austrian lichens, Hafellner & Türk (2001) were so brave as to distinguish between strictly “terricolous” species (those growing only on “real soil”), and those which occur as epiphytes on living or half-dead bryophytes, or on living plants found on the ground.

In this book, however, the term “terricolous” has a very broad sense, perhaps closer to the roots of the term “soil”: it refers to all lichens found on the ground, irrespectively of whether they occur on mineral or humous soil, strongly weathered rocks, dead bryophytes or small, half-dead plants.

One could rightly wonder whether such a broad definition is adequate for delimiting a clear-cut guild of ecologically different organisms.

Several lichens which usually dwell on rocks or bark occasionally become “terricolous”. Such shifts in the main substrata are most common in strongly oceanic or continental areas, e.g. along

the coasts of W Europe and in the steppes of C Asia. The senior author has seen *Ramalina farinacea* and *Lobaria pulmonaria* growing on soil in Portugal, and a hill near Lake Baikal whose “soil” was covered by a lichen community dominated by *Parmelia caperata* and other foliose lichens, very much resembling that which can be found on isolated trees near Trieste. Several epiphytic or epilithic lichens occasionally occur on “soil” in the most humid parts of the Mediterranean, and in the driest valleys of the Alps. Not all of them are included in these keys, the selection being restricted to the most common ones.

Italy, however, is the “temperate” country *par excellence*, where most lichens are bound to a given type of substrate. Keys to the “terricolous” species of Italy may have a practical sense.

The terricolous lichen vegetation of Italy

No study was ever published on terricolous lichen communities in Italy. Northern and Central Europe - as the whole circumboreal-subarctic zone - are better known, due to the prominent role of terricolous lichens in these biomes (see e.g. Klement 1955, James et al. 1977, Gilbert 1980, Daniëls 1982, Ahti & Oksanen 1990, Paus 1997, Fryday 2001). The work of Kalb (1970), although restricted to a narrow area, gives important insights on the terricolous vegetation of the Alps. Southern Europe, on the contrary, is almost unexplored, with relevant exceptions due to Spanish authors (e.g. Crespo & Barreno 1978, Egea 1985, Burgaz & Ventureira 1990, Barreno 1991), who described the terricolous vegetation of dry areas of their Country. In other dry areas of the world, esp. America and Australia, intensive research was devoted to “soil crusts”, often - not always - without much detail about the species making up the so-called “crusts” (for a review, see Rosentreter & Eldrige 2002).

At least in Europe, the scarce interest for “terricolous” lichen communities could be due to methodological problems related to the prevailing phytosociological approach (Nimis 1991). Terricolous lichens grow together with vascular plants and bryophytes, and are just one of the components of vegetation. Several authors wondered whether it is correct to describe “terricolous lichen communities” without considering the other organisms occurring together with lichens (for a discussion see e.g. Barkman 1958, Nimis 1991). However, it is difficult to put together three experts, a lichenologist, a

bryologist and a “botanist”, for studying a lichen-rich terricolous vegetation. In the European phytosociological literature there is a huge number of relevés produced by non-lichenologists. They mostly contain records of species such as “*Cladonia pyxydata*, *Cetraria islandica*, *Toninia coeruleonigricans*, *Peltigera canina*”, which tell very little on lichen vegetation.

The best-known communities are those where lichens are so prominent as to force serious phytosociologist to ask for assistance by a lichenologists: the *Toninion* (the famous *Bunte Erdflechengemeinschaft*), the carpets of *Cladonia* found under pine-woods or among *Rhododendron* heaths in the Alps, the vegetation of wind-swept ridges (*Loiseleurio-Alectorietum*).

As a result of this state of affairs, the senior author of this book is not able to describe the “terricolous” lichen vegetation of Italy.

In order to provide a kind of “State of the Art” for the next generation of Italian lichenologists, we present here, with a few comments, the honest phytosociological scheme of Wirth (1995), warning that it is based on a few papers only, that it is largely incomplete, and that much interesting work is needed before to attain a clear picture of the terricolous lichen vegetation of Italy.

Physcietea Tomaselli & De Micheli 1957

Xanthorion parietinae Oksner 1928 - Strongly nitrophytic, mostly epiphytic communities of well-lit situations. Occasionally, at bird perchings' sites several *Xanthorion* species may occur on the ground, mostly on bryophytes, especially on calciferous substrata. Only a few of them are included in the present keys.

Cladonio-Lepidozietea Ječek & Vondr. 1962 – Communities of lichens and bryophytes on rotting wood. Only a few species are included in the present keys, the border between rotting wood and a real “soil” being rather ambiguous.

Psoretea decipientis Mattick ex Follm. 1974 – *Toninion sedifoliae* Hadač 1948 - Lichen-rich communities of calciferous substrata.

Toninio-Psoretum decipientis Stodieck 1937 – Dominated by several species of *Toninia*, *Fulgensia*, *Catapyrenium* s.lat., this vegetation of open calciferous soil, most frequent below the alpine belt, includes different communities - several of which await description.

Cladonietum convolutae Kaiser 1926 – Dominated by *Cladonia convoluta*, *C. rangiformis*, *C. subrangiformis*. Found in

slightly more sheltered and humid situations than the *Toninio-Psoretum*. Frequent also in areas with sand dunes, mostly in intradunal depressions, from the mediterranean to the submediterranean belts.

Cladonietum symphyicarphae Doppelb. in Klem. 1955 – *Cladonia symphycarpha*, *C. polycarpoides*, *C. pocillum*. A rather ill-defined community of calciferous soil, somewhat intermediate between the *Cladonietum convolutae* and the *Toninion*, with optimum in the mediterranean-submediterranean belts.

Psoretum decipientis Frey 1922 (= *Fulgensietum alpinum* Poelt) - The counterpart of the *Toninio-Psoretum decipientis* above treeline, mostly on intermediate, weakly calciferous soil. A ill-defined “community”, characterised by the presence of *Fulgensia bracteata* and perhaps of *Placidium lachneum*. The vegetation with *Solorinella asteriscus* still awaits description.

Endocarpetum pusilli Galle 1964 – A poorly defined “community”, characterised by “*Endocarpon pusillum*” and perhaps by *Anaptychia bryorum*, it colonises thin layers of soil on steeply inclined faces of siliceous rocks with dripping of water in the continental Alps (Kalb 1970).

Ceratodonto-Polytrichetea piliferi Mohan 1978 – Lichen-rich vegetation of siliceous soils, often dominated by bryophytes.

Peltigeretalia Klem. 1950 – This “order” of the phytosociological hierarchy is supposed to include all lichen-rich communities on siliceous ground. After the monograph of *Peltigera* by Vitikainen (1994) the name “*Peltigeretalia*” sounds like a garbage can from old times. The many species of *Peltigera* have different, nuanced, not always well-known ecological requirements. Many of them could be used to distinguish among lichen-rich communities which hardly can be subsumed under the same umbrella.

Baeomycion rosei Klem. 1955 – *Lecideetum uliginosae* Langerf. ex Klem. 1955 - Pioneer communities of acid soil dominated by crustose lichens.

Cladonion arbusculae Klem. 1950 – Subarctic-subalpine communities of well-lit situations, occurring on acid soil, dominated by species of *Cladonia*, such as *C. arbuscula s.lat.*, *C. crispata*, *C. pleurota*, *C. rangiferina*, *C. uncialis*.

Cladonietum mitis Krieger 1937 – This is the typical “reindeer lichen community” - perhaps the only one which really belongs to the *Cladonion arbusculae* - most frequent in the subalpine-alpine belts, both in tundra-like vegetation and in the understory of

very open coniferous woodlands (esp. in the most continental parts of the Alps, where it can descend to ca. 1000 m). It is not uncommon throughout the Alps, and it occurs in fragmentary and impoverished forms also in the Gran Sasso and Majella Massives (C-Apennines).

Cladonietum foliaceae Klem. 1955 – This “community”, dominated by *Cladonia foliacea* and certainly not related with the *Cladonion arbusculae*, is the silicicolous counterpart of the *Cladonietum convolutae*. In Italy, *Cladonia foliacea* occurs from the mediterranean belt to near treeline, and is likely to take part into several, well-distinct communities which, however, still await description.

Cladonietum destrictae Krieger 1937 - This ill-defined community is characterised by the dominance of *Cetraria aculeata*, a species which, in Italy, is broad-ranging, and which is likely to be an element of different vegetation types.

Cetrarion nivalis Klem. 1955 – Arctic-alpine communities of wind-swept ridges above treeline, dominated by *Flavocetraria cucullata*, *F. nivalis* and *Thamnolia vermicularis s.lat.*

Empetro-Cladonietum stellaris Du Rietz 1925 – A well-defined, mainly subarctic-subalpine community of mostly organic, acid soil in well-lit but wind-protected, rather humid situations, characterised by the dominance of *Cladonia stellaris*, and by the higher frequency of *C. amaurocraea*. This community - which has little to do with the *Cetrarion nivalis* and is more related to the *Cladonietum mitis* - needs a long ecological continuity. Hence, it is very rare, and strictly limited to above treeline in the Alps of Italy.

Loiseleurio-Alectoretum ochroleucae Du Rietz 1925 – The typical community of wind-swept ridges (short snow-lie) above treeline, best developed on siliceous substrata but also occurring on calciferous ground. It is dominated by *Alectoria nigricans*, *A. ochroleuca*, *Flavocetraria cucullata*, *F. nivalis*, *Thamnolia vermicularis s.lat.* Common throughout the Alps, it also occurs in an impoverished form in the Gran Sasso and Majella Massives (C-Apennines).

Solorinion croceae Klem. 1955 – Arctic-alpine to subarctic-subalpine communities of siliceous, more or less acid soil, near or above treeline. Best developed and mostly restricted to the Alps in Italy.

Lecidomatetum demissae Frey 1923 – Characterised by the dominance of *Lecidoma demissum*, this “community” of siliceous

substrata above treeline is actually dominated by higher plants: the lichens (among them *Cetraria islandica*, *Cladonia coccifera*, *Protopannaria pezizoides*, *Solorina crocea*, *Stereocaulon alpinum*, etc.) colonise the bare soil amongst tufts of grasses. The soil is mostly clay, with an organic component, hence rather humid. Restricted to the Alps in Italy, with some species reaching south to the mountains of Sicily.

Lecideetum limosae Klem. 1955 – A pioneer community of (mainly) crustose lichens, occurring on naked soil in sites with a long snow-lie, e.g. in clearings of Alpine grasslands.

Stereocaulium alpini Frey 1937 – Characterised by the dominance of *Solorina crocea*, *Stereocaulon alpinum* and *Cladonia macrophyllodes*, this community very much resembles the *Lecidomatetum demissae*, but tends to colonise mineral acid soil in slightly drier, more illuminated situations. In Italy it is restricted to above treeline in the Alps.

Caloplacetum nivalis Kalb 1970 – Characterised by *Arthrorhaphis alpina*, *Bryodina rhypariza*, *Bryonora castanea*, *Caloplaca nivalis*, this community colonises pockets of mostly organic soil in depressions with a long snow-lie on siliceous substrata. It is restricted to the Alps in Italy.

Megasporion verrucosae Kalb 1970 – Arctic-Alpine to subarctic-subalpine communities of living or moribund bryophytes and plant debris on calciferous substrata (*Megaspora verrucosa*, *Mycobilimbia hypnorum*, *Pertusaria geminipara*, etc.).

Megasporetum verrucosae Frey 1927 – A rather ill-defined, arctic-alpine community of more or less calciferous soil, found in rather sheltered situations with a long snow-lie. It is apparently dominated by *Gyalecta foveolaris*, *Rinodina mniaraea*, *R. turfacea*, *Solorina bispora*, *Vulpicida tubulosus*, with several species of the following community.

Caloplacetum tirolensis Kalb 1970 – Dominated by species such as *Caloplaca ammiospila*, *C. cerina* v. *chloroleuca*, *C. saxifragarum*, *C. tirolensis*, *Lecanora hagenii* v. *fallax*, *Lecidella wulfenii*, *Peltigera lepidophora*, *Phaeorrhiza nimbosea*, this vegetation is fairly common above treeline, on calciferous substrata, mostly on plant debris and bryophytes in rather exposed, well-lit situations. Widespread throughout the Alps, well-developed also in the Gran Sasso and Majella Massives (C-Apennines), it occurs also in the highest calcareous peaks of the S Apennines (e.g. the Pollino Massif).

The senior author of this book is not a supporter of the so-called “syntaxonomical” approach of phytosociologists. The existing phytosociological schemes are based on old species concepts, and often on a poor knowledge of species. Some examples: the recently-revised genera *Catapyrenium s.lat.* (Breuss 1990) and *Placidiopsis* (Breuss 1996) include many species which occur in the so-called *Toninion*; in the phytosociological literature they were mostly subsumed under the epithet “*Dermatocarpon trapeziforme*”. Before the monograph of *Toninia* by Timdal (1991) most terricolous species were called “*Toninia coeruleonigricans*”. Even for *Peltigera* information is scanty: before the monograph by Vitikainen (1994) most phytosociologists recognised a few species only (e.g. *P. aphthosa*, *P. canina*, *P. rufescens*). The genus *Fulgensia*, one of the most characteristic elements of the *Toninion*, like *Endocarpon* and many other groups, is still in need of a thorough revision.

Much work is needed to appreciate the real role of lichens in the “terricolous” vegetation of Italy.

Three suggestions from the senior author to the next generation of Italian lichenologists: 1) be accurate in identifying the species (this book might be of some help), 2) avoid the phytosociological “*orapronobis*”, 3) use a rigorous sampling design in your studies.

Identification and classification

After Gutenberg, information useful for identifying organisms was printed on paper, as in any classical Flora, and in the present book. The constraints of a paper-printed text have forced most authors to organise information according to the hierarchical scheme of biological classification.

Classical keys first lead to families, then to genera, and finally - if everything works - to species. Supraspecific taxa often need “difficult” characters. Many of the easy-to-look-at characters, such as the colour of the thallus, and those referring to ecology and distribution, are alien to the hierarchical-taxonomic scheme. There is an abysmal difference between the amount of information requested by a classical flora, and that which would be enough for giving a name to an organism. Odd options may be encountered, such as the distinction between two species that never had the pleasure to meet with each other, having completely different ecology and distribution: that between two lichens, one with a yellow, the other with a black

thallus, using the character: “ascus *Porpidia*-type”. The old hierarchical-taxonomic scheme still maintains a prominent position for projects aiming at producing a “global” key for any group of organisms. Until now - fortunately - no such keys were produced for lichens (see later).

Classification and identification - albeit related - belong to two different operational processes (Bridgman 1927). Classification is the job of taxonomists, identification can be fun for anybody. The great American lichenologist Mason Hale was aware of this fact when he produced the classical “booklet” *How to know the lichens* (Hale 1969, 1979).

Nowadays, information can fly on wings much stronger and elastic than sheets of printed paper. Computer-based programs can utilise, in a multi-dimensional way, a wealth of morphological-anatomical data, plus the distributional-ecological information usually hidden in the large ocean of scientific literature. A revolution!

Traditional floras had several drawbacks:

- 1) Being printed on paper, their content is "frozen". Nomenclatural-taxonomic changes, progress in floristic exploration, the discovery of new species, often render a flora outdated within a few decades. Computerised systems, on the contrary, can be updated and corrected in real time.
- 2) The larger a flora (or a taxon) is, the more difficult it is for the user to identify an organism. Computerised tools permit to reduce the set of organisms using different combinations of morphological, ecological, distributional characters.
- 3) Traditional keys are "rigid". They contain a huge amount of information which is frozen into the format and the logical structure selected by the author. Computerised floras, being “elastic”, can generate products which would have required a huge amount of work in the past. Some examples: a) regional-local floras (e.g. of a biotope, a natural park, a province); b) keys for "virtual habitats", by combining distributional data with ecological indicator values (see Nimis & Martellos 2001), c) keys for special users.

In Italy, lichens are widely used in educational projects at all levels, from the ground school to the university. FRIDA (see later) not only permits to construct keys for the area in which the school is located, but also to adapt the language to the educational level of schoolchildren (see Nimis et al. 2003). Some characters can be automatically downscored in the keys (e.g. the use of

Paraphenylendiamine for colour tests, which, being cancerogenic, is not appropriate for children).

4) Databases are “accumulative”. A small database (e.g. limited to a taxonomic group, or to a local flora) can be the starting point for future expansions. For example, the production of a key of terricolous lichens known from Slovenia has required the addition of 17 species only to the Italian database.

5) Outputs can be edited in several different formats, from simple texts to illustrated books (see Nimis et al., 2003). Any user can now produce her/his "personalised books", *à la carte*, on-line. A warning for the “global” publishing industry?

The present book is still printed on paper. One could wonder why at the same time - it is made freely available in the internet (<http://dbiodbs.univ.trieste.it>).

Databases are ephemeral: an economic crisis, the change of policy in a Department, the sudden demise of The Professor, could prevent the purchase of new servers, the payment of a Webmaster, any further updating.

On-line databases can disappear in the matter of a few hours.

Paper-printed information, while bulky and rigid, still may enjoy a longer, safer life-span.

Program FRIDA

One of the first and best known packages for interactive identification is IntKey, based on the DELTA format, developed in the CSIRO Division of Entomology (Australia) starting from as early as 1971 (<http://www.biodiversity.uno.edu/delta/>). Its facilities include the generation of descriptions and conventional keys, the conversion of data for use by classification programs, and packages for interactive identification and information retrieval. The system is capable of producing high-quality printed descriptions. IntKey generates conventional identification keys: in selecting characters; at any step, the program determines how well they divide the remaining taxa, and balances this information against subjectively determined weights which specify the ease of use and reliability of the characters. The system is in use worldwide for a wide array of organisms, including viruses, corals, crustaceans, insects, fish, fungi, plants, and wood.

IntKey was tested in Trieste in 2000 on some subsets of lichens. A trial was also made on the genera of Graminaceae occurring

in NE Italy (Ganis et al. 2000, and <http://www.univ.trieste.it/~biologia/gram/indxgram.htm>). The judgement of the package was positive, but several negative aspects were also pointed out.

For lichens, IntKey was adopted by LIAS (*A Global System for Lichenized and Non-Lichenized Ascomycetes*), an ambitious, well-established, multi-authored information system for the collection and distribution of descriptive and other biodiversity data on lichens and non-lichenised ascomycetes coordinated by the Botanische Staatssammlung München (Rambold, 1996–2004).

One could wonder why, instead of joining LIAS, we have produced our keys using a different program. The main reason is the critical attitude of the senior author toward “global” projects.

The Utopia of a unique, “global” system which could permit to “give a name” to any organism collected on Earth is justified by the progress of informatics, but not by the state-of-art of knowledge on biodiversity. Such a Utopia was conceived for a World without problems. The present World, however, is full of problems. Two examples: 1) Does *Helocarpon crassipes* occur in the Alps? According to some checklist, yes. Other authors maintain that the populations of the Alps differ from those of N Europe; further study is needed. 2) Is the continental *Dirina stenhammari* a “good” species or just a morph of *Dirina massiliensis* f. *sorediata*? Tehler (1983) is for the second option, other authors (e.g. Hafellner, in litt., and the senior author) still have doubts. DNA data could perhaps solve the problem.

Contrasting opinions by different authors are powerful triggers of research: they point to problems. Global systems are full - as the present book, or any monograph, checklist, and flora - of hasty synonymisations, wrong species concepts, and wrong records. Nothing new, no problem. But a disaster if such systems will become the “only” way to access biodiversity information worldwide. If the next, probably small, generation of lichenologists will be fed on clicks into “The Global System” to get inspiration for research.

A “global” repository of taxonomic-morphological information is certainly possible, useful, and desirable. However, if this were the only one on Earth (can we imagine more than one “global” system?), it could turn into a nightmare: “*The McDonaldization of Taxonomy*”, with swards of young lichenologists from Italy to Singapore eating the same taxonomical *BigMac*. “Global” projects must live in the real World. The real World is diverse, full of different systems, ideas,

taxonomic concepts, sometimes in agreement with each other, sometimes not, as in the old “Floras”.

We did not join LIAS because we wanted to give a modest contribution to the diversity of ideas and approaches in the “global” World.

In 2000, the junior author proposed to write a completely new program. Work developed in a continuous, intense, often conflictual interaction between the two authors. This was a good exercise for both of them, which contributed in making the software digestible to colleagues who know well the plants, but are not acquainted with computers.

The result is program FRIDA, which attracted the interest of AREA Science Park Trieste in the framework of project SISTER, that financed the promotion of its products, and its patenting by the University of Trieste.

Procedures and functions of FRIDA are written in PL/SQL language, running on a Oracle Database Server, which is connected to the Web by an Oracle server. FRIDA is flexible, its use does not require learning any special language nor using codes to input information, and is able to export data in several other formats.

Partial on-line access to keys produced by FRIDA is available since May 2003 through *ITALIC* (<http://dbiodbs.univ.trieste.it>), limited to terricolous lichens (Nimis & Martellos 2003). An interactive key of vascular plants of the Trieste Karst, produced by FRIDA, is available at <http://dbiodbs.univ.trieste.it/quint/carso/init.html>.

The keys printed in this book and those available on-line look similar, but are basically different. In the on-line version, the user can specify any set of ecological, distributional, morphological or chemical characters he likes. These characters act as “filters” reducing the set of species included in the key. For example, if one has found *Caloplaca cerina*, a crustose lichen with a grey thallus and orange apothecia reacting K+ red on a tree near Trieste, one can limit the search to “crustose”, “thallus neither dark nor yellow-orange”, “apothecia yellow to orange”, “on trees”, “Trieste”. The result is a key to 6 species, without questions such as “*Photobiont trentepohlioid?*”, “*Spores polar-diblastic?*”, “*Cortex paraplechtenchymatous?*”.

The users of paper-printed keys, such as those of this book, cannot enjoy such privileges. However, informatics is developing rapidly: multi-dimensional identification tools will be soon available on-line.

The distributional-ecological filter: *ITALIC*

The present book also includes four simplified keys for lichens of calcareous and siliceous substrata, above and below the montane belt. They were produced by joining FRIDA with information stored into *ITALIC*, the information system on Italian lichens (Nimis & Martellos 2002).

ITALIC was created in 1999, when the junior author proposed to the senior one to transform his bulky catalogue of Italian lichens (Nimis 1993) into a database searchable on-line. Since then, *ITALIC* is being developed as an organiser of several databases dealing with the lichens of Italy, such as herbaria, regional checklists, archives of pictures and maps, and presently FRIDA.

The first version of *ITALIC* was searchable in the internet since October 2000, the second version was published on-line in 2001 (Nimis & Martellos 2002), a third version appeared in May 2003. In 2003, a thesaurus of more than 12.000 infrageneric epithets was incorporated into the system, which permits connection with other databases following different nomenclatural standards (Nimis & Martellos 2003).

Lichens are broad-ranging; many species present in Italy also occur in other European countries, several of them extend to the whole holarctic region, sometimes to the Southern Hemisphere. Information from *ITALIC* could be useful outside the narrow borders of Italy.

A description of *ITALIC* can be found in Nimis & Martellos (2002). Here we only mention the data used for producing the simplified keys.

Geographic subdivisions – Maps (see later) and simplified keys are based on two main subdivision of the Country:

1) Administrative regions. 21 Operational Geographic Units (OGUs, see Fig. 1), the small Province of Trieste being separated from Friuli due to its peculiar biogeographical features. For each species, *ITALIC* gives references for each region, limited to papers published after Nimis (1993).

2) Phytoclimatic areas. 9 OGUs, delimited on the basis of several GIS-maps (altitude, precipitation, etc.), also taking into account the climatic difference between the Tyrrhenian (humid) and Adriatic (dry) parts of the peninsula (Nimis & Tretiach 2004). Commonness-rarity values (see later) were calculated for each taxon in each of the 9 areas.

A0) Nival area: well above treeline, in areas occupied by glaciers, near the tops of the highest mountains (Alps only).

A) Alpine area (above treeline in the Alps and in the highest peaks of the Apennines, Gran Sasso and Majella Massives in Abruzzi). An area devoid of trees, where terricolous lichens give rise to a diversified palette of communities, depending on the main substrate, and on microhabitats (from fissures of the rocks to organic soil in snow-beds). The so-called “arctic-alpine” element is most common on acid siliceous substrata, whereas many species of calciferous ground extend to the high mountains of Asia (Nimis 1999).

A1) Subalpine-oroboreal area (near treeline in the Alps, dominated by *Larix-Rhododendron*, also including semi-natural, closed *Picea abies* forests). Several so-called “boreal-montane” lichens form distinct communities, such as those dominated by species of *Cladonia*. In Italy, the limit of most arctic-boreal vascular plants lies somewhere in the N Apennines, with the relevant exception of the Gran Sasso-Majella Massives in the Central Apennines. As far as lichens are concerned, however, the mountains of Calabria and even those of Sicily do still host several so-called “boreal” lichens.

B) Oromediterranean area (above treeline outside the Alps and Abruzzi). In southern and insular Italy only a few mountains attain treeline. Some of them (e.g. the recent Etna Vulcano in Sicilia, and the much older Gennargentu Massif in Sardegna) host a peculiar vegetation, dominated by thorny-shrubs of the genus *Astragalus*, *Tragagantha*-section. The thorny-shrubs formations of the mediterranean mountains have an old history, perhaps dating back to the Messinian period, when the Mediterranean was a semi-desert, biogeographically connected with the Iranian-Turanian region (Pignatti et al. 1997, Nimis 1981). The lichen flora of the few truly Oromediterranean peaks of Italy still awaits exploration.

C) Montane area (beech forests). Beech (*Fagus sylvatica*) is the dominant tree in the mountains of Italy. In the Alps it forms pure to mixed forests (with *Abies alba* in cool-humid situations), with a broad altitudinal range, from ca. 600 m, in contact with the submediterranean belt, to ca. 1800 m, in contact with the oroboreal belt. Along the Apennines, down to Sicily, albeit thwarted and shrub-like, beech marks treeline, but it does not occur in Sardegna. During the glacial periods, *Fagus*-forests and their flora were confined to refuges in southern Europe, esp. in the Balkan and

Italian peninsulas, and later expanded northwards, the vascular flora of beech forests becoming poorer from southern Europe to S-Scandinavia (Nimis & Bolognini 1993). Beech forests are the “national” forest of many C-European writers and poets, but those of Italy and the Balkan Peninsula are the “original” ones, those with the highest diversity. The beech forests of Italy, however, are still a mystery for lichenologists: some of them (e.g. those in the W part of Calabria), host an unusually rich, interesting, luxuriant lichen vegetation (e.g. with mediterranean-montane species such as *Melanelia laciniatula*, *Physconia venusta* and *Ochrolechia balcanica*), others - even those located in rainy areas (e.g. parts of Liguria and Friuli) - are almost a lichen desert. The balance between air humidity and precipitation in the liquid form can perhaps explain the dramatic differences. Commonness-rarity values (see later) for beech forests wrongly consider the beech-belt as a continuum from the Alps to the mountains of Sicily. A clever exploration of the lichens in Italian beech-forests could give rise to interesting results. Interestingly, no terricolous lichen of Italy has an optimum on mineral soil in this belt, but the distribution of many species of *Peltigera* still awaits further study.

D) Submediterranean area (deciduous oaks, excluding E and F): the submediterranean area, lying between the montane and the mediterranean belts, covers most of the lowlands and hills of Italy. The potential vegetation is dominated by deciduous trees, esp. *Quercus* and *Carpinus*, most forests having being substituted by coppices dominated by *Ostrya* and *Fraxinus ornus*, urban areas and cultivations. The glacial and post-glacial history of submediterranean forests is similar to that of beech forests, with a difference related to the thermic requirements of the dominant trees, which survived in warmer sites, mostly in lowland areas, esp. in S Italy. The vascular flora is richer in the south, poorer in the north (see Bolognini & Nimis 1993), while lichen richness mainly depends on air humidity. In *ITALIC*, the submediterranean area is split into three different OGUs: 1) Padanian (the Po-plain, mostly occupied by urban areas or intensive cultivations, almost devoid of forests), 2) Tyrrhenian (exposed to humid air masses), and, 3) the present OGU, which includes what is left excluding areas nr. 1 and 2. This area includes the hills and the alpine valleys of N Italy, and the eastern part of the Peninsula (see map in *ITALIC*).

E) *Padanian area* (the plains of the North, plus a narrow strip along the eastern side of peninsular Italy): this is the most heavily anthropised part of Italy, where several species do not occur because of pollution and/or almost total deforestation. Before Roman colonisation, most of the Po-plain was covered by dense deciduous forests. Presently, it is an agricultural, industrial or densely urbanised area. This OGU has no biogeographic meaning (it formally belongs to the previous OGU): it was established only because of its peculiar features, which are not favourable to lichens.

F) *Humid submediterranean area* (Tyrrhenian), (as D, but restricted to areas with a warm-humid climate: see Nimis & Tretiach 2004). The western part of the Italian Peninsula has a mild-humid climate generated by Tyrrhenian maritime air masses, while the Adriatic coast, on the lee-side of the Apennines, is subject to cold-dry winds from Eurasia during winter. Tyrrhenian Italy is characterised by several suboceanic species, some of which have clear tropical-subtropical affinities. The inland extent of maritime influence differs according to the presence-absence of high mountains stretching parallel to the coasts, being more pronounced in Tuscany and Latium, where the humid Tyrrhenian air masses can reach the watershed of the Apennines. The submediterranean part of Tyrrhenian Italy was delimited taking the arbitrary threshold of 100 m as the limit between mediterranean and submediterranean vegetation (like in the map of potential vegetation by Tomaselli et al. 1973), and considering the main geomorphological features. For further details see Nimis & Tretiach (2004).

G) *Humid Mediterranean area* (Tyrrhenian): see previous point.

H) *Dry Mediterranean area*. Contrary to the Iberian Peninsula - a small continent in itself - the narrow Italian Peninsula and its islands, bathed on all sides by the Mediterranean, rarely experience extreme climates. There are, however, a few parts of Italy which have a really dry-mediterranean climate. These are mostly located in S Sicily, SE Sardegna, and in parts of Puglia. Such areas are important for terricolous lichens: they host several species also occurring in N-Africa, and sometimes in the steppes and semi-deserts of C-Asia (Barreno 1991). After Nimis & Poelt (1987), no thorough exploration of dry-mediterranean Italy was undertaken: in our opinion, an exploration of this area is likely to produce interesting results.



Fig. 1 – The geographic subdivisions of Italy adopted in this book: **Abr**: Abruzzi, **Bas**: Basilicata, **Cal**: Calabria, **Camp**: Campania, **Emil**: Emilia-Romagna, **Frl**: Friuli, **Laz**: Lazio, **Lig**: Liguria, **Lomb**: Lombardia, **Mar**: Marche, **Mol**: Molise, **Piem**: Piemonte, **Sar**: Sardegna, **Si**: Sicilia, **TAA**: Trentino-AltoAdige, **Tosc**: Toscana, **Umbr**: Umbria, **VA**: Val d’Aosta, **Ven**: Veneto, **VG**: Venezia Giulia.

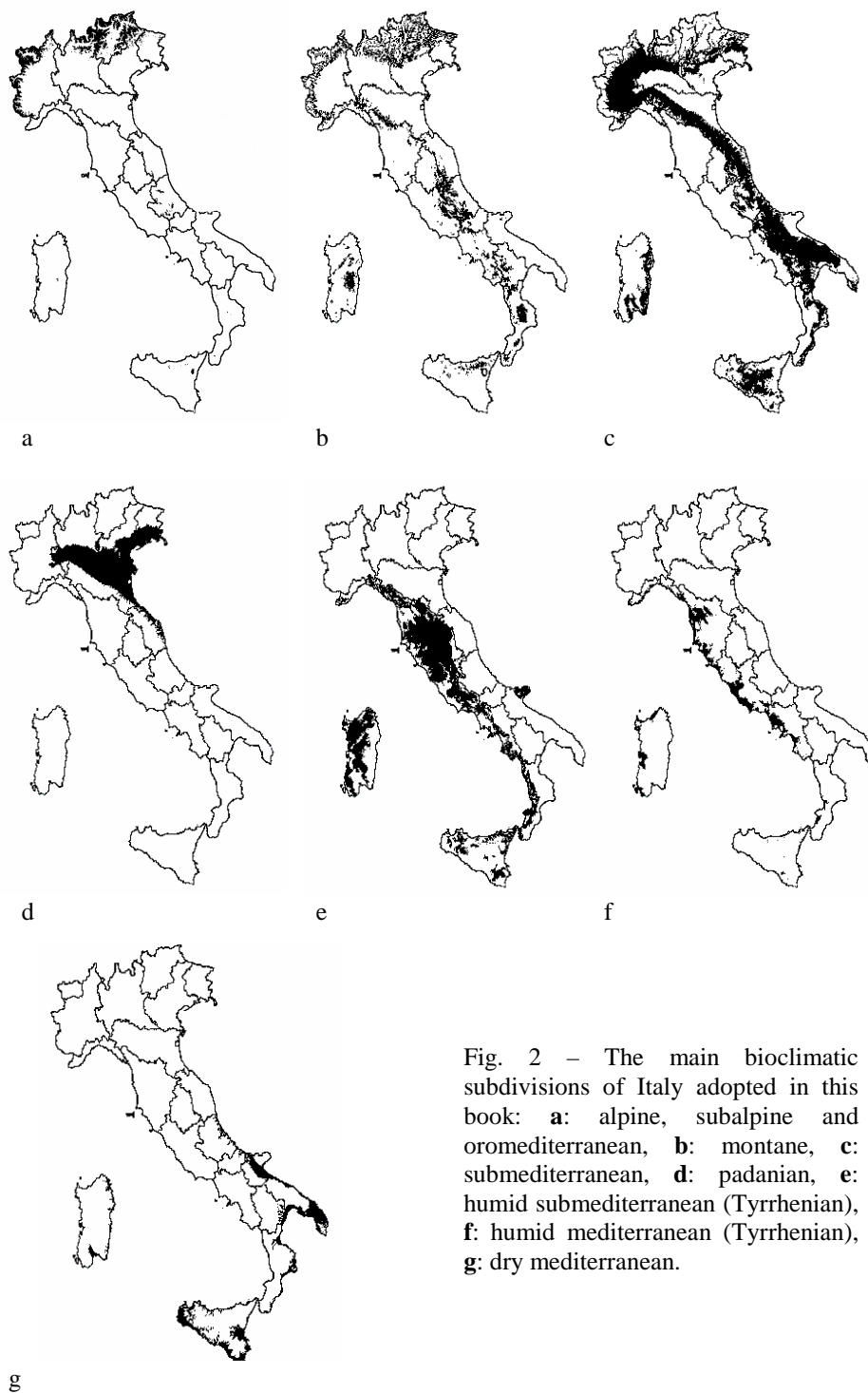


Fig. 2 – The main bioclimatic subdivisions of Italy adopted in this book: **a**: alpine, subalpine and oromediterranean, **b**: montane, **c**: submediterranean, **d**: padanian, **e**: humid submediterranean (Tyrrhenian), **f**: humid mediterranean (Tyrrhenian), **g**: dry mediterranean.

Altitudinal distribution - This parameter refers to potential vegetation only, on a 6-class ordinal scale:

- 1) eu-Mediterranean belt (potential vegetation: evergreen *Quercus ilex* forest),
- 2) submediterranean belt (deciduous *Quercus-Carpinus* forests),
- 3) montane belt (*Fagus* forests),
- 4) Oroboreal belt of the Alps (natural *Picea abies*, and *Larix-Pinus cembra* stands),
- 5) Alpine and oromediterranean (above treeline in the mountains),
- 6) Nival.

The island of Sardegna is a special case: *Fagus* is missing, and the few remains of the “montane” belt, largely destroyed by cattle-grazing, consists of scattered forests dominated by *Ilex* and *Taxus*. In this book, the altitudinal belts of Sardegna were adjusted as to fit those of Arrigoni (1968), but the "submediterranean" belt may be dominated by evergreen forests, the "montane" belt by deciduous oaks, or by remnants of ancient woodlands. On the whole, the island of Sardegna does not fit in the phytoclimatic scheme adopted in this book.

Commonness-rarity - The related concepts of “commonness” and “rarity” are difficult to define, and hence intrinsically fuzzy ones. A given species might be fairly “common” in a narrow OGU, while it may be extremely rare when the OGU is made broader. For example, *Cetraria islandica* is fairly common in the Alps, rare along the Apennines, extremely rare in the mountains of Sicily, and certainly absent in the Po-Plain. There is obviously no sense in specifying its “commonness” nationwide. In *ITALIC*, commonness-rarity - as a first approximation - was calculated separately for each of the 9 phytoclimatic areas, on the basis of three main criteria: a) number of samples in the TSB lichen herbarium (% on the total for each phytoclimatic area), b) number of citations in the literature (taken from *ITALIC*), c) an expert judgement used in particular cases (e.g. that of recently-described taxa). A detailed explanation of the methodology will be presented in a forthcoming paper. Commonness-rarity was expressed on a 9-class scale, as follows: *a*: absent, *er*: extremely rare, *vr*: very rare, *r*: rare, *rr*: rather rare, *rc*: rather common, *c*: common, *vc*: very common, *ec*: extremely common. The “*er*” class was adopted for lichens which are known from less than five stations, and/or were not found in recent times, excluding most

recently-described species, and taxonomically very poorly known taxa. This parameter was used to produce the distribution maps (see later).

Maps - Distributional maps appear at the left side of the description of each taxon. They show - with different shadings - the probability of encountering a given species in a given part of the country. The maps are automatically produced by crossing information from *ITALIC* with a GIS-based map subdividing Italy into phytoclimatic areas, administrative regions, and altitudinal belts. *ITALIC* provides information on: 1) commonness/rarity in the 9 phytoclimatic areas, 2) Presence/absence in the administrative regions, and in the altitudinal belts. The overlapping of the 9 phytoclimatic areas and of 7 altitudinal belts upon the regional borders (the nival belt being merged with the alpine-oromediterranean belts) produces a map (downloadable from *ITALIC*) with 97 OGUs, each of which has different shadings, related to commonness-rarity, with a single constraint: if a species was never reported from a region, all of its area remains white. These maps are likely to change at every updating of *ITALIC*, e.g. when a species is found as new for a region. Their ephemeral nature, however, can be beneficial for lichenologists: it gives an added value to good floristic papers which rarely find a space in high-impact journals. Any record of a species found as new to a region immediately modifies its map, contributing to a better image of its country-wide distribution. Due to their small size, the maps included in this book utilise only 4 commonness-rarity classes: 1) extremely to very rare, 2) rare to rather rare, 3) rather common to common, 4) very to extremely common. More detailed maps are available on-line through *ITALIC*.

Indicator values - Ecological Indicator Values (German: *Zeigerwerte*) are expert assessments which express the ecological range of organisms with respect to different ecological factors. They are, at least in Europe, one of the most frequently used tools for summarising the complex body of knowledge on the ecology of organisms. Ecologists are rarely able to produce predictive models. However, we have now a huge amount of information on the ecological requirements of organisms, mostly hidden in many scattered publications. For vascular plants, the best-known indicator values are those proposed by Landolt (1977) for the Swiss flora, and by Ellenberg (1974, 1991) for that of Central Europe. Indicator values are presently available for several other organisms, e.g. diatoms (Van

Dam et al., 1994), bryophytes (Düll 1991) and lichens (Wirth 1991, 1995: Central Europe, Nimis 1999b: Italy). In this book, indicator values (taken from the latest version of *ITALIC*, Nimis & Martellos 2003) were used for producing the simplified keys. They specify, for each factor and for each species, a range on a 5-class ordinal scale. Only one value, that relative to pH was used, to separate lichens of siliceous and calcareous substrata. The indicator values for pH are as follows: 1) on very acid substrata, such as very acid organic soil, rotting wood, mineral soil deriving from acid siliceous rocks, 2) on acid substrata (a buffer between 1 and 3), 3) on subacid to subneutral substrata, such as soils deriving from base-rich siliceous rocks (weakly calciferous sandstone, basic volcanic rocks, basalt, some types of brick and tiles, etc.) 4) on slightly basic substrata, such as soils deriving from calciferous sandstone, 5) on basic substrata, e.g. more or less mineral soils deriving from pure limestone.

Notes - The notes which appear at the end of descriptions are basically taken from the 3rd version of *ITALIC* (Nimis 2003), with several modifications, which will be incorporated in the next version. In order to automatically produce notes in paper-printed form, those of *ITALIC* were split into two distinct fields: a) information of general interest, which can live independently from that provided by the system (e.g. ecology and general distribution), b) information which is bound to literature records of no general interest, or which cannot live independently from the system (e.g. “*the record from Piedmont by XY is dubious, because...etc*”, “*see also note to species X*”, etc.). Only the former were included in this book. The notes of *ITALIC*, however, were written in a very short format, excluding information provided elsewhere in the system, e.g. in the ecological indicator values, the altitudinal distribution, etc. When isolated from *ITALIC*, many of them may appear as poor and dry. For this reason, several notes were re-worked for this book, to include in a textual form at least the most important information provided by *ITALIC*.

Pictures - We originally thought to complement this book with a CD-Rom containing an illustrated version of the general key. Our system can produce illustrated keys in a few minutes, thanks to a program written by Dr. G. Incerti (Trieste) which automatically connects taxon name, its description, the keys produced by FRIDA, and the archives of *ITALIC* with distributional maps and pictures. The CD-Rom, however, was not included, because of different reasons, some of which have to do with complicate regulations concerning its

distribution together with a paper-printed book. Illustrated keys for any subset of species specified by the user, can be purchased from the Department of Biology of the University of Trieste. Photographs of most taxa are freely available on-line through *ITALIC* (at the moment, ca. 4000 images of ca. 2000 species). They show the general habitus of the lichen, and mostly refer to samples preserved in the TSB herbarium (with a few samples from GZU). These pictures have no “aesthetic-artistic” pretension, having been mostly made by the senior author with the idea of rapidly providing users with a first, rough set of images. With all of its faults, the iconographical archive of *ITALIC* contains the only extant image of many taxa. Input from colleagues about “wrong” pictures - those referring to a different taxon - is most welcome. Work on images is progressing rapidly: many more will be added after the publication of this book, incl. those of anatomical details.

The rank of characters

As with most programs for interactive identification, the keys produced by FRIDA are based on a hierarchy of characters, taxa being separated on the basis of those which come first in the hierarchy.

In the present keys, characters are ranked according to the price of instruments which are necessary to appreciate them, beginners - and people from less wealthy countries as Italy - coming first: a) bare eyes, b) a lens helping the eyes, c) a few easy-to-get chemicals, d) a cheap microscope (such as those for children), e) a UV-lamp, f) a professional microscope, g) access to chromatography, scanning electron microscopy, etc.

Bare eyes - Eyes are extremely sophisticated instruments. They can reveal whether our lichen looks as a flat crust or a small shrub, whether it is dark-coloured or bright-yellow, whether it drastically changes of colour after the application of a chemical, etc.

The lens - Most lichens are small, and many of them look alike under the eye. If they were several meters large, they would look much different. A cheap lens can help the eye to appreciate such differences. With this help one can decide whether *pseudocyphellae* (see glossary) are linear or punctiform, whether the lichen has *soredia* or *isidia* (see glossary), whether the latter are flattened or cylindrical in section, etc.

Chemicals – Lichens produce a wide palette of complex, sometimes unique substances, whose importance for identification is often fundamental. Some of these substances change the colour of the thallus or of the medulla under the effect of some reagents. The colour-tests are often reliable enough to distinguish among species. A table of the main reactions caused by the main lichen substances can be found in Wirth (1995).

A cheap microscope - Several lichens look alike both under the eye and the lens, they have the same chemical reactions, but they are completely different if seen - in section - under a cheap microscope. For example, *Lecidella elaeochroma* and *Arthrosporum accline* look almost identical under a lens: they both have a grey, thin crustose thallus, and black apothecia with a thin black margin. However, a section of the apothecia under a cheap microscope reveals fundamental differences: *Lecidella* has one-celled, oval spores, *Arthrosporum* has kidney-shaped, four-celled spores.

The UV-lamp. - A UV-lamp may be useful to identify some lichens, because the colour of a thallus or its medulla under UV-rays can tell a lot about their chemistry. UV-lamps are rather cheap, and not difficult to get..but be careful about your eyes!

The professional microscope - Many lichens look similar under the eye, the lens, the chemicals, the cheap microscope, and the UV-lamp...but they look different when observed under a professional microscope. This instrument can reveal such things as the exact size of the spores, the presence-absence of warts on their walls, the form of the asci and of their apical structures, the presence, size and shape of crystals in the hymenium seen under polarised light, etc. We have tried to give a low profile to such characters in these keys, but they are often indispensable for giving a correct name to many lichens. Professional microscopes are expensive. If you cannot afford to buy one, you can contact the nearest Museum of Natural History, the Departments of Biology of the nearest University, perhaps the Association of Amateurs in your village: they are likely to let you use their precious instruments.

Chromatography - Chemicals and UV lamps are helpful for understanding the chemistry of lichens. There are, however, several cases in which chromatography is the only means to identify substances which are fundamental for distinguishing among species. Thin-layer chromatography (TLC), or - even worst - gas-chromatography, are neither easy to get nor to use, although we know

several dedicated beginners which were able to set up a small TLC-lab in their private houses. The main chemicals produced by a species, while often mentioned in the descriptions, have a low profile in the keys, unless they are the only means for distinguishing among species.

The order of the main characters adopted in the keys is as follows:

- 1) Growth form: fruticose, foliose, squamulose, crustose, leprose (*bare eyes*).
- 2) General colour of thallus: dark, bright yellow to red, of any other colour (*bare eyes*).
- 3) Photobiont (cyanobacterial, chlorococcoid, trentepohlii) (*bare eyes, sometimes helped by a lens or a cheap microscope*).
- 4) Macroscopic characters such as the presence of pseudocyphellae, cilia, rhizines, whether a fruticose thallus is filamentous or not, whether the lower surface of foliose lichens is dark or pale, etc. (*bare eyes, sometimes helped by a lens*).
- 5) Presence/absence of vegetative propagules, like isidia and soredia, and their general features (*bare eyes, sometimes helped by a lens*).
- 6) Type of ascomata: apothecia (lecanorine, non-lecanorine) or perithecia (*bare eyes, sometimes helped by a lens, or a cheap microscope*).
- 7) General colour of the ascomata: dark, bright yellow to red, of any other colour (*bare eyes*).
- 8) Colour reactions of (first) thallus and (secondly) medulla, under chemicals (*bare eyes, chemicals, sometimes a cheap microscope*).
- 9) Anatomical characters such as spore shape and colour, or chemical reactions of thallus of ascocarp sections (*chemicals, cheap microscope*).
- 10) Colour of thallus and medulla as seen under a UV-lamp (*UV-lamp*).
- 11) Several, rather variable general features of the thallus, or of the ascomata, e.g. isotomic versus anisotomic ramification, form, size and shape of the areolae in crustose lichens (*bare eyes, sometimes helped by a lens*).
- 12) Detailed anatomical characters, such as chemical reactions of microscopic sections, presence size and shape of crystals in apothecial sections, fine structure of spore walls, spore size, etc. (*professional microscope*).
- 13) Presence of specific lichen substances (*chromatography*).

The present keys are not organised according to systematic criteria, and especially not by genera. FRIDA, however, can generate more “ortodox” keys, just by changing the order of characters.

The Keys

Five keys are included into this book:

There is a general key to all “terricolous” lichens known from Italy, also including some species not known from Italy but occurring in neighbouring areas, whose presence in Italy is possible. This is the most complete, but also the most difficult key. It contains dichotomies between species which will be never found together, such as lichens from the driest parts of Sicily and those restricted to the nival belt of the Alps. The total number of taxa is 439.

The general key is followed by four smaller keys (ca. 200 taxa each) obtained by connecting FRIDA with *ITALIC*, using two ecological parameters: a) altitudinal distribution, b) type of substrate (siliceous versus calcareous substrata).

Keys 1 and 2 include lichens occurring in upland areas, from the subalpine belt of the Alps (*Larix*-stands) to above treeline (Northern Italy only).

1) On acid to subneutral (acid to basic siliceous) substrata.

2) On subneutral to basic (basic siliceous to calciferous) substrata.

Keys 3 and 4 include lichens occurring from the mediterranean to the montane belt (beech forests).

3) On acid to subneutral (acid to basic siliceous) substrata.

4) On subneutral to basic, (basic siliceous to calciferous) substrata.

An ecological buffer was invoked in the production of the smaller keys: all of them include lichens occurring on intermediate, subneutral substrata. The most common and ecologically wide-ranging species were included in most keys: for example, *Squamarina cartilaginea*, very common on calciferous substrata below treeline, very rarely also occurs in the subalpine belt on basic siliceous substrata. Formally, it should occur only in keys 2 and 4. However, due to its commonness, and to the practical difficulty for beginners in distinguishing among different types of siliceous substrata, it is found in all of the simplified keys.

Tips and limitations

Here we give some explanations concerning the most important characters in the hierarchy, and some warnings about the use of the keys.

Growth-form: the traditional subdivision into fruticose, foliose, squamulose, crustose and leprose thalli has been maintained, as it is fairly efficient from the practical point of view. However, there are several species which are difficult to accommodate in any of the traditional categories. Examples are frequent among “squamulose” lichens, which include both subfruticose and subcrustose forms (e.g. *Toninia caulescens* vs. *Catapyrenium cinereum*), or among small-fruticose species which are traditionally treated among the “crustose” lichens (e.g. *Lichinella stipatula*). A beginner confronted with a fruiting *Baeomyces placophyllus* is likely to consider it as a fruticose lichen, in spite of the prominent crustose primary thallus. In such cases, different growth-forms were assigned to the same lichen: e.g. *Catapyrenium cinereum* appears both in the key of squamulose and in that of crustose lichens, *Baeomyces placophyllus* both in that of fruticose and in that of crustose lichens.

Colour: unless otherwise stated, colours refers to lichens in the dry state. Colour is a useful character, but also a very ambiguous one, especially in the case of lichens. Lichens exhibit a extremely broad and nuanced palette of “complex” colours (greenish grey, greyish green, greenish yellow, yellowish green, pale lemon yellow, yellowish brown, etc.), which often prove to be a disaster if used as diagnostic characters, people having different concepts of colours. Colours can also vary within the same species, sun-forms tending to be darker or brighter than shade-forms. In the present keys, colour is used as a discriminating character at three hierarchical levels. The first one, which plays a prominent role, is a broad distinction into three main “colour families”: a) bright-coloured, from bright yellow to orange-red; b) dark-coloured, from dark brown to black, c) of any other colour (white, pale grey, greenish, brownish, pale yellowish, etc.). This subdivision proved to work well under several tests, with the exception of the character state “dark-coloured”. For example, *Melanelia subaurifera* is “dark” with respect to *Parmelina tiliacea*, although it is much less dark than e.g. *Collema tenax*. Several species with ambiguous “general colours” appear more than one time in the

keys. The second, much lower hierarchical level is used to distinguish between lichens such as *Parmelina tiliacea* and *Flavoparmelia caperata*. They both fall under the category “neither dark, nor bright yellow to red”, but the former is grey, the latter yellowish green. The third level of the colour hierarchy is hidden in a textual note which, although rarely used in the keys, appears in the descriptions of individual species.

“Wrong” dichotomies: in our keys, the dichotomies sometimes contradict the descriptions. This happens because of characters which may be difficult to interpret, especially by beginners. For example, *Belonia* appears both among the lichens with perithecia and those with apothecia. The fruiting bodies of *Belonia* are apothecia, but they often open through a narrow pore, being similar to perithecia. In such case, the description tells the correct nature of the ascocarp.

Missing species in the general key: the general key includes all “terricolous” species hitherto known from Italy, plus a selected set of species known from neighbouring countries that are likely to occur in Italy. More terricolous species are likely to occur in Italy. Keys such as those by Poelt (1969), Ozenda & Clauzade (1970), Poelt & Vězda (1977, 1981), Clauzade & Roux (1985), Purvis et al. (1982), Wirth (1995), Ahti et al. (1999), plus the relevant literature (see Nimis 1993, and *ITALIC*) should be consulted whenever a lichen does not fit well the description.

Missing species in the simplified keys: the simplified keys refer to subsets of species delimited according to ecological and distributional criteria. Lichens, however, are broad-ranging organisms. These keys are likely to exclude several species which - albeit rarely - might occur outside their main distributional-ecological ranges. Hence, they should be used with special caution. They were thought as an aid for beginners, to be used for identification courses, under the guidance of an expert.

GENERAL KEY

Subkey 1 - Fruticose lichens

- 1 Thallus orange, K+ red 2
- 1 Thallus of other colours, K- or K+ yellow 3
- 2 Thallus not filamentous, with flattened lobes. Montane to alpine

1 - Xanthoria contortuplicata (Ach.) Boistel



Thallus fruticose to subfoliose-squamulose, orange to dirty orange, but sometimes grey in shade-forms, K+ red, C-, KC-, P-. Lobes 0.2-1 mm broad, to 4 mm long, ascending to prostrate, flattened, fragile, forming more or less compact and entangled tufts, mostly (but not always) with deeply incised margins and covered with thin transparent hairs (binocular!). Apothecia extremely rare, lecanorine. Disc orange, K+ red. Asci clavate, thickened at apex, with a broad internal beak, I+ blue in the outer part of the apex. Spores 2-celled, hyaline, ellipsoid, polar-diblastic, 8 per ascus, 10.5-12 x 6-7.5 µm. Pycnidia orange, semi-immersed in the thallus. Photobiont chlorococcoid. Note: esp. in south-facing niches and underhangs of calciferous rocks in the Alps, with optimum above treeline, sometimes on thin layers of soil; locally frequent also in the central Apennines along the Adriatic side of the peninsula (subcontinental climate).

- 2 Thallus more or less filamentous, with long, subterete branches. Restricted to humid mediterranean stands

2 - Teloschistes flavicans (Sw.) Norman



Thallus fruticose, intricately branched, orange-red to golden yellow (greenish yellow in shade-forms), attached by a single point, K+ red, C-, KC-, P-. Branches 0.5-1.5 mm thick and several cm (3-12) long, subterete, forming lax, entangled tufts, rounded to angled, glabrous or rarely sparsely pubescent, more or less dichotomously branched. Soredia granular, orange to yellowish orange, into tuberculate to elongate soralia, K+ red. Apothecia extremely rare (never found in Italian material), lecanorine. Asci clavate, bitunicate, thickened at apex with a broad internal beak, I+ blue in the outer part of the apex. Spores 2-celled, hyaline, ellipsoid, polar-diblastic, 8 per ascus. Pycnidia orange-yellow, Conidia crescent-shaped. Photobiont chlorococcoid. Note: a humid subtropical to mediterranean-atlantic lichen, found on branches and rocks, very rarely on terricolous mosses. Extremely rare, being known from a few warm-humid stands of Tyrrhenian Italy, mostly near the coast (Sardegna, island of Marettimo W of Sicilia).

- 3 Thallus dark-coloured, black to dark brown 4
- 3 Thallus not dark-coloured 12
- 4 Thallus filamentous (thread-like) 5

- 4 Thallus non filamentous, without squamules at the base (if these are present, go to option 31) 8
- 5 With cyanobacteria; branches <0.2 mm thick

3 - *Polychidium muscicola* (Sw.) Gray



Thallus small-fruticose, filamentous, brown-black, shining at least at the top of young branches, forming small cushions to 1.5 cm tall, loosely attached, K-, C-, KC-, P-. Branches smooth, slender, 20-100(-200) µm thick, narrower toward apices, divergently and dichotomously or (more rarely) palmately divided. Cortex of 1-3 layers of polygonal cells, 130(-200) µm thick. Medulla of loosely interwoven hyphae in young branches to almost paraplectenchymatous in old ones. Apothecia very rare, without a thalline margin, mostly lateral, sessile, strongly constricted, up to 2 mm diam. (usually less). Disc red-brown, concave to flat. Margin thin, smooth. Epithecium brownish, hypothecium colourless to pale brown. Paraphyses simple, distinctly thickened above. Asci clavate, with a I+ blue tholus. Spores 2-celled, hyaline, sometimes weakly pigmented when old, fusiform-elongate, 8 per ascus, (15-)18-24(-30) x 4.5-7(-11) µm. Pycnidia dark, not common. Conidia bacilliform, 1.5-3.5 x ca. 1 µm. Photobiont cyanobacterial (*Nostoc*), the cells mostly in groups, or short chains. Note: a mild-temperate to southern boreal lichen, found on soil and amongst bryophytes, more rarely on basal parts of ancient trees, mostly in sites with frequent percolation of water; widespread throughout the country, in (mostly) upland areas with siliceous substrata.

- 5 With green algae; branches >0.2 mm thick 6
- 6 Without pseudocyphellae. Medulla P-

4 - *Bryoria chalybeiformis* (L.) Brodo & D.Hawksw.



Thallus fruticose, filamentous, olive-brown to mostly black, sometimes paler towards the base, smooth, dull to somehow shiny, without lateral spinules, K-, C-, KC-, P-. Branches prostrate to more rarely ascending, isotomic-dichotomously ramified at the base, becoming anisotomic towards the apices, to 10(-15) cm long, subterete, of uneven thickness and often strongly twarved, with the main branches much thicker than the others (0.5-1.5, exceptionally to 2 mm thick). Soredia rarely present, whitish, arranged into small tuberculate soralia, P- or (rarely) P+ red. Medulla K-, C-, KC-, P- or (very rarely) P+ red. Apothecia unknown. Photobiont chlorococcoid. Without lichen substances (traces of fumarprotocetraric acid sometimes present in the soralia). Note: an arctic-alpine to boreal-montane, circumpolar lichen, found on wind-exposed siliceous rocks visited by birds, but also on soil, mosses and plant remains in exposed habitats with frequent fog, mostly near or above treeline. More common in the Alps, also known from the Gennargentu Massif in Sardegna.

- 6 With linear pseudocyphellae. Medulla P+ yellow or P+ red 7
- 7 Medulla K+ faintly yellow to reddish, KC+ red, C+ red, P+

yellowish, with alectorialic and barbatolic acids. Mostly on soil

5 - *Alectoria nigricans* (Ach.) Nyl.



Thallus fruticose, filamentous, rigid, pinkish grey to pale grey brown at the base, dark grey-brown to black at the apices, dull, forming large, loosely attached entangled mats, the medulla K+ faintly yellow to reddish, C+ red, KC+ red, P+ yellowish. Branches 0.5-1(-1.5) mm thick, ascending, anisotomic-dichotomously ramified, to 10 cm long, subterete, becoming compressed at the base. Pseudocyphellae abundant, slightly raised, linear, to 1.2 mm long. Medulla white, rather compact, K+ faintly yellow to reddish, C+ red, KC+ red, P+ yellowish. Apothecia extremely rare (never found in Italian material), lecanorine. Asci *Lecanora*-type. Spores 2 per ascus, 1-celled, broadly ellipsoid, hyaline. Photobiont chlorococcoid. With alectorialic and barbatolic acids. Note: an arctic-alpine, circumpolar species, found on ground or siliceous rocks in wind-exposed ridges, in moss-lichen heaths; restricted to the Alps in Italy, above treeline.

- 7 Medulla K-, KC-, C-, P+ red, with fumarprotocetraric acid. Mostly on bark, extremely rare

6 - *Bryoria bicolor* (Ehrh.) Brodo & D.Hawksw.



Thallus fruticose, filamentous, black at the base, often brownish black above, with olive-grey to pale brown apices, and with dark, often arcuate lateral spinules, shiny, loosely attached, K-, C-, KC-, P+ red. Branches 0.2-0.5(-0.8) mm thick, smooth, ascending. Pseudocyphellae linear. Medulla white, compact, K-, C-, KC-, P+ red. Apothecia unknown. Photobiont chlorococcoid. With fumarprotocetraric acid. Note: a mainly boreal-montane, circumpolar lichen, found esp. on mossy trunks of old, more or less isolated trees in areas with frequent fog, sometimes on mossy rocks, very rarely on terricolous bryophytes; very rare and restricted to the Alps; several Italian records need re-confirmation.

- 8 Lobes >4 mm broad. Medulla P+ yellow to orange, with fumarprotocetraric acid

7 - *Cetraria islandica* (L.) Ach.



Thallus fruticose, dark brown to pale olive-green in shade, the basal parts often reddish, loosely attached, K-, C-, KC-, P-. Lobes elongate, smooth, sometimes pitted, bifacial, ascending, flattened, up to 4 cm broad and to 10 cm tall, often sparingly branched, the margins in-rolled, with short marginal spinules bearing pycnidia. Pseudocyphellae maculiform, spread throughout the lower surface, which is generally paler than the upper surface. Medulla K-, C-, KC-, P+ yellow to orange, UV-. Apothecia extremely rare (found only once in Italian material), lecanorine. Asci *Lecanora*-type. Spores 1-celled, hyaline, ellipsoid to ovoid, 8 per ascus. Photobiont chlorococcoid. With fumarprotocetraric acid and variable amounts of protocetraric and protolichesterinic acids. Note: an arctic-alpine to boreal-montane, circumpolar lichen, found on mineral and organic soil, amongst thick moss carpets, exceptionally on bark or lignum near the ground, with optimum near treeline; very common

in the Alps, less frequent in the mountains of the south, south to Sicily.

- 8 Lobes <4 mm broad. Medulla P-, without fumarprotocetraric acid 9
9 Lobes canaliculate, with enrolled margins

8 - *Cetraria ericetorum* Opiz



Thallus fruticose, dark brown, somehow shining, loosely attached, K-, C-, KC-, P-. Lobes 0.5-3(-4)mm broad, to 8-9 cm tall (usually much less), smooth, erect, strongly channelled, curved, more or less tubular, with numerous marginal spinules bearing pycnidia, with maculiform to elongate pseudocyphellae restricted to the margins of the lower surface, which is of the same colour as the upper surface, or slightly paler. Medulla K-, C-, KC-, P-, UV-. Apothecia extremely rare (never found in Italian material), lecanorine. Asci *Lecanora*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Conidia bacilliform. Photobiont chlorococcoid. With protolichesterinic acid. Note: an arctic-alpine, circumpolar species, with optimum on wind-exposed ridges on siliceous substrata; common throughout the Alps, but much rarer than *C. islandica* in the Apennines (Abruzzi).

- 9 Lobes not canaliculate, the margins not enrolled 10
10 Medulla yellowish, C+ yellow, with secalonic acid C. Branches more or less appressed to the substratum, never forming tufts. Restricted to above treeline

9 – *Cetraria obtusata* (Schaer.) Van den Boom & Sipman



Thallus fruticose, matt to glossy, brown, loosely attached, K-, C-, KC-, P-. Branches 0.3-1(-2) mm broad, dichotomously to irregularly branched, without main stems, terete to somehow flattened, ascending or mostly appressed to the substratum, with obtuse tips. Pseudocyphellae rounded, punctiform, often surrounded by black projections. Medulla arachnoid, lax, pale yellow, K-, C+ yellow, KC+ yellow, P-, UV-. Apothecia unknown. Pycnidia dark, brought on spinulose outgrowths up to 1 mm long and 0.1 mm thick. Conidia clavate, 6-7 x 1-1.5 µm. Photobiont chlorococcoid. With secalonic acid C, and two unidentified substances. Note: restricted to above treeline in the Alps, in dry-continental situations, esp. in snow-beds; to be looked for throughout the Italian Alps, in areas with siliceous substrata.

- 10 Medulla white, C-, with lichesterinic and protolichesterinic acids. Branches ascending, forming tufts. From the lowlands to above treeline 11
11 Branches flattened, uneven, to ca. 1 mm diam., branching open and coarse; pseudocyphellae concave, elongate

10 - *Cetraria aculeata* (Schreb.) Fr.

Thallus fruticose, matt to glossy brown, shrubby, very stiff and brittle, loosely attached, K-, C-, KC-, P-. Branches 0.5-1 mm broad,



to ca. 4 cm tall, flattened, uneven, with open and coarse dichotomous branching; pseudocyphellae scanty, maculiform, concave, elongate. Medulla white, lax and web-like to hollow, K-, C-, KC-, P-, UV-. Apothecia extremely rare (not seen in Italian material), lecanorine, sessile. Asci *Lecanora*-type. Spores 1-celled, hyaline, ellipsoid, 6-8 per ascus. Pycnidia dark, at the top of the branches. Conidia bacilliform. Photobiont chlorococcoid. With lichesterinic and protolichesterinic acids. Note: on siliceous, often sandy mineral soil in clearings of *Calluna*-heaths in wind-exposed situations; see also note to the next species.

- 11 Branches rounded, even, delicate, to ca. 0.5 mm diam., branching dense and spinulose; pseudocyphellae flat, circular

11 - *Cetraria muricata* (Ach.) Eckfeldt



Thallus fruticose, matt to glossy brown, fragile, shrubby, loosely attached, K-, C-, KC-, P-. Branches more or less rounded, even, delicate, to ca. 0.5 mm diam., 1-4 cm tall, branching dichotomously, dense and spinulose; pseudocyphellae maculiform, flat, circular. Medulla white, K-, C-, KC-, P-, UV-. Apothecia extremely rare (not seen in Italian material), lecanorine, sessile. Asci *Lecanora*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Pycnidia dark, at the top of the branches. Conidia bacilliform. Photobiont chlorococcoid. With protolichesterinic acid. Note: optimum on wind-exposed siliceous ridges above treeline; the distinction from *C. aculeata* is not always clear; esp. in the south there are specimens which are difficult to assign to either taxon.

- 12 Thallus filamentous (thread-like) 13
 12 Thallus non filamentous 14
 13 Thallus not greenish, K+ yellow, KC+ red, C+ red, with alectorialic and barbatolic acids

see 5 - *Alectoria nigricans* (Ach.) Nyl.

- 13 Thallus greenish at least in part, K-, CK+ yellowish, C-, with diffractaic acid

12 - *Alectoria ochroleuca* (Hoffm.) A.Massal.



Thallus fruticose, more or less filamentous and shrubby, rigid, greenish grey to yellowish green, the apices concolour or blackened, matt, the medulla K-, C-, CK+ yellowish, P-, UV-. Branches 1-2(-3) mm thick, stiff, elongate, prostrate to ascending, anisotomic-dichotomously ramified, to 13 cm long, the apices sometimes drooping. Pseudocyphellae numerous, linear, longitudinally oriented, raised, to ca. 1 mm long. Medulla white, compact, K-, C-, KC-, P-, UV-. Apothecia extremely rare (not seen in Italian material), lecanorine. Epithecium brown. Asci *Lecanora*-type. Spores 1-celled, 2-4 per ascus, broadly ellipsoid, pigmented when old. Pycnidia dark, semi-immersed. Conidia bacilliform. Photobiont chlorococcoid. With diffractaic acid. Note: an arctic-alpine, circumpolar species, found on windy ridges in moss-lichens heaths, more frequent on siliceous substrata, but sometimes also

occurring in areas with dolomite; restricted to the Alps and the northern Apennines in Italy, mostly above treeline.

- 14 Thallus thin, flat in section 15
- 14 Thallus thick, inflated to round in section 17
- 15 Thallus grey, with prominent marginal cilia

13 - *Anaptychia ciliaris* (L.) Körb.



Thallus subfoliose to subfruticose, grey to grey-brown, lead grey to almost blackish in sun-forms, somehow shrubby, loosely attached, K-, C-, KC-, P-, UV-. Lobes (2-)3-6 mm broad, several cm long, linear, sometimes densely and finely tomentose, with prominent marginal cilia. Lower surface whitish to (rarely) whitish, channelled, ecorticate. Upper cortex prosoplectenchymatous. Apothecia frequent, rounded, lecanorine, substipitate and strongly constricted, up to 8 mm diam. Disc black, often faintly pruinose. Margin grey to grey brown, smooth to crenulate. Epithecium brown. Hymenium and hypothecium colourless. Paraphyses mostly simple. Asci *Lecanora*-type, thick-walled, the apex I+ blue with a wide, divergent axial body. Spores 2-celled, pigmented, ellipsoid, constricted at septa, thin-walled (*Physconia*-type), ornamented, 8 per ascus, 30-45 x 17-24 µm. Pycnidia dark, semi-immersed. Conidia short-bacilliform. Photobiont chlorococcoid. Without lichen substances. Note: a mild-temperate species, found on bark of more or less isolated trees, more rarely on rock and amongst terricolous mosses in open situations; locally common in the Apennines and on the islands south of Marche, much rarer - and almost menaced of extinction- in the North.

- 15 Thallus cream-coloured, without marginal cilia (if thallus pale brown, go back to option 8) 16
- 16 Thallus smooth, lobes channelled, deep red-purple at the base

14 - *Flavocetraria cucullata* (Bellardi) Kärnefelt & Thell



Thallus fruticose, cream-coloured, deep red-purple to violet at the base, loosely attached, K-, C-, KC+ yellowish, P-. Lobes smooth, channelled (cucullate), ascending, 2-4(-8) cm tall, to 5 mm broad (usually less in Italian material), sometimes forming compact mats, the edge with dark, short, spinulose pycnidia. Underside corticate, with narrow pseudocyphellae along the edges. Medulla K-, C-, KC+ yellowish, P-, UV-. Apothecia extremely rare, lecanorine. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Photobiont chlorococcoid. With usnic and protolichesterinic acids. Note: a circumpolar, arctic-alpine lichen, a typical element of tundra-like vegetation of open, dry habitats above treeline; most frequent in the Alps on basic siliceous substrata, in wind-exposed ridges.

- 16 Thallus reticulate-sulcate, lobes not channelled, yellowish brown at the base

15 - *Flavocetraria nivalis* (L.) Kärnefelt & Thell

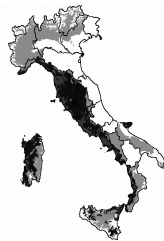
Thallus fruticose, cream-coloured, yellowish brown at the base,



loosely attached, K-, C-, KC-, P-. Lobes 6-10 mm broad (usually narrow in Italian material), reticulate-sulcate, ascending, 2-4 (-8) cm tall, often forming compact mats. Underside with scattered white pseudocyphellae. Medulla K-, C-, KC+ yellowish, P-, UV-. Apothecia extremely rare, lecanorine. Asci *Lecanora*-type. Spores 1-celled, hyaline, ellipsoid or with one end thicker, 8 per ascus. Photobiont chlorococcoid. With usnic and protolichesterinic acids. Note: a circumpolar, arctic-alpine lichen, typical of tundra-like vegetation in open, dry habitats above treeline; common throughout the Alps, this species is surprisingly abundant on the Gran Sasso Massif (Campo Imperatore, Gran Sasso Massif, C Apennines).

- 17 Thallus without a central cavity (section!) 18
- 17 Thallus with a central cavity 31
- 18 Thallus (fruticose thallus parts) densely covered by greenish soredia-like granules or by grey small scale-like structures (phyllocladia) 19
- 18 Thallus (fruticose thallus parts) erect, naked 25
- 19 Thallus small, subleprose, covered by greenish, soredia-like, ecorticate granules; branches <0.3 mm diam.

16 - *Leprocaulon microscopicum* (Vill.) Gams



Thallus small-fruticose, consisting of a dense mass of delicate, loosely attached, white pseudopodetia densely covered by bluish-green to yellowish-green, leprose-arachnoid, ecorticate granules 35-100 µm in diam., the whole forming a subleprose crust when seen from above, K-, C-, KC- or KC+ yellowish, P-. Primary thallus leprose-granulose. Pseudopodetia 0.1-0.3 mm thick, 2-6 mm long, cylindrical, entangled to ascending, simple or sparingly branched near the top, with a whitish central axis composed by parallel hyphae, and an outer mantle of loosely interwoven hyphae. Apothecia unknown. Photobiont chlorococcoid. With usnic acid and zeorin, plus some unidentified accessory substances. Note: a mainly mild-temperate to mediterranean lichen, found on basic siliceous rocks covered by a thin film of soil; very common on brick walls in archaeological areas of Tyrrhenian Italy, where it is also found on bark (e.g. of *Olea*), extremely rare along the E side of the peninsula, exceptionally reaching the montane belt in warm, S-exposed sites of the W Alps.

- 19 Thallus stout, clearly fruticose, densely covered by coarse, whitish to grey, corticate scale-like structures (phyllocladia); branches >0.3 mm diam. 20
- 20 Thallus P+ orange, with stictic acid. Podetia tomentose, on soil (if podetia naked, firmly attached to the rock: *Stereocaulon vesuvianum* Pers.)

17 - *Stereocaulon tomentosum* Fr.

Thallus fruticose, whitish grey, densely covered by wart-like to



squamulose phyllocladia, loosely attached, with cephalodia, K+ yellow to yellow-orange, C-, KC-, P+ orange. Primary thallus ephemeral. Pseudopodetia elongate, prostrate to ascending, terete, tomentose, clearly dorsiventral. Phyllocladia abundant, granulose to squamulose, ash-grey, mostly rounded and flattened, often overlapping. Cephalodia inconspicuous, more or less spherical, to 0.7 mm broad (usually less), hidden by the tomentum of the underside, with *Nostoc*. Apothecia frequent, without a thalline margin, to 0.6 mm diam. Disc dark brown to blackish brown, convex. Margin indistinct. Paraphyses simple, slightly thickened above, with dark cap. Asci clavate to cylindrical. Spores 4(-8)-celled, hyaline, fusiform, 8 per ascus, 20-50 x 8-10 μm . Pycnidia dark, immersed. Conidia filiform, straight. Photobiont chlorococcoid. With atranorin, stictic acid and variable amounts of norstictic acid. Note: a mainly boreal-montane, circumpolar lichen, found on mineral soil in open habitats, such as clearings of *Pinus*-stands. Restricted to the Alps in Italy

- 20 Thallus P- or P+ yellow, without stictic acid 21
- 21 Crustose primary thallus persistent, consisting of more or less scattered phyllocladia (This character may be difficult to appreciate if you have collected only the fruticose thallus parts. If you are uncertain, check descriptions until option 24, esp. whether the pseudopodetia are tomentose and dorsiventral or not). 22
- 21 Crustose primary thallus disappearing. 23
- 22 Pseudopodetia non tomentose, loosely attached. Cephalodia with *Stigonema* (microscopic section!), dark brown, with a rough surface. Apothecia frequent

18 - *Stereocaulon condensatum* Hoffm.



Thallus fruticose, grey, densely covered by squamulose, lobulate phyllocladia, loosely attached, with cephalodia, K+ yellow, C-, KC-, P- or P+ yellowish. Primary thallus persistent, of warty or incised-elongate phyllocladia with abundant interspersed cephalodia. Pseudopodetia elongate, prostrate to ascending, terete, to 1.5 (-3) cm tall, 0.5-1 mm thick, simple or sparingly branched. Phyllocladia small, wart-like to incised, horizontal, greyish white. Cephalodia abundant, with *Stigonema*, dark reddish brown, with a rough surface, 1-1.5 mm diam. Apothecia frequent, rounded, without a thalline margin, terminal, 1-2 mm diam. Disc dark brown, convex. Margin indistinct, thin. Paraphyses simple, slightly thickened above, with dark cap. Spores 4-celled, hyaline, fusiform, 8 per ascus, 22-40 x 2.5-3 μm . Pycnidia dark, immersed in the basal phyllocladia. Conidia filiform, straight or slightly curved. Photobiont chlorococcoid. With atranorin and variable amounts of lobaric acid. Note: a cool-temperate to boreal-montane, circumpolar lichen, found on sandy to gravelly, often disturbed soil in open situations; probably restricted to the Alps in Italy, and often associated with *Pycnothelia*.

- 22 Pseudopodetia tomentose, firmly attached. Cephalodia with *Nostoc* (microscopic section!), brown to bluish green, with a smooth surface. Apothecia rare

19 - *Stereocaulon glareosum* (Savicz) H.Magn.



Thallus fruticose, grey, densely covered by squamulose, lobulate phyllocladia, loosely attached, with cephalodia, K+ yellow, C-, KC-, P- or P+ yellowish. Primary thallus persistent, consisting of dense clusters of phyllocladia. Pseudopodetia elongate, sparingly branched, ascending, terete, entirely white tomentose, dispersed or forming tufts, firmly attached, 1-2.5 cm tall, the base to 1 mm thick, tapering to 0.5 mm at the apices. Phyllocladia abundant, esp. below, cylindrical or papilliform, 0.3-1 mm long. Cephalodia abundant on the branches, verruciform to globose, with *Nostoc*, brown to bluish green, with a smooth surface. Apothecia rare, without a thalline margin, terminal. Disc dark brown, convex. Margin indistinct, thin. Paraphyses simple, slightly thickened above, with dark cap. Spores 4-celled, hyaline, fusiform, 8 per ascus, 22-42 x 2.5-3.5 μ m. Pycnidia dark, immersed. Conidia cylindrical-fusiform, slightly curved. Photobiont chlorococcoid. With atranorin and lobaric acid. Note: an arctic-alpine to boreal-montane, probably circumpolar lichen, found on sandy or gravelly ground, such as on banks of streams and in snow-beds; reported only from the Dolomites (Veneto), but probably more widespread in the Italian Alps.

- 23 Pseudopodetia not dorsiventral, without an evident upper and lower surface

20 - *Stereocaulon incrustatum* Flörke



Thallus fruticose, grey, densely covered by granulose phyllocladia, loosely attached, with cephalodia, K+ yellow, C-, KC-, P- or P+ yellowish. Primary thallus ephemeral, of small granules. Pseudopodetia elongate, terete, densely tomentose, forming thick to loose tufts, prostrate to ascending at the periphery, erect in the centre, 1-3 cm tall, 0.8-1.2 mm thick. Phyllocladia irregularly distributed, thicker at the apices, whitish to bluish grey, verruciform and very small, often hidden by the tomentum, <0.2 mm in diam. Cephalodia bluish green, with *Nostoc*, globose, localised in the parts free from phyllocladia, often covered by the tomentum, to 2 mm broad. Apothecia frequent, without a thalline margin, terminal, to 2 mm broad. Disc dark brown, convex. Margin indistinct, thin. Paraphyses simple, slightly thickened above, with dark cap. Spores 4-celled, hyaline, fusiform, 8 per ascus, 35-44 x 2.5-3 μ m. Pycnidia dark, immersed. Conidia bacilliform. Photobiont chlorococcoid. With atranorin and variable amounts of lobaric acid. Note: an arctic-alpine to boreal-montane, circumpolar lichen, found on mineral, nutrient-poor soil, in *Pinus*-woodlands, in the vicinity of glaciers and by rivers; restricted to the siliceous Alps in Italy.

- 23 Pseudopodetia dorsiventral, the upper surface looking different from the lower one

24

- 24 Cephalodia bluish green. Pseudopodetia not very brittle when dry

21 - *Stereocaulon alpinum* Laurer



Thallus fruticose, grey, densely covered by phyllocladia, loosely attached, with cephalodia, K+ yellow, C-, KC-, P+ yellow. Primary thallus ephemeral. Pseudopodetia elongate, prostrate to mostly ascending, terete, with whitish to pale pink tomentum esp. on the lower surface, 1-4 cm tall, 0.5-1(-2) mm thick at the base, sparingly branched. Phyllocladia crowded towards the apices, whitish-grey, first granuliform or united, then somehow flattened and minutely lobate, ca. 0.5 mm broad. Cephalodia mainly on the lower side and partly hidden by the tomentum, globose, 0.3-0.8 mm broad, bluish green, with *Nostoc*. Apothecia frequent, without a thalline margin, terminal. Disc dark brown, convex. Margin indistinct, thin. Paraphyses simple, slightly thickened above, with dark cap. Spores 4-celled, hyaline, cylindrical with one end narrower, 8 per ascus, 27-38 x 2.5-3 μ m. Pycnidia dark, immersed. Conidia bacilliform, straight. Photobiont chlorococcoid. With atranorin and lobaric acid. Note: an arctic-alpine, circumpolar early coloniser of more or less mineral, siliceous soil; restricted to the Alps in Italy, where it is rather frequent.

- 24 Cephalodia violet brown, small, with a rough surface. Pseudopodetia brittle when dry. On gravel and sand along rivers.

22 - *Stereocaulon rivulorum* H.Magn.



Thallus fruticose, grey, densely covered by phyllocladia, loosely attached, with cephalodia, K+ yellow, C-, KC-, P- or P+ yellowish. Primary thallus ephemeral. Pseudopodetia elongate, ascending, terete, tomentose, very brittle when dry, forming low lax tufts, 0.5-1.2 mm thick sparingly branched sometimes with no distinct main axis. Phyllocladia glaucous white, granular to elongate, broader at the apices, dispersed in groups along the pseudopodetia which are partly naked. Cephalodia not frequent, on the underside, with *Nostoc*, inconspicuous, violet brown, tubercular to slightly elongate, with a rough surface. Apothecia frequent, without a thalline margin, terminal. Disc dark brown, convex. Margin indistinct, thin. Paraphyses simple, slightly thickened above, with dark cap. Spores 4-celled, hyaline, fusiform, 8 per ascus, 20-30 x 4-5 μ m. Pycnidia dark, immersed. Conidia cylindrical, straight or slightly curved, 6-8 x 1 μ m. Photobiont chlorococcoid. Note: an arctic-alpine lichen, found on siliceous gravel and sand in snow-beds or on banks of streams near glaciers; sometimes on weakly calciferous schist; restricted to the Alps in Italy.

- 25 With conspicuous pseudocyphellae. An extremely rare species.



23 - *Aspicilia hispida* Mereschk.

Thallus fruticose, greenish to brownish grey, smooth, loosely attached to vagrant, K-, C-, KC-, P-, UV-. Branches 0.3-1 mm thick, elongate, ascending, generally no more than 2.5 cm tall, irregularly ramified, often contorted. Pseudocyphellae maculiform, elongate. Photobiont chlorococcoid. Without lichen substances. Note: a widespread species of dry, steppe-like areas, with a disjunct distribution in the most continental parts of the Iberian Peninsula,

recently found in the mountains of Greece, and in the W Alps; certainly extremely rare in Italy.

- 25 Without pseudocyphellae 26
- 26 Thallus (fruticose thallus parts) mostly sterile, >1.5 cm tall. Crustose primary thallus absent 27
- 26 Thallus mostly fertile, consisting in short erect stipes bearing apothecia, <1.5 cm tall. Crustose primary thallus present 28
- 27 Thallus greenish, soft. Medulla lax. Branches >1 mm thick. With protolichesterinic acid, without sphaerophorin

24 - *Allocetraria madreporiformis* (Ach.) Kärnefelt & Thell



Thallus fruticose, greenish to yellowish green, sometimes browned in the sun, shrubby, K-, C-, KC- P-. Branches ascending, subterete, to 5 cm tall and to 2 mm thick, soft, cylindrical, foveolate, branching sparsely isotomic-dichotomously from near the base to form tufts. Medulla lax, P-. Apothecia extremely rare (not seen in Italian material), lecanorine. Spores 8 per ascus, one-celled, thick-walled, spherical, ca 10 µm in diam. Pycnidia dark, immersed. Conidia filiform, slightly curved, 13-20 x 0.5 µm. Photobiont chlorococcoid. With protolichesterinic acid. Note: an arctic-alpine species, found in open grasslands and in wind-exposed ridges above treeline, widespread but extremely rare throughout the Alps, and also known from the Gran Sasso Massif in the C Apennines.

- 27 Thallus whitish grey, rigid. Medulla compact. Branches <1 mm thick. With sphaerophorin, without usnic acid

25 - *Sphaerophorus fragilis* (L.) Pers.



Thallus fruticose, pale whitish grey to grey-brownish, shrubby, K-, C-, KC-, P-, UV+ blue. Branches 0.5-1 mm thick, smooth, ascending, subterete, scarcely isotomic-dichotomously ramified (main branches not differentiated, hence branches of the same thickness), forming dense tufts to 4-5 cm tall (usually less). Medulla K-, C-, KC-, P-, I-. Apothecia extremely rare, terminal. Disc black. Asci cylindrical, disintegrating early, producing a mass of spores (maezedium) which accumulates on the surface. Spores 1-celled, pigmented, globose, thick-walled, ornamented, 8-10 µm in diam. Photobiont chlorococcoid. With sphaerophorin, and variable amounts of hypothamnolic and squamatic acids. Note: an arctic-alpine to boreal-montane, circumpolar lichen of siliceous rocks and mineral soil in very rainy areas, restricted to the Alps in Italy, where it is very rare.

- 28 Crustose primary thallus with evident (to 6 mm broad), radiating marginal lobes

26 - *Baeomyces placophyllus* Ach.

Primary thallus crustose, glaucous grey-green, thick, forming rosettes, the centre squamulose, with radiating marginal lobes, often covered by peltate, pale-coloured, fragile, mostly marginal schizidia



to 0.2 mm diam., K+ yellow, C-, KC+ orange, P+ orange. Marginal lobes to 6 mm broad, flattened, contiguous, raised at the tips. Medulla P+ orange, UV+ orange. Apothecia frequent, without a thalline margin, terminal, brought on short, smooth, subfruticose stipes, to 6 mm tall and 2 mm thick. Disc ochraceous to reddish brown, flat, the margin often reflexed, to 4-5 mm broad. Epihymenium yellowish brown. Hymenium colourless, I-. Paraphyses slender, simple or sparingly branched towards the tips, not anastomosing. Asci cylindrical, unitunicate, thin-walled, the apex truncate, I-. Spores 1(-2)-celled, hyaline, fusiform, 8 per ascus, 8-14 x 2-4 μm . Photobiont chlorococcoid. With stictic acid. Note: an arctic-alpine to boreal-montane, probably circumpolar lichen, found on sandy-clay soil in open stands (e.g. montane-subalpine grasslands), often in moderately disturbed habitats, sometimes reaching the Alpine belt. Probably restricted to the Alps in Italy, but to be looked for also in the highest siliceous mountains of the Apennines.

28 Primary thallus without marginal lobes

29

29 Thallus K+ yellow rapidly changing to blood-red. Very rare

27 - *Baeomyces carneus* Flörke



Primary thallus crustose to squamulose, grey-green to dull greenish, K+ yellow changing to red, C-, KC+ yellow, P+ orange. Areolae (squamules) flat to convex, contiguous, 0.2-2 mm long, 0.2-0.7 mm broad, more or less schizidiolate, the margin crenulate. Medulla P+ orange, UV-. Apothecia frequent, without a thalline margin, terminal, stipitate, to 2 mm broad, the stipes to 5 mm tall. Disc reddish brown, flat to more frequently convex, K+ rapidly blood-red (needle-like red crystals are soon formed in a microscopic section). Paraphyses slender, simple to slightly branched at the tips. Hymenium colourless, usually thin. Asci unitunicate, cylindrical, thin-walled, the apex truncate, I-. Spores hyaline, fusiform, 8 per ascus, 1(-2)-celled, 3-11 x 2-2.8 μm . Photobiont chlorococcoid. With norstictic acid. Note: a mainly boreal-montane, perhaps circumpolar, rather poorly known lichen, found on soils high in clay and on weathered siliceous rocks, exceptionally also on acid bark. Known only from Lombardia (an old record by Anzi, which needs re-confirmation, see Nimis 1993: 118), and certainly restricted to the Alps in Italy, where - if really present - it is extremely rare.

29 Thallus K+ yellow, often slowly changing to red. More common

30

30 Apothecia brownish, concave to flat and marginate at first, later swollen and with reflexed margin. Thallus and medulla UV-. Asci I-. With stictic acid, and variable amounts of norstictic and constictic acids

28 - *Baeomyces rufus* (Huds.) Rebert.

Primary thallus crustose, grey-green to dull greenish white, thick, areolate, K+ yellow, C-, KC+ yellow, P+ orange-yellow, UV-. Areolae convex, contiguous, to 1 mm broad, with a warty to smooth cortex, often powdery sorediate, the soredia greenish grey.



Schizidia present occasionally, <0.2 mm diam., disc-like. Medulla UV-. Apothecia frequent, without a thalline margin, somehow flattened, terminal, brought on erect, subfruticose, smooth, flattened to subcylindrical, often longitudinally fissured stipes 2-4(-6) mm tall. Disc red brown, flat to convex, the margins often in-rolled, most often fissured, to 2.5 mm diam., single or coalescing. Paraphyses simple to poorly branched above, slender, 1-1.8 μ m thick. Asci unitunicate, cylindrical, thin-walled, the apex truncate, I-. Spores 1-(2-)celled, hyaline, fusiform, 8 per ascus, 8-13 x 2.5-4.5 μ m. Pycnidia rare. Conidia bacilliform. Photobiont chlorococcoid. With stictic acid, and variable amounts of norstictic and constictic acids. Note: a holarctic early coloniser of acid soils with high clay content and of weathered siliceous rocks, often found in disturbed sites; mostly sterile in upland areas. Throughout Italy, mostly in the mountains.

- 30 Apothecia pink-coloured, soon swollen and without margin. Thallus and medulla UV+ orange. Asci I+ blue. With baeomycesic acid, and variable amounts of squamatic acid and atranorin

29 - *Dibaeis baeomyces* (L. fil.) Rambold & Hertel



Primary thallus crustose, grey, white or pale pinkish, thick, areolate, usually with soft, rounded, white to pale pink, more or less shiny, warty schizidia which reach 1 mm diam. in sterile thalli, K+ yellow, C-, KC+ yellow, P+ yellow to orange, UV+ orange. Areolae convex, contiguous. Medulla P+ yellow to orange, UV+ orange. Apothecia frequent, globose also when young, pink-coloured, 1-4 mm broad, emarginate or with a narrow margin, brought on erect, subfruticose, smooth stipes (podetia), 2-5 mm tall and to 3 mm in diam. Hymenium I+ pale blue (reaction ephemeral!). Hypothecium colourless. Paraphyses simple, not anastomosing, only slightly thickened above. Asci unitunicate, cylindrical, thin-walled, slightly thickened above, I+ blue, the tip deep blue. Spores hyaline, mainly 1-celled (some spores 2-celled), fusiform, 8 per ascus, 10-26 x 2-3 μ m. Pycnidia immersed in warts, mostly laminal. Conidia shortly bacilliform. Photobiont chlorococcoid. With baeomycesic acid, and variable amounts of squamatic acid and atranorin. Note: on humid, disturbed clay soil, often in *Calluna*-heaths, mostly sterile near or above treeline; most frequent in the north, to be looked for further on the siliceous mountains of the C and S Apennines.

- 31 Thallus densely ramified, shrub-like 32
 31 Thallus not or scarcely ramified, never shrub-like 53
 32 Podetia without cortex (surface arachnoid under a strong lense) and without squamules. Primary thallus crustose, ephemeral and rarely seen 33
 32 Podetia with cortex, with or without squamules. Primary thallus mostly evident, squamulose 41

- 33 Thallus K+ yellow 34
 33 Thallus K- 35
 34 Pycnidial jelly colourless (microscope!), bases of podetia not black, or, if black, without white spots. Common in the Alps

30 - *Cladonia rangiferina* (L.) F.H.Wigg.



Thallus fruticose, ash-grey, shrubby, loosely attached, K+ yellow, C-, KC-, P+ red, UV-. Primary thallus crustose, ephemeral and rarely seen, consisting of thin subglobose verruculae 0.2-0.4 mm diam. Podetia anisotomically (i.e. main branches thicker)-tetrachotomously ramified, 4-13 cm tall and to 2(-3) mm in diam., ecorticate. Tips of ramifications mostly bent to one side, situated around an open axil. Apothecia rare, terminal, brown, convex. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Pycnidia dark, semi-immersed, on the tips of podetia; pycnidial jelly colourless. Conidia cylindrical. Photobiont chlorococcoid. With fumarprotocetraric acid and atranorin. Note: a circumpolar, arctic-alpine lichen, one of the most abundant elements of lichen-rich tundra-like vegetation on mineral soil in exposed habitats; common only in the Alps, but also known from the highest siliceous mountains of Sardegna.

- 34 Pycnidial jelly reddish (microscope!), bases of podetia black, with scattered white spots. Very rare in the Alps, restricted to bogs.

31 - *Cladonia stygia* (Fr.) Ruoss



Thallus fruticose, grey, shrubby, loosely attached, K+ yellow, C-, KC-, P+ red, UV-. Primary thallus crustose, ephemeral. Podetia anisotomically (i.e. main branches thicker)-tetrachotomously ramified 4-10 cm tall, to 2 mm in diam., ecorticate. Tips of ramifications mostly bent to one side, situated around an open axil. Bases of podetia black, with scattered white spots. Apothecia rare, terminal, brown, convex. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Pycnidia dark, semi-immersed, on the tips of podetia; pycnidial jelly reddish. Conidia cylindrical. Photobiont chlorococcoid. With fumarprotocetraric acid and atranorin. Note: a rare, declining, subarctic-subalpine species of *Sphagnum* bogs. Known only from Val d'Aosta.

- 35 Thallus P+ yellow

32 - *Cladonia arbuscula* (Wallr.) Flot. subsp. *arbuscula*



Thallus fruticose, pale yellowish white, shrubby, loosely attached, K-, C-, KC+ yellow, P+ yellow, UV-. Primary thallus crustose, ephemeral and rarely seen, consisting of subglobular verruculae 0.10-1.5 mm diam. Podetia anisotomically (i.e. main branches thicker)-tetrachotomously ramified, ecorticate, 4-10 cm tall, richly branched, with terminal branches strongly orientated in one direction, young apices blunt, and axils open. Apothecia rare, terminal, brown, convex. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Pycnidia dark, semi-immersed, on the tips of podetia. Conidia cylindrical. Photobiont chlorococcoid.

With fumarprotocetraric, usnic and psoromic acid. Note: the species taken in a broad sense has a circumpolar, boreal-subarctic-subalpine distribution, and is one of the most abundant elements of lichen-rich tundra-like vegetation on mineral soil in exposed habitats; in Italy the typical subspecies is probably very rare (the map refers to the three subspecies together); see also notes on the other subspecies.

- 35 Thallus P+ red, or P- 36
 36 Thallus P+ red, with fumarprotocetraric acid 37
 36 Thallus P-, without fumarprotocetraric acid 38
 37 Mostly below treeline. Ramifications mainly dichotomous. Thallus yellowish to grey

33 - *Cladonia ciliata* Stirt.



Thallus fruticose, pale yellowish to grey, shrubby, K-, C-, KC- or KC+ yellow, P+ red, UV-. Primary thallus crustose, ephemeral and rarely seen. Podetia anisotomically (i.e. main branches thicker)-dichotomously ramified, ecorticate, 4-7 cm tall, with main branches thicker and pointed apices orientated in one direction. Apothecia rare, brown, convex. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Pycnidia dark, semi-immersed, on the tips of podetia; pycnidial jelly red. Conidia cylindrical. Photobiont chlorococcoid. With two chemotypes: a) with fumarprotocetraric and occasionally with traces of usnic acid (thallus grey), b) with fumarprotocetraric and usnic acid (thallus yellowish). All Italian records refer to the latter (var. *tenuis*). Note: a humid-temperate species, found on mosses in shrublands, esp. in maquis vegetation. Extremely rare in Italy, and restricted to humid, undisturbed areas.

- 37 Mostly near or above treeline. Ramifications mainly tetrachotomous. Thallus yellowish, never grey

34 - *Cladonia arbuscula* (Wallr.) Flot. subsp. *squarrosa* (Wallr.) Ruoss



Thallus fruticose, pale yellowish white, shrubby, loosely attached, K-, C-, KC+ yellow, P+ red, UV-. Primary thallus crustose, ephemeral and rarely seen, consisting of subglobular verruculae 0.10-1.5 mm diam. Podetia anisotomically (i.e. main branches thicker)-tetrachotomously ramified, ecorticate, 4-10 cm tall, richly branched, with terminal branches strongly orientated in one direction, young apices blunt, and axils open. Apothecia rare, terminal, brown, convex. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Pycnidia dark, semi-immersed, on the tips of podetia. Conidia cylindrical. Photobiont chlorococcoid. With fumarprotocetraric and usnic acids, without psoromic acid. Note: this is the most widespread representative of the *C. arbuscula* complex in the Alps; also known from the highest siliceous mountains of Sardegna.

- 38 Mediterranean to submediterranean (very rare species) 39
 38 Subalpine to alpine 40

- 39 Ramifications mainly dichotomous. Thallus yellowish. Restricted to humid, undisturbed, mediterranean stands. Without perlatolic acid, with usnic acid

35 - *Cladonia mediterranea* P.A.Duvign. & Abbayes



Thallus fruticose, pale yellowish, shrubby, loosely attached, K-, C-, KC+ yellow, P-. Primary thallus crustose, ephemeral and rarely seen, consisting of subglobular verruculae. Podetia anisotomically (i.e. main branches thicker)-dichotomously ramified, 4-10 cm tall, non squamulose, ecorticate. Tips of ramifications mostly spreading in all directions, axils open. Apothecia rare, brown, convex. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Pycnidia dark, semi-immersed, on the tips of podetia. Conidia cylindrical. With usnic acid. Photobiont chlorococcoid. Note: a mediterranean-macaronesian lichen, found almost always amongst pleurocarpous mosses in sheltered situations with plenty of diffuse light; presently restricted to a few very humid sites along the Tyrrhenian coast, and perhaps in danger of extinction.

- 39 Ramifications mainly trichotomous. Thallus grey. Mainly submediterranean. With perlatolic acid

36 - *Cladonia portentosa* (Dufour) Coem.



Thallus fruticose, pale grey, shrubby, K-, C-, KC- or KC+ yellowish, P-, UV+ white. Primary thallus crustose, ephemeral and rarely seen, consisting of subglobular verruculae. Podetia anisotomically (i.e. main branches thicker)-trichotomously ramified, 4-10 cm tall, ecorticate. Tips of ramifications mostly spreading in all directions, axils open. Apothecia rare, brown, convex. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Pycnidia dark, semi-immersed, on the tips of podetia. Conidia cylindrical. Photobiont chlorococcoid. With perlatolic and traces of usnic acids. Note: a mainly cool-temperate, western species, found on acid soil in open situations, such as in *Calluna*-heaths; probably more frequent in the past, presently extremely rare, and extinct in many parts of the country.

- 40 Main branches much thicker than lateral ones. Top of podetia not dome-shaped

37 - *Cladonia arbuscula* (Wallr.) Flot. subsp. *mitis* (Sandst.) Ruoss



Thallus fruticose, pale yellowish white, shrubby, K-, C-, KC+ yellow, P-, UV-. Primary thallus crustose, ephemeral. Podetia anisotomically (i.e. main branches thicker)-tetrachotomously ramified, 4-15 cm tall, ecorticate; branches generally - not always - not strongly orientated in one direction; axils open. Apothecia very rare, brown, convex. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Pycnidia dark, semi-immersed, on the tips of podetia. Conidia cylindrical. Photobiont chlorococcoid. With usnic and rangiformic acids, rarely also fumarprotocetraric acid. Note: probably restricted to the Alps; more common at higher altitudes than the typical subspecies, but less frequent than subsp. *squarrosa*.

- 40 Most branches of the same thickness. Top of podetia regularly dome-shaped

38 - *Cladonia stellaris* (Opiz) Pouzar & Vězda



Thallus fruticose, pale yellowish white, shrubby, K-, C-, KC+ yellow, P-. Primary thallus crustose, ephemeral and rarely seen, of dispersed granules 0.15-0.3 mm diam. Podetia isotomically-tetrachotomously ramified, 4-10(-15) cm tall, non squamulose, ecorticate, with most branches of the same thickness, forming compact, rounded, subglobose heads (top of podetia regularly dome-shaped). Axils open. Apothecia very rare, brown, convex. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Pycnidia dark, semi-immersed, on the tips of podetia, with a reddish jelly. Conidia cylindrical. Photobiont chlorococcoid. With usnic acid, sometimes also with perlatolic and pseudonorrangiformic acids (not proven in Italian material). Note: a circumpolar subarctic-subalpine species, found in wind-protected sites with a long snow-lie above treeline, on acid siliceous substrata; restricted to the Alps, where it is very rare.

- 41 With cups 42
 41 Without cups 43
 42 Thallus yellowish, KC+ yellowish, UV-, with usnic acid. Podetia without squamules

39 - *Cladonia amaurocraea* (Flörke) Schaer.



Thallus fruticose, pale yellowish, K-, C-, KC+ yellowish, P-, UV-. Primary thallus ephemeral and rarely seen, of small crenate to incised squamules up to 1.5 mm broad and long. Podetia ramified, non squamulose, to 12 cm tall and up to 1.5(-3) mm diam., dichotomously or sympodially branched. Apices pointed or terminating in narrow cups which flare rapidly, the cups open or closed, often with thorn-like brownish lateral projections. Axils closed or slightly perforate. Apothecia rare, brown to yellowish brown, convex. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Pycnidia dark, semi-immersed in the tips of podetia or in the margins of cups; pycnidial jelly colourless. Conidia cylindrical. Photobiont chlorococcoid. With usnic and barbatic acids. Note: a circumpolar, boreal-subarctic-subalpine lichen, found on siliceous soil and bryophytes in open habitats, mostly in sites with a long snow lie and above or near treeline; probably restricted to the Alps in Italy.

- 42 Thallus greenish grey to brown, KC-, UV+ white, without usnic acid. Podetia mostly with squamules, at least at the base

40 - *Cladonia crispata* (Ach.) Flot.

Thallus fruticose, greenish grey to brown, K-, C-, KC-, P-, UV+ white. Primary thallus squamulose, the squamules middle-sized (1-4 mm long and ca. 0.5 mm broad), indented, often ephemeral and rarely forming cushions, white below. Podetia extremely polymorphic, usually ramified, squamulose, to 10 cm tall and up to



5 mm in diam. (usually much less), irregularly branched esp. above, often terminating in a cup-like perforation with spinulose margins, the spines sometimes proliferating. Apothecia dark brown, convex. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Pycnidia dark, semi-immersed, mostly in the margins of cups. Conidia cylindrical. Photobiont chlorococcoid. With squamatic acid and variable amounts of barbatic acid. Note: a boreal-montane to subarctic-subalpine, circumpolar species, found on soil, more rarely on lignum, in open habitats, in areas with siliceous substrata; restricted to the Alps in Italy, mostly near or above treeline.

- 43 Cortex disrupted into soredia-like structures (a very rare species of very humid areas)

41 - *Cladonia scabriuscula* (Delise) Leight.



Thallus fruticose, pale greenish grey, shrubby, K- or K+ brownish, C-, KC-, P+ red, UV-. Primary thallus squamulose, the squamules mostly ephemeral, middle-sized (1-4 mm long and broad), crenate, ascending, glaucescent above, white below. Podetia corticate only at base, dichotomously ramified, slender, to 10 cm tall and up to 2-5 mm in diam., forming irregular tufts, with pointed apices and a microsquamulose, partly decorticate surface. Apothecia very rare, dark brown, convex. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Pycnidia dark, semi-immersed, on the tips of podetia. Conidia cylindrical. Photobiont chlorococcoid. With fumarprotocetraric acid, sometimes with traces of atranorin. Note: a mainly temperate, widespread but very rare lichen, found on soil and amongst mosses in humid-sheltered situations, such as open woodlands.

- 43 Cortex continuous to cracked, not disrupted into soredia-like structures (common species) 44
44 Thallus K+ brownish

42 - *Cladonia furcata* (Huds.) Schrad.



Thallus fruticose, greenish grey, shrubby, K- or K+ brownish, C-, KC-, P+ red, UV-. Primary thallus squamulose, the squamules mostly ephemeral, middle-sized (1-4 mm long and broad), crenate, ascending, glaucescent above, white below. Podetia elongate, ramified, to 8(-10) cm tall, forming irregular tufts, with pointed apices and smooth surface, sparsely squamulose. Apothecia rare, dark brown, convex. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Pycnidia dark, semi-immersed on the tips of podetia. Conidia cylindrical. Photobiont chlorococcoid. With fumarprotocetraric acid, sometimes with traces of atranorin. Note: a holarctic, temperate to boreal-montane lichen, found on soil, amongst mosses, sometimes on bark and lignum, in areas with calcareous or siliceous base-rich rocks; more hygrophytic than *C. rangiformis*; surprisingly rare along the Adriatic part of the peninsula.

- 44 Thallus K+ yellow, or K- 45
45 Thallus K+ yellow, with atranorin 46

45 Thallus K-, without atranorin 48

46 Thallus P-, without fumarprotocetraric acid

43 - *Cladonia rangiformis* Hoffm.

Thallus fruticose, greenish grey to whitish grey, shrubby, K+ yellowish, C-, KC-, P- or P+ red. Primary thallus squamulose, the squamules middle-sized (1-3 mm long and broad), persistent or ephemeral, white below. Podetia to 6 cm tall (most often less), richly branched, forming tufts, with pointed apices and a distinctly areolate surface, sparsely to densely squamulose, without medullary outbursts at the base. Apothecia rare, terminal, dark brown, convex. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Pycnidia dark, semi-immersed on the tips of podetia. Conidia cylindrical. Photobiont chlorococcoid. With atranorin and rangiformic acid, rarely also with fumarprotocetraric acid. Note: a mainly temperate species, found on calciferous or base-rich siliceous soil in open habitats, with optimum in dry grasslands; one of the most frequent species of *Cladonia* in Italy.



46 Thallus P+ red, with fumarprotocetraric acid 47

47 Podetia greenish to whitish grey, slender, densely ramified, usually squamulose, without convex, white medullary outbursts at the base

see 44 - *Cladonia rangiformis* Hoffm.

47 Podetia brown, stout, non- or scarcely squamulose, with evident, convex, white medullary outbursts at the base

45 - *Cladonia subrangiformis* Sandst.

Thallus fruticose, brown, shrubby, K- or K+ yellowish, C-, KC-, P+ red. Primary thallus squamulose, the squamules middle-sized (1-3 mm long and broad), most often ephemeral, white below. Podetia ramified, to 10 cm tall (usually much less), stout, forming irregular tufts, with pointed apices and smooth to wrinkled surface, non- or very sparsely squamulose, with evident, convex, white medullary outbursts at the base. Apothecia rare, dark brown, convex. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Pycnidia dark, semi-immersed on the tips of podetia. Conidia cylindrical. Photobiont chlorococcoid. With atranorin and fumarprotocetraric acid. Note: a mild-temperate to mediterranean lichen, found on mineral calciferous soil, often amongst bryophytes; the dark, stout thallus and especially the prominent white medullary outburst at the base are diagnostic with respect to *C. rangiformis* (the two species often occur together, in which case they are easily distinguished).



48 Thallus P+ red 49

48 Thallus P- 51

49 Thallus KC+ yellow, with usnic acid. Squamules absent.

Restricted to above treeline

46 - *Dactylina ramulosa* (Hook.) Tuck.



Thallus fruticose, yellowish straw-coloured, spotted brownish yellow or pale violet-pruinose, shrubby, K-, C-, KC+ yellow, P+ red or P-. Branches 1-2(-3) mm thick, ascending, subterete, fragile, erect, to 2.5 cm tall, the base dying, more or less sympodial with a few branches but many short, often black-tipped side branches, usually forming tufts. Medulla hollow, with a few loosely arranged hyphae scattered in the cavity, P+ red or P-. Cortex compact, up to 50 µm thick, of prosoplectenchymatous arranged hyphae, the cells thick-walled, sharply distinguished from the arachnoid medullary hyphae. Apothecia extremely rare (never found in Italian material), on the tips of side branches, 1-3 mm broad. Spores biseriate in the asci, globose, thick-walled, 5-6 µm in diam. Pycnidia rare, dark, immersed. Conidia cylindrical, straight, 5-6 x ca. 1 µm. Photobiont chlorococcoid. With usnic acid (cortex) and usually physodalic and physodic acids in the medulla (in which case it reacts P+ red). Note: an arctic-alpine, circumpolar species, mostly found in open stands on soil developing from calcareous schist above treeline. Restricted to the Alps, where it is extremely rare.

49 Thallus KC-, without usnic acid. Squamules usually present, at least at the base of the podetia. Mainly below treeline 50

50 Podetia greenish grey, slender, squamulose, without evident, convex, white medullary outbursts at the base

see 42 - Cladonia furcata (Huds.) Schrad.

50 Podetia brown, stout, with evident, convex, white medullary outbursts at the base

see 45 - Cladonia subrangiformis Sandst.

51 Thallus greenish grey to brown, KC-, without usnic acid

see 40 - Cladonia crispata (Ach.) Flot.

51 Thallus pale yellowish, KC+ yellowish, with usnic acid 52

52 With usnic acid only. Ramifications mainly tri- to tetrachotomous. Surface of central canal not powdery

47 - *Cladonia uncialis* (L.) F.H.Wigg. subsp. *uncialis*



Thallus fruticose, pale yellowish, often with brownish tips, shrubby, K-, C-, KC+ yellow, P-, UV-. Primary thallus squamulose, ephemeral and rarely seen, the squamules to 1 mm long, white below. Podetia mostly tri- to tetrachotomously ramified, non squamulose, to 6(-10) cm tall and ca. 1.5 (-3.5) mm diam., subcylindrical in section, cupless, with pointed apices and divergent branches, the axils mostly perforate, forming compact tufts. Surface of central canal not powdery. Apothecia extremely rare, brown, convex. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Pycnidia dark, semi-immersed, apical; pycnidial jelly

reddish. Conidia cylindrical. Photobiont chlorococcoid. With usnic acid, rarely also with squamatic acid. Note: mainly subalpine-alpine, mostly, but not only, on siliceous substrata, probably restricted to the Alps in Italy; see also note to the following taxon.

- 52 With usnic and squamatic acid. Ramifications predominantly dichotomous. Surface of central canal white-powdery

48 - *Cladonia uncialis* (L.) F.H.Wigg. subsp. *biuncialis* (Hoffm.)



Thallus fruticose, pale yellowish, often with brownish tips, shrubby, K-, C-, KC+ yellow, P-, UV+ white. Primary thallus squamulose, ephemeral and rarely seen, the squamules to 1 mm long, white below. Podetia mainly dichotomously ramified, non squamulose, to 6(-10) cm tall, with pointed apices and divergent branches, the axils mostly perforate, forming compact tufts. Apothecia extremely rare, brown, convex. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Pycnidia dark, semi-immersed, apical; pycnidial jelly reddish. Conidia cylindrical. Photobiont chlorococcoid. With usnic and squamatic acid. Note: more hygro- and acidophytic than the typical subspecies, probably widespread in the Alps.

- | | | |
|----|--|----|
| 53 | With cups | 54 |
| 53 | Without cups | 88 |
| 54 | With soredia (do not confuse schizidia-like, corticate structures with true soredia!) | 55 |
| 54 | Without soredia | 71 |
| 55 | Apothecia and pycnidia scarlet red, K+ blood red (if apothecia are absent, look at the margins of cups for pycnidia !) | 56 |
| 55 | Apothecia and pycnidia pale to dark brown, K- | 59 |
| 56 | Primary squamules large (>0.5 cm diam.). Thallus K+ yellow, KC- or KC+ yellowish, P+ orange, with thamnolic acid, without usnic acid | |

49 - *Cladonia digitata* (L.) Hoffm.



Thallus fruticose, grey-green to olive-green, K+ yellow, C-, KC- or rarely KC+ yellowish, P+ deep orange. Primary thallus squamulose, the squamules prominent, large, to 1.5 cm diam., rounded, entire, lobed or weakly incised, horizontally spreading, with farinose soredia along the up-turned margin, grey-green to olive-green above, white and farinose below, often pale orange near the attachment point. Podetia corticate only at base, to 1.5 cm tall, pointed or with irregular small cups gradually broadening toward the base. Apothecia rare, scarlet red. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Pycnidia scarlet red, semi-immersed at the top of podetia or along the margins of cups. Conidia cylindrical. Photobiont chlorococcoid. With thamnolic

acid. Note: a cool-temperate to boreal-montane, circumpolar species, found on strongly weathered lignum, mosses, on the bases of trunks, sometimes on soil rich in humus; common only in the Alps, in the montane-subalpine belts, much rarer along the Apennines, south to the mountains of Sicily.

- 56 Primary squamules small to middle-sized (<0.5 cm diam.).
Thallus K-, KC+ yellow, P-, with usnic acid, without thamnolic acid 57
- 57 Podetia with broad cups and short stalks (like *C. pyxidata*)

50 - *Cladonia pleurota* (Flörke) Schaer.



Thallus fruticose, yellowish green, K-, C-, KC+ yellow, P-, UV-. Primary thallus squamulose, the squamules variable, persistent or disappearing, rounded to sparsely indented, 1-6 mm long, up to 4 mm broad, irregularly crenate, yellowish green to olivaceous green above, white or sometimes yellowish below towards the attachment point. Podetia goblet-shaped, corticate only at base, farinose-sorediate, 1-2(-3) cm tall, with broad cups flaring soon into short stalks, regular, sometimes dentate or proliferating from margins, non-squamulose or sometimes sparsely squamulose at the base. Apothecia frequent, scarlet red. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Pycnidia scarlet red, semi-immersed. Conidia cylindrical. Photobiont chlorococcoid. With usnic, iso-usnic, porphyrylic acids, and zeorin. Note: an arctic-alpine to boreal-montane, circumpolar lichen found on soil, rotting wood, more rarely on basal parts of trunks in open habitats; most frequent in the Alps above the montane belt, on siliceous substrata; also known from the N Apennines.

- 57 Podetia slender, with long stalks and narrow cups 58
- 58 Podetia mostly without cups, and then with pointed ends, but sometimes with narrow, lacerated cups. With usnic and sometimes squamatic acids, without zeorin. Thallus UV+ white or UV-

51 - *Cladonia sulphurina* (Michx.) Fr.



Thallus fruticose, yellowish green, K-, C-, KC+ yellowish, P-, UV+ white or UV-. Primary thallus squamulose, the squamules rather large, 2-8 mm long and 2.5 to 4 mm broad, yellowish green above, white to brownish below. Podetia elongate, 2-8 cm tall, corticate only at base, mostly without cups, and then with pointed ends, sometimes with narrow, lacerated cups, farinose-sorediate. Apothecia scarlet red. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Pycnidia scarlet red, semi-immersed. Conidia cylindrical. Photobiont chlorococcoid. With usnic and sometimes squamatic acids. Note: a circumboreal-subarctic lichen, found on organic substrata in cold-shaded situations, most common on rotting wood, e.g. on stumps and decaying fallen trunks; to be looked for throughout the Alps.

- 58 Podetia with narrow, more or less regular cups, more rarely pointed, squamulose esp. toward the base. With usnic acid and

zeorin. Thallus always UV-

52 - *Cladonia deformis* (L.) Hoffm.



Thallus fruticose, yellowish green, K-, C-, KC+ yellow, P-, UV-. Primary thallus squamulose, often ephemeral, the squamules middle-sized (2-4 mm long), rounded to crenate-lobate, white below, but yellowish brown towards the attachment point, occasionally sorediate. Podetia corticate only at base, 3-9 cm tall and up to 5 mm thick on the stalk, with narrow, more or less regular, gradually flaring and usually non-perforated cups, more rarely pointed, squamulose esp. toward the base, farinose-sorediate. Apothecia scarlet red, convex. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Pycnidia scarlet red, semi-immersed. Photobiont chlorococcoid. With usnic acid and zeorin. Note: a mainly boreal-montane, circumpolar species, found on rotting wood and organic soil; known from the Alps, and from the high siliceous mountains of Calabria.

- 59 Thallus K+ yellow turning to red, C+ red, KC+ red, with cryptochlorophaeic acid

53 - *Cladonia cryptochlorophaea* Asahina



Thallus fruticose, brownish-green, K+ yellow turning to red, C+ red, KC+ red, P+ red, UV+ pale yellow. Primary thallus squamulose, the squamules middle-sized (1-3 mm), thin, greenish grey, ascending, white below. Podetia goblet-shaped, non squamulose, 0.5-4 cm tall, with broad cups gradually tapered to a short stalk, regular or proliferating marginally, granular-sorediate above and in the cups. Apothecia frequent, brown, convex. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Pycnidia dark, semi-immersed. Photobiont chlorococcoid. With cryptochlorophaeic and fumarprotocetraric acids. Note: a mainly cool-temperate, perhaps holarctic lichen, found on soil rich in humus, on peat, etc.; probably a western lichen in Europe; its distribution in Italy is still poorly known.

- 59 Thallus K+ yellow or K-, without cryptochlorophaeic acid 60
60 Thallus K+ yellow 61
60 Thallus K- 62
61 Primary squamules large, with distinct brownish to pinkish veins below. Without atranorin. Extremely rare in Italy, restricted to humid-warm mediterranean stands

54 - *Cladonia cyathomorpha* Walt. Watson

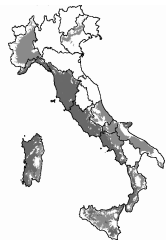
Thallus fruticose, greyish-green, K.+ yellow-, C-, KC-, P+ red, UV-. Primary thallus squamulose, the squamules large, rounded to indented, more or less ascending, with distinct pinkish to brownish veins below. Podetia goblet-shaped, mostly densely squamulose at the base, to 0.8 cm tall, the cups granular-“sorediate” inside. Apothecia brown, convex. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Photobiont chlorococcoid. With



fumarprotocetraric acid and an unidentified compound. Note: a humid subtropical species, extremely rare in the most humid parts of Tyrrhenian Italy (Calabria, Sardegna).

- 61 Primary squamules without veins below. With atranorin. More common species

55 - *Cladonia humilis* (With.) J.R.Laundon



Thallus fruticose, greyish-green, K+ yellow, C-, KC-, P+ red, UV-. Primary thallus squamulose, the squamules middle-sized (1-3 mm long), rounded to sparingly incised, white below. Podetia corticate only at base, generally non squamulose, to 7 mm tall, with regular cups abruptly tapered to a very short stalk, continuously corticate at the base, sorediate above and inside the cups. Apothecia frequent, terminal, brown, convex. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Photobiont chlorococcoid. With atranorin and fumarprotocetraric acid. Note: a mild-temperate, widespread species, found on disturbed, often sandy, mostly acid to subneutral soil, more rarely on lignum and mossy trees; mainly Tyrrhenian in Italy.

- 62 Soredia granular (including also some species with schizidia) 63
 62 Soredia farinose 65
 63 Thallus KC+ red, with merochlorophaeic acid (warning! the reaction is visible in extracts only!)

56 - *Cladonia merochlorophaea* Asahina



Thallus fruticose, brown to brownish-green, K-, C+ reddish to yellowish, KC+ red in extracts only (microscope!), P+ red or P-, UV+ pale blue. Primary thallus squamulose, the squamules persistent, middle-sized (1-3 mm long), thin, greenish grey, ascending, white below. Podetia goblet-shaped, usually non squamulose, 0.5-4 cm tall, with broad cups gradually tapered to a short stalk, regular or proliferating marginally, sometimes granular-sorediate to mostly schizidiate above and in the cups. Apothecia frequent, brown, on the margin of the cups. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Photobiont chlorococcoid. With merochlorophaeic, 4-0-methylcryptochlorophaeic and fumarprotocetraric acids. Note: a mainly cool-temperate, probably circumpolar lichen, found on humus-rich soil; the distribution in Italy is still poorly known.

- 63 Thallus KC-, without merochlorophaeic acid 64
 64 Thallus UV-, with fumarprotocetraric acid only

57 - *Cladonia chlorophaea* (Florke ex Sommerf.) Spreng.



Thallus fruticose, greyish-green, K-, C-, KC-, P+ red, UV-. Primary thallus squamulose, the squamules small to middle-sized (3-6 mm long and almost as broad), incised to crenate, greyish-green above, white below, but darkening towards the base. Podetia goblet-shaped, non squamulose, 0.5-4 cm tall, with broad cups gradually tapered to a short stalk, regular or proliferating marginally, granulose-sorediate above and in the cups, non-corticate or corticate only at the base. Apothecia frequent, on the margin of the cups, brown, convex. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Pycnidia dark, semi-immersed. Conidia cylindrical. Photobiont chlorococcoid. With fumarprotocetraric acid only. Note: delimitation of the species, and hence distribution poorly known: the map refers to the species taken in a very broad sense.

- 64 Thallus UV+ bluish white, with grayanic and fumarprotocetraric acids

58 - *Cladonia grayi* Sandst.



Thallus fruticose, brownish-green, K-, C-, KC-, P+ red, UV+ bluish white. Primary thallus squamulose, the squamules usually persistent, small to middle-sized (1-3 mm), white below. Podetia goblet-shaped, non squamulose, 0.5-4 cm tall, with broad cups gradually tapered to a short stalk, regular or proliferating marginally, abundantly granular-sorediate above and in the cups. Apothecia frequent, on the margin of the cups, brown, convex. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Pycnidia dark, semi-immersed. Conidia cylindrical. Photobiont chlorococcoid. With grayanic and fumarprotocetraric acids. Note: a holarctic, rather northern representative of the *C. pyxidata-chlorophaea* complex, found on acid soil rich in humus, peat and on rotting wood; most frequent in the Alps.

- 65 Cups regular, goblet or funnel-shaped (like those of *C. pyxidata* or *C. fimbriata*) 66
- 65 Cups, when present, irregular 67
- 66 Podetia with broad cups and short stalks, like those of *C. pyxidata*. Thallus P-, with zeorin, without fumarprotocetraric acid. Apothecia and pycnidia waxy yellowish brown. Restricted to near or above treeline

59 - *Cladonia carneola* (Fr.) Fr.



Thallus fruticose, yellowish-greyish-green, K-, C-, KC+ yellowish, P-, UV-. Primary thallus squamulose, the squamules persistent or disappearing, small and often inconspicuous, yellowish-greyish-green above, white to yellowish below, darkening towards the base. Podetia non squamulose, 0.5-2(-3) cm tall, with regular cups abruptly tapering to stalk, entirely farinose-sorediate. Apothecia frequent, on the margin of the cups, waxy yellowish to very pale brown, convex. Asci *Porpidia*-type. Spores 1-celled, hyaline,

ellipsoid, 8 per ascus. Photobiont chlorococcoid. With zeorin, rarely barbatic acid. Note: a circumpolar, mainly boreal-montane to subarctic lichen, found on rotting wood and soil rich in humus in open woodlands; hitherto known only from the Alps near or above treeline, but to be looked for in the highest siliceous mountains of the south.

- 66 Podetia with small cups and long stalks. Thallus P+ orange-red, without zeorin, with fumarprotocetraric acid. Apothecia and pycnidia medium to dark brown. From the mediterranean belt to above treeline

60 - *Cladonia fimbriata* (L.) Fr.



Thallus fruticose, greyish-green, K-, C-, KC-, P+ orange-red, UV-. Primary thallus squamulose, the squamules persistent or disappearing, middle-sized to rather large (2-5 mm long), elongate and incised, white below. Podetia funnel-shaped, ecorticate or corticate only at base, non squamulose, 0.5-2 cm tall, with small regular cups and long stalks 1-2 mm thick, farinose-soresidiate throughout. Apothecia rare, dark brown, convex. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Pycnidia brown, mainly from the margins of the cups. Photobiont chlorococcoid. With fumarprotocetraric acid. Note: a widespread, temperate to arctic-alpine, holarctic species, found on rotten wood, soil, on bases of trunks, with a wide ecological range; common throughout Italy.

- 67 Thallus P+ yellow changing to orange-red

61 - *Cladonia rei* Schaer.



Thallus fruticose, pale brownish grey, K-, C-, KC-, P+ yellow changing to orange-red, UV+ white. Primary thallus squamulose, the squamules small, incised, greenish to pale brownish grey above, white below. Podetia elongate, 1-5 cm tall, simple or sparingly branched, with pointed apices, occasionally with irregular small cups, often corticate and squamulose at the base, farinose-soresidiate above. Apothecia rather frequent, terminal, brown, convex. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Photobiont chlorococcoid. With homosekikaic acid and accessory fumarprotocetraric acid. Note: a mainly temperate, probably holarctic species, found on mineral, clay and base-rich soil, mostly in slightly disturbed habitats such as on track sides and clearings of light forests and heaths. Hitherto known only from the north, mostly below the montane belt; to be looked for further along the Apennines, in areas with siliceous substrata.

- | | | |
|----|---|----|
| 67 | Thallus P-, or P+ red | 68 |
| 68 | Thallus P- | 69 |
| 68 | Thallus P+ red | 70 |
| 69 | Cups open at the bottom (i.e. with a hole). With squamatic acid | |

62 - *Cladonia cenotea* (Ach.) Schaer.



Thallus fruticose, grey to greyish brown, K-, C-, KC-, P-, UV+ white. Primary thallus squamulose, the squamules small (1-3 mm long and ca. 1 mm broad), indented, greyish green to brownish above, white below. Podetia elongate, corticate only at base, non- or scarcely squamulose, 1-4 cm tall, unbranched or sparingly branched and farinose-sorediate above with narrow, irregular, perforated cups, the margins in-rolled into the perforation. Apothecia livid to waxy pale brown, convex, mostly on the margins of the cups. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Photobiont chlorococcoid. With squamatic acid. Note: a temperate to boreal-montane, circumpolar species, found on rotting wood, mainly on old stumps, and on soil rich in humus; most frequent in the Alps, but extending along the Apennines down to Calabria.

69 Cups closed at the bottom. With homosekikaic acid

see 61 - *Cladonia rei* Schaer.

70 Podetia >4 cm tall, corticate only at base, non squamulose. Thallus pale grey to whitish, sometimes with a greenish or brownish tinge

63 - *Cladonia subulata* (L.) F.H.Wigg.



Thallus fruticose, ashy grey to whitish, sometimes with a greenish or brownish tinge, K-, C-, KC-, P+ red, UV-. Primary thallus squamulose, the squamules persistent or disappearing, very small (<1 mm), inconspicuous, elongate and deeply incised, whitish-glaucous above, white below. Podetia mostly bacilliform, corticate only at base, non squamulose, 1-6 cm tall and up to 3 mm thick (usually much less), with pointed apices, sometimes irregularly branched above and antler-like, rarely with irregular cups proliferating from margins, farinose-sorediate. Apothecia terminal, brown, convex. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Photobiont chlorococcoid. With fumarprotocetraric acid. Note: a cool-temperate to subarctic lichen, found on mineral soil on track sides and in clearings of light forests and heaths, more rarely on rotting wood, in areas with siliceous substrata. Rare, and mostly restricted to the Alps, with a single record from the highest mountains of Calabria.

70 Podetia <4 cm tall, squamulose-granular to partly decorticate. Thallus greenish brown

64 - *Cladonia ramulosa* (With.) J.R.Laundon



Thallus fruticose, greenish brown, K-, C-, KC-, P+ red, UV-. Primary thallus squamulose, the squamules very small (<1 mm), elongate and indented, fragile. Podetia 1-3.5 cm tall, simple with pointed apices or irregular small cups, squamulose-granular to partly decorticate. Apothecia frequent, brown, convex. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Photobiont chlorococcoid. With fumarprotocetraric acid. Note: a mainly temperate to southern boreal-montane lichen, found on epilithic bryophytes, rotting wood and organic soil; not known

along the Adriatic side of the Peninsula.

- 71 Apothecia and pycnidia scarlet red 72
71 Apothecia and pycnidia brown 75
72 With squamatic acid (UV+ white). Podetia >3 cm tall, densely squamulose, with long stalks and narrow cups

65 - *Cladonia bellidiflora* (Ach.) Schaer.

Thallus fruticose, grey-green to yellowish green, K-, C-, KC+ yellow, P-, UV+ white. Primary thallus squamulose, the squamules small (but sometimes up to 2 mm long!), mostly inconspicuous, deeply indented, non sorediate, white below, sometimes yellowish brown towards the base. Podetia elongate, densely squamulose, 3-5 cm tall, pointed at apices or with small, regular to irregular cups, becoming granular or decorticate towards apices. Apothecia rather frequent, scarlet red, convex. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Pycnidia scarlet red, semi-immersed. Conidia cylindrical. Photobiont chlorococcoid. With usnic and squamatic acids. Note: a cool-temperate to boreal-montane, circumpolar lichen, found on acid soil and mossy rocks in wind-protected and humid situations (e.g. in sites with a long snow lie); hitherto known only from the Alps, where it is rather rare; to be looked for in the highest siliceous mountains of the Apennines, esp. in Calabria.



- 72 Without squamatic acid (UV-). Podetia <3 cm tall, scarcely or non-squamulose, with short stalks and broad cups, similar to those of *C. pyxidata* (if you cannot assess chemical differences among the following taxa, call your samples “*Cladonia coccifera* s.lat.”) 73
73 With usnic and barbatic acids

66 - *Cladonia borealis* S. Stenroos

Thallus fruticose, yellowish-green to glaucescent and olive-coloured, K-, C-, KC+ yellow, P-, UV-. Primary thallus squamulose, the squamules middle-sized (1-3 mm long), variable in form, rounded or a little indented, white or often yellowish towards the base below. Podetia goblet-shaped, non- or scarcely squamulose, 1-2(-3) cm tall, bearing broad, regular cups flaring into a short stalk, corticate-areolate. Apothecia frequent, scarlet red, convex. Asci *Porpidia*-type. Spores 1-celled hyaline, ellipsoid, 8 per ascus. Pycnidia scarlet red, semi-immersed. Conidia cylindrical. Photobiont chlorococcoid. With usnic and barbatic acids. Note: on mineral siliceous soil in open habitats, mostly above treeline; related to *C. coccifera*, and with a similar ecology; certainly more widespread in the Alps.



- 73 With usnic acid and zeorin 74
74 Squamules on podetia scarce to absent. Podetia 1-2(-3) cm tall, with conspicuous corticate, convex granules, esp. within the cups, sometimes sparsely squamulose at the base

67 - *Cladonia coccifera* (L.) Willd.



Thallus fruticose, yellowish-green to glaucescent and olive-coloured, K-, C-, KC+ yellow, P-, UV-. Primary thallus squamulose, the squamules middle-sized (1-3 mm long), variable in form, rounded or a little indented, white or often yellowish towards the base below. Podetia goblet-shaped, corticate-areolate, non- or scarcely squamulose, 1-2(-3) cm tall, with broad cups and short stalk, with conspicuous corticate, convex granules, esp. inside the cups, sometimes sparsely squamulose at the base. Apothecia frequent, scarlet red, convex. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Pycnidia scarlet red, semi-immersed. Conidia cylindrical. Photobiont chlorococcoid. With usnic acid and zeorin. Note: a cool-temperate to arctic-alpine, circumpolar lichen, found on soil in open situations, such as in dry tundra-like habitats, more rarely on wood; most common in the Alps, but also known from the highest siliceous mountains of Sardegna and Calabria.

- 74 Squamules on podetia abundant. Podetia to 2(-3) cm tall, squamulose at the base, microsquamulose-granulose in upper part and inside the cups

68 - *Cladonia diversa* Asperges



Thallus fruticose, yellowish-green to glaucescent and olive-coloured, K-, C-, KC+ yellow, P-, UV-. Primary thallus squamulose, the squamules middle-sized (1-3 mm long), variable in form, rounded or a little indented, white or often yellowish towards the base below. Podetia goblet-shaped, areolate, 2(-3) cm tall, with broad cups and short stalks, richly squamulate at the base, bearing broad, regular cups flaring into a short, corticate-areolate stalk. Apothecia frequent, scarlet red, convex. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Pycnidia scarlet red, semi-immersed. Conidia cylindrical. Photobiont chlorococcoid. With usnic acid and zeorin. Note: see comment to the previous species.

- 75 Thallus K+ yellow 76
75 Thallus K- 80
76 Thallus P+ orange, with thamnolic and barbatic acids

69 - *Cladonia squamosa* Hoffm. var. *subsquamosa* (Leight.) Vain.



Thallus fruticose, grey, K+ yellow, C-, P+ orange, UV-. Primary thallus squamulose, the squamules persistent to rarely ephemeral, 2-5 mm long and 1 mm broad, irregularly subpinnate or subdigitate or wedge-shaped, scattered to crowded, sometimes forming dense mats, white below. Podetia very variable, usually densely squamulose with small, fragile squamules, very variable in shape and size, to 5(-8) cm tall, irregularly branched, with pointed apices or with irregular, small, perforated cups with often proliferating margins, the surface scabrid, usually partly decorticated, but sometimes subcontinuous. Apothecia frequent, brown, convex. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Pycnidia dark, semi-immersed. Conidia cylindrical. Photobiont

chlorococcoid. With thamnolic and barbatic acids. Note: more hygrophytic than the typical variety, and more bound to higher altitudes, from the Alps to Calabria.

76 Thallus P+ red, with fumarprotocetraric acid

77

77 Podetia >4 cm tall

70 - *Cladonia ecmocyna* Leight.

Thallus fruticose, dull greenish grey to brownish green in sun-forms, sometimes weakly pruinose at the top of podetia, often yellowish at the base, K+ yellow (reaction best observed under a microscope), C-, KC-, P+ red. Primary thallus squamulose, the squamules ephemeral, middle-sized (1-3 mm), white below. Podetia elongate, to more than 10 cm tall and 2-4(-5) mm thick, cupless or with narrow cups, sparsely squamulose, the cortex subcontinuous to areolate. Apothecia rare, brown, convex. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Pycnidia dark, semi-immersed in the margins of the cups. Photobiont chlorococcoid. With atranorin and fumarprotocetraric acid. Note: a mainly boreal-montane to subarctic-subalpine, circumpolar lichen, found on organic soil and amongst bryophytes in cool depressions with a late snow lie; restricted to the Alps in Italy, where it is extremely rare (most -if not all - records need re-confirmation).



77 Podetia <4 cm tall

78

78 Squamules pure white below. Mostly near or above treeline

71 - *Cladonia macrophyllodes* Nyl.

Thallus fruticose (but primary squamules prominent!), greenish grey, K+ yellow, C-, KC-, P+ red. Primary thallus squamulose, the squamules very large, 8-30 mm long and 1-9 mm broad, lobate to incised, concave to involute, greenish grey above, white below. Podetia rare, to 10 mm tall (usually much less), and to ca. 2 mm thick, with funnel-shaped cups which are up to 7 mm in diam., with a continuous to areolate cortex. Apothecia rare, brown, convex. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Pycnidia dark, semi-immersed in the margins of the cups or in the primary squamules. Photobiont chlorococcoid. With atranorin and fumarprotocetraric acid. Note: an arctic-alpine, circumpolar species found on soil in open sites with a long snow-lie; optimum in the siliceous Alps. Much overlooked or misunderstood in the past.



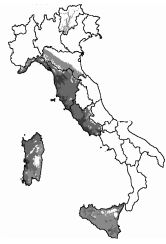
78 Squamules greyish to pinkish grey below. Mostly below treeline

79

79 Squamules pinkish grey below

72 - *Cladonia firma* (Nyl.) Nyl.

Thallus fruticose (but mostly reduced to the primary squamules), greenish grey, K+ yellow, C-, KC-, P+ red, UV-. Primary thallus squamulose, the squamules prominent, persistent, forming dense mats, 0.5-1.5 cm long, mostly ascending, entire to slightly indented, often curved at apices when dry, forming dense mats, grey-green above, reddish grey below, darker towards the base. Podetia very rare, funnel-shaped, sometimes proliferating from the center, with a



continuous to shallowly areolate cortex. Apothecia extremely rare, dark brown, convex. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Pycnidia dark, semi-immersed. Photobiont chlorococcoid. With fumarprotocetraric acid, atranorin, and variable amounts of rangiformic acid. Note: a mild-temperate lichen, found on mineral, often base-rich siliceous soil in open Mediterranean grasslands; certainly occurring throughout Tyrrhenian Italy, in areas with siliceous substrata.

79 Squamules grey below, without a pinkish hue

73 - *Cladonia subcervicornis* (Vain.) Kernst.



Thallus fruticose (but mostly reduced to the primary squamules), K+ yellow, C-, KC-, P+ red, UV-. Primary thallus squamulose, the squamules prominent, persistent, large, 0.5-2 cm long and 2-4(-5) mm broad, with an entire to weakly indented margin, ascending, forming cushions, bluish-green to lead-greyish-green above, grey below, often with black spots near the attachment point. Podetia rare, with funnel-shaped, rapidly flaring cups which sometimes proliferate from the centre or from the margins, lacking squamules, with a more or less continuous or areolate cortex. Apothecia rare, dark brown, convex, often clustered, originating from the margins of the cups. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Pycnidia dark, semi-immersed on the margins of cups. Conidia cylindrical. Photobiont chlorococcoid. With fumarprotocetraric acid and atranorin. Note: on siliceous rocks and on soil rich in humus in open habitats; probably more widespread, but certainly not common in Tyrrhenian Italy.

80 Thallus P-, with squamatic acid, without fumarprotocetraric acid

74 - *Cladonia squamosa* Hoffm. var. *squamosa*



Thallus fruticose, greyish, K-, C-, KC-, P-, UV+ white. Primary thallus squamulose, the squamules persistent or disappearing, middle-sized, indented, to 2 mm long, forming dense mats, white below. Podetia ramified, areolate, densely squamulose, to 5 cm tall, extremely variable in shape and size, irregularly branched, with pointed apices or with irregular small perforate cups, the surface scabrid, densely squamulose and partly decorticated. Medulla UV+ white. Apothecia frequent, brown, convex, located at the top of podetia, often clustered. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Pycnidia dark, semi-immersed on the top of podetia. Photobiont chlorococcoid. With squamatic acid and variable amounts of barbatic acid. Note: a widespread holarctic lichen, found on organic substrata in sheltered situations, rarely on bark, on basal parts of trunks; a very polymorphic taxon.

- | | | |
|----|--|----|
| 80 | Thallus P+ red, with fumarprotocetraric acid | 81 |
| 81 | Podetia <4 cm tall | 82 |
| 81 | Podetia >4 cm tall | 84 |
| 82 | Squamules bluish-grey below. Podetia proliferating from the center | |

75 - *Cladonia cervicornis* (Ach.) Flot. subsp. *cervicornis*



Thallus fruticose, greyish to brownish green, K-, C-, KC-, P+ red, UV-. Primary thallus squamulose, the squamules persistent, large, to 1 cm long, contiguous, forming cushions grey-green above, bluish grey below, the margins entire to indented. Podetia rather rare, funnel-shaped, to ca. 1 cm tall, flaring from the base, often proliferating from the centre, with a continuous to areolate cortex, often sparingly squamulose at the base. Apothecia rare, brown, convex, on the margins of cups. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Pycnidia dark, semi-immersed in the margins of cups. Photobiont chlorococcoid. With fumarprotocetraric acid. Note: a temperate to southern boreal-montane lichen, found on mineral siliceous soil in open grasslands and garrigues; most frequent in Tyrrhenian Italy.

82 Squamules white below. Podetia non proliferating or proliferating from the margin

83

83 Thallus more or less brownish. Primary squamules 0.5-2 mm thick, flat, forming a thick subrosulate crust

76 - *Cladonia pocillum* (Ach.) O.J. Rich.



Thallus fruticose, more or less brownish, K-, C-, KC-, P+ red, UV-. Primary thallus squamulose, the squamules persistent, prominent, adnate, middle-sized, 1-5 mm long, 1-2 mm thick, flat, forming a subrosulate crust around the base of podetia, brownish to greenish brown above, white below. Podetia funnel-shaped, mostly non squamulose, 0.5-3 cm tall, with broad cups and short stalks, gradually tapering toward base, regular or rarely proliferating from margin, the cortex disrupted into contiguous to scattered areoles (schizidia), esp. inside the cups. Medulla UV-. Apothecia rare, brown, convex, on the margins of cups. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Pycnidia brown, on the margins of cups. Conidia cylindrical. Photobiont chlorococcoid. With fumarprotocetraric acid. Note: a widespread holarctic species, found on calciferous soil and amongst bryophytes in dry, open grasslands; one of the most common Cladonias of Italy, esp. in calcareous areas.

83 Thallus greyish-green. Primary squamules <0.5 mm thick, more or less ascending, never forming a thick subrosulate crust

77 - *Cladonia pyxidata* (L.) Hoffm.



Thallus fruticose, greyish-green, K-, C-, KC-, P+ red, UV-. Primary thallus squamulose, the squamules persistent, middle-sized 2-7 mm long (rarely more) and up to 4 mm broad (usually less), irregularly lobed or incised, the tips rounded, mostly ascending, thin (less than 0.4 mm thick), never forming a subrosulate crust, greenish grey above, white below. Podetia funnel-shaped, non squamulose, 0.5-3(-5) cm tall, with broad cups gradually tapering toward base and short stalks, the cups regular or rarely proliferating from margin, with contiguous to scattered corticate granules or peltate squamules (schizidia), esp. inside the cups. Medulla UV-. Apothecia frequent,

brown, convex. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Pycnidia dark, semi-immersed on the margins of cups. Conidia cylindrical. Photobiont chlorococcoid. With fumarprotocetraric acid. Note: a widespread, very polymorphic, holarctic species with a wide altitudinal-latitude range, one of the most common *Cladonias* throughout Italy.

- 84 Cups proliferating marginally with elongate structures resembling the podetia of *C. furcata*, branching dichotomously from open axils. (An extremely rare species, restricted to lowland areas)

78 - *Cladonia dimorpha* S. Hammer



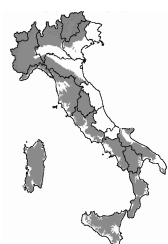
Thallus fruticose, greyish white to pale greenish grey, K-, C-, KC-, P+ red, UV-. Primary thallus squamulose, the squamules usually persistent, middle-sized, 2-4 x 1-3 mm, entire to subdigitately lobed, white below. Podetia elongate, densely squamulose, dimorphous, the lower part consisting of a ecorticate cup resembling that of *C. pyxidata*. This proliferates from the margin, giving rise to elongate structures which ramify dichotomously from open axils, resembling *C. furcata*. Medulla UV-. Apothecia rare, terminal, brown, convex. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Pycnidia dark, semi-immersed. Conidia cylindrical. Photobiont chlorococcoid. With fumarprotocetraric acid. Note: extremely rare in Italy, being known from two stations only (Sardinia and Calabria) on calcareous or base-rich soil; a poorly known member of the difficult *C. pyxidata* complex, also known from N America.

- 84 Cups not proliferating with elongate structures resembling *C. furcata* (less rare species)

85

- 85 Podetia proliferating from the centre (forming several stocks of superimposed cups); squamules bluish grey below

79 - *Cladonia cervicornis* (Ach.) Flot. subsp. *verticillata* (Hoffm.) Ahti



Thallus fruticose, greenish grey, K-, C-, KC-, P+ red. Primary thallus squamulose, the squamules persisting or more rarely ephemeral, very variable in size, up to 8 mm long and 4 mm broad, wedge-shaped or lobed, with indented margins, often ascending, upper surface grey-green to brownish in sun-forms, lower surface bluish grey. Podetia frequent, flaring quickly into short, broad cups (up to 9 mm diam.), which tend to proliferate from the centre, often giving rise to several tiers of superimposed cups. Cortex more or less continuous to areolate, the areoles smooth, subcontiguous. Apothecia frequent, brown, convex. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Pycnidia dark, semi-immersed. Conidia cylindrical. Photobiont chlorococcoid. With fumarprotocetraric acid. Note: a boreal-montane to subarctic-subalpine, circumpolar lichen, found on acid soil in open habitats; more frequent in upland areas than the typical subspecies; several records from Tyrrhenian Italy could refer to subsp. *cervicornis*, and need re-confirmation.

85 Podetia non proliferating, or proliferating from the margin;
squamules white below 86

86 Podetia 2-5 mm thick, very tall (to 12 cm)

80 - *Cladonia macroceras* (Delise) Hav.

Thallus fruticose, brownish grey to dark brown, K-, C-, KC-, P+ red. Primary thallus squamulose, the squamules middle-sized (1-3 mm), often ephemeral, white below. Podetia elongate, to 15 cm tall, non- or scarcely squamulose, stout, simple or scarcely ramified, with a few branches starting from near the base, with pointed apices or with narrow regular cups, sparsely or non-squamulose. Apothecia rare, brown, convex. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Pycnidia dark, semi-immersed. Conidia cylindrical. Photobiont chlorococcoid. With fumarprotocetraric acid. Note: a subarctic-subalpine, circumpolar lichen, one of the most abundant species in *Rhododendron* heaths throughout the Alps, mostly deeply immersed amongst mosses.



86 Podetia 1-2 mm thick, usually up to 6 cm tall 87

87 Squamules on podetia scarce to absent. Tips of podetia not tomentose (microscope!). Thallus brownish grey to dark brown

81 - *Cladonia gracilis* (L.) Willd.

Thallus fruticose, from greenish glaucescent in shade-forms to brownish grey and dark brown, K-, C-, KC-, P+ red, UV-. Primary thallus squamulose, often persistent only at the base of podetia or ephemeral, the squamules small to middle-sized 2-5 mm long, 0.8-5 mm broad, irregularly crenate or lobed, glaucescent to olive-green above, white below, ascending. Podetia elongate, non- or scarcely squamulose, to 6(-8) cm tall, slender, unbranched or sparingly branched, pointed or with small, rapidly flaring, closed cups, smooth, corticate-areolate, the cortex continuous or disrupted into flat areolae separated by white lines. Apothecia rare, brown, convex, terminal or on the margins of the cups. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Pycnidia dark, semi-immersed, on the margins of the cups or at the tip of cupless podetia. Conidia cylindrical. Photobiont chlorococcoid. With fumarprotocetraric acid. Note: a circumpolar, cool-temperate to southern arctic-alpine lichen, found on acid soil, more rarely on decaying wood; optimum in the siliceous Alps, very rare in the Apennines.



87 Squamules on podetia abundant. Tips of podetia faintly tomentose. Thallus pale grey to pale brownish grey

82 - *Cladonia phyllophora* Hoffm.

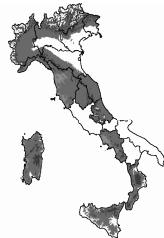
Thallus fruticose, grey to brownish grey, K-, C-, KC-, P+ red, UV-. Primary thallus squamulose, the squamules persistent or disappearing, small to middle-sized, 2-5 mm long (rarely more), up to 4 mm broad (usually less), crenate to incised, ascending, glaucescent above, white below. Podetia elongate, to 5(-8) cm tall (usually much less) and up to 4 mm in diam., with a subarachnoid



surface (the part between corticate areolae is ecorticate and subtomentose), and with blackish ecorticate areas at the base, variously squamulose, with irregular, closed cups which often proliferate marginally. Medulla UV-. Apothecia rare, brown, convex, on the tips of the proliferations from the margins of the cups. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Pycnidia dark, semi-immersed, on the margins of the cups or on the proliferations. Conidia cylindrical. Photobiont chlorococcoid. With fumarprotocetraric acid. Note: a cool-temperate to boreal-montane, probably holarctic lichen, found on acid mineral soil; most common in the North, to be looked for also along the Apennines, where however it is certainly rare.

- | | | |
|----|--|-----|
| 88 | With soredia | 89 |
| 88 | Without soredia | 104 |
| 89 | Apothecia and pycnidia scarlet red | 90 |
| 89 | Apothecia and pycnidia brown | 93 |
| 90 | Thallus K+ yellow, with thamnolic acid | 91 |
| 90 | Thallus K-, without thamnolic acid | 92 |
| 91 | Podetia mostly simple, bacilliform. With thamnolic acid, and variable amounts of barbatic and didymic acids. Primary squamules small (less than 1.5 mm long) | |

83 - *Cladonia macilenta* Hoffm. subsp. *macilenta*



Thallus fruticose, greenish grey to whitish in the parts which have lost the soredia, K+ yellow, C-, KC-, P+ orange. Primary thallus squamulose, the squamules usually persistent, elongate, divided, very small (less than 1.5 mm long), white below. Podetia bacilliform, corticate only at the base, 1-3 cm tall, up to 1.5 mm thick at the base, simple or very rarely sparingly branched above, without cups, farinose-sorediate, often broadening slightly below the apothecium and becoming club-like. Apothecia rather frequent, scarlet red, terminal, up to 2 mm diam., usually smaller. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Pycnidia scarlet red, semi-immersed, in the tips of the podetia or on the surface or margins of the primary squamules. Conidia cylindrical. Photobiont chlorococcoid. With thamnolic acid, and variable amounts of barbatic and didymic acids. Note: a cool-temperate to boreal-montane, circumpolar lichen, found on different organic substrata such as rotting wood, bark (mostly on basal parts of trunks) and more rarely on soil rich in humus; in the south it is most frequent in old *Castanea* woodlands.

- | | | |
|----|--|--|
| 91 | Podetia often with a few ramifications. With thamnolic acid only. Primary squamules to 3 mm long | |
|----|--|--|

84 - *Cladonia polydactyla* (Flörke) Spreng.

Thallus fruticose, greenish grey, K+ yellow, C-, KC-, P+ orange, UV-. Primary thallus squamulose, the squamules middle-sized,



divided, 2-8 x 1-3 mm, whitish below. Podetia corticate only at base, 1-2(-3) cm tall, pointed or with narrow, irregular cups, often proliferating from margins or dentate, squamulose esp. toward the base, farinose-sorediate above. Apothecia frequent, scarlet red. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Pycnidia scarlet red, semi-immersed. Conidia cylindrical. Photobiont chlorococcoid. With thamnolic acid. Note: a cool-temperate to boreal-montane, circumpolar lichen, found on organic soil and rotting wood in woodlands, more rarely on bark, on basal parts of old trunks; certainly widespread throughout the Alps, becoming much rarer southwards, where it is mostly confined to old *Castanea* plantations.

- 92 Podetia small and inconspicuous, <0.5 cm tall, yellowish grey. Primary squamules to 4 mm long. Extremely rare in Italy

85 - *Cladonia incrassata* Flörke



Thallus fruticose, yellowish grey, K-, C-, KC+ yellow, P-, UV+ white or UV-. Primary thallus squamulose, the squamules to 4 mm long, crenulate-incised, often contorted, densely sorediate esp. below. Podetia simple, 0.2-0.5 cm tall, often deformed, more or less flattened, with a partly corticate partly farinose-sorediate surface. Apothecia frequent, scarlet red, convex. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Pycnidia scarlet red, semi-immersed. Conidia cylindrical. Photobiont chlorococcoid. With usnic and squamatic acids; chemically variable, some strains contain also didymic, barbatic and thamnolic acids. Note: a cool-temperate to boreal-montane species with a fragmented circumpolar range, found on peaty and humus-rich soil and on strongly weathered lignum. Extremely rare in Italy, being known from a few stations in the western Alps, the northern Apennines, and the high siliceous mountains of Calabria.

- 92 Podetia stout, >1 cm tall, yellowish green. Primary squamules 2-8 mm long. More common species

Go back to option 58

- 93 Thallus K+ yellow, with thamnolic acid

86 - *Cladonia parasitica* (Hoffm.) Hoffm.



Thallus fruticose, whitish grey to pale grey-brown, K+ yellow, C-, KC- P+ yellow-orange, UV-. Primary thallus squamulose, the squamules persisting, whitish to pale greenish grey, very finely divided, granulose-sorediose, to 5 mm long, 0.2-1 mm broad, white below. Podetia densely squamulose, to 2 cm tall (usually less), deformed and very irregularly branched, often covered by isidioid granules and partly decorticated with scattered to numerous squamules, fissured, with gaping holes. Apothecia rare, dark brown, convex, often clustered. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Pycnidia dark, semi-immersed in the upper part of the squamules. Photobiont chlorococcoid. With thamnolic acid and variable amounts of barbatic acid. Note: a mainly temperate, probably holarctic species; normally lignicolous, on stumps, sometimes on basal parts of old trunks; optimum in

Castanea stands.

- 93 Thallus K-, or K+ yellow changing to red, without thamnolic acid 94
94 Thallus K+ yellow changing to orange-red, with atranorin and norstictic acid

87 - *Cladonia acuminata* (Ach.) Norrl.

Thallus fruticose, grey to chalky white in the decorticate parts, K+ yellow changing to orange-red, C-, KC-, P+ yellow, UV-. Primary thallus squamulose, the squamules persisting, up to 7 mm long (usually much less) and 3 mm broad, narrowly elongate, sinuate to crenate, involute-concave, glaucescent above, white below. Podetia inflated-bacilliform, corticate only at base, simple and cupless, 2-4(-5) mm tall and up to 2.5 mm in diam., often squamulose, esp. below, the sterile apices blunt, the fertile becoming dilated, sparsely granulose-soresiate. Apothecia (very rare in Italian material), terminal, brown, convex, often perforate. Asci *Porpidia*-type. Spores 1-celled, ellipsoid, 8 per ascus. Pycnidia dark, semi-immersed. Photobiont chlorococcoid. With atranorin and norstictic acid. Note: a cool-temperate to circumboreal-montane lichen found on calciferous soil rich in humus in open situations; probably restricted to the Alps in Italy, where it is extremely rare.



- 94 Thallus K- 95
95 Thallus KC+ yellow, with barbatic acid

88 - *Cladonia cyanipes* (Sommerf.) Nyl.

Thallus fruticose, yellowish-green in upper part, greyish-green below, K-, C-, KC+ yellow, P-, UV-. Primary thallus squamulose, the squamules persistent or ephemeral, small to middle-sized, up to 6 mm long (usually much less) and ca. 1 mm broad, narrowly lacinate, crenate, ascending, yellowish green above, white or yellowish-white below, the underside often soresiate. Podetia bacilliform, 2-5(-8) cm tall, cupless, non squamulose, thin and elongate, simple or sparingly branched above, covered with farinose soresia. Apothecia rather frequent at the tip of the podetia, very pale brown to yellowish brown, convex. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Photobiont chlorococcoid. With barbatic acid and occasionally zeorin. Note: a mainly boreal-montane, perhaps circumpolar species, found amongst bryophytes and on organic soil, much more rarely on wood, in areas with siliceous substrata, in open heaths and forest glades; restricted to the Alps in Italy, where it is extremely rare.



- 95 Thallus KC-, without barbatic acid 96
96 Thallus P+ yellow, slowly changing to orange-red
see 61 - Cladonia rei Schaer.
96 Thallus P+ rapidly red, or P- 97
97 Thallus P-, without fumarprotocetraric acid 98

- 97 Thallus P+ red, with fumarprotocetraric acid 100
 98 *Podetia corticate* and often squamulose at the base. With homosekikaic acid

see 61 - Cladonia rei Schaer.

- 98 *Podetia ecorticate* at the base. Without homosekikaic acid 99
 99 With perlatolic acid. *Podetia* with cortex disrupted into patches which tend to become subsquamulose, sometimes with granular soredia

89 - *Cladonia decorticata* (Flörke) Spreng.



Thallus fruticose, pale grey, K-, C-, KC-, P-. Primary thallus squamulose, the squamules persistent, up to 4 mm long and 2 mm broad, irregularly divided, usually becoming concave; upper side glaucescent or olive-green, lower side white, darkening towards the attachment point. *Podetia* bacilliform, 1-4 cm tall, to 2.5 mm thick, cupless, sometimes with a few apical branches, with a verruculose cortex, the verruculae dispersed, tending to become subsquamulose, sometimes with granular soredia. Apothecia dark brown, convex, terminal. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Photobiont chlorococcoid. With perlatolic acid. Note: an arctic-alpine to boreal-montane, circumpolar species, found on mineral, more rarely on organic soil and rotting wood in open habitats; restricted to siliceous areas in the Alps.

- 99 With squamatic acid. *Podetia* with a single inconspicuous longitudinal fissure, without squamules, or with a few squamules below, farinose-sorediate

90 - *Cladonia glauca* Flörke



Thallus fruticose, pale grey, K-, C-, KC-, P-, UV+ bluish white. Primary thallus squamulose, the squamules ephemeral or persisting, 1-5 mm long and ca. 1 mm broad, irregularly lobed, pale greenish white or glaucescent above, white below. *Podetia* bacilliform, 1-5(-8) cm tall and up to 2.5 mm in diam., usually cupless, simple to sparingly branched above, with a single inconspicuous longitudinal fissure, decorticate and farinose-sorediate, sometimes with a few squamules below. Apothecia brown, convex. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Photobiont chlorococcoid. With squamatic acid. Note: a cool-temperate to boreal-montane, perhaps circumpolar lichen, found on acid soil in open habitats; all Italian records are from the Alps, and require re-confirmation.

- 100 *Podetia* >4 cm tall 101
 100 *Podetia* <4 cm tall 102
 101 *Podetia* brownish, up to 10 cm tall, with the soredia in rounded patches toward the upper part, a large part of the base corticate.

Primary squamules scarcely incised. Rather common in the Alps

91 - *Cladonia cornuta* (L.) Hoffm.



Thallus fruticose, brownish, K-, C-, KC-, P+ red (young parts of the podetia and sorediate areas sometimes K+ yellowish). Primary thallus squamulose, the squamules usually ephemeral, 3-8 mm long, 1-4 mm broad, crenate to irregularly lobed, ascending, glaucescent to olive-green above, whitish below. Podetia bacilliform, corticate only at base, non squamulose, 4-10(-15) cm tall, up to 2.5(-4) mm thick, evenly corticate below, farinose-sorediate above, with pointed apices, mostly unbranched. Apothecia rare, brown, convex, terminal. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Pycnidia dark, semi-immersed. Conidia cylindrical. Photobiont chlorococcoid. With fumarprotocetraric acid. Note: a boreal-montane to subarctic-subalpine, circumpolar species, found on mineral and organic soil, but also on wood; optimum in areas with siliceous substrata, near or above treeline; probably restricted to the Alps in Italy.

- 101 Podetia pale grey to whitish, up to 5(-7) cm tall, mostly evenly covered with soredia, only a small part of the base corticate. Primary squamules inconspicuous, elongate and deeply incised. Extremely rare in the Alps

see 63 - Cladonia subulata (L.) F.H.Wigg.

- 102 Podetia phyllopodiate, i.e. arising from inflated primary squamules, densely squamulose, pycnidia generally on the squamules. Very, rare, restricted to lowland areas

92 - *Cladonia pseudopityrea* Vain.



Thallus fruticose, pale brownish grey, K-, C-, KC-, P+ red, UV-. Primary thallus squamulose, the squamules persisting, forming dense mats, small to middle-sized, incised, densely granulose, white below. Podetia densely squamulose-granulose, sorediate, to 3 cm tall, irregularly ramified above or simple, rarely with cups. arising from inflated primary squamules (phyllopodiate). Pycnidia generally immersed in the squamules. Apothecia frequent, brown, convex. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Photobiont chlorococcoid. With fumarprotocetraric acid. Note: on lignum e.g. of *Olea*, *Abies*, *Pinus*, *Fagus*, but also on soil rich in humus in forests, esp. along creeks; a mediterranean to mediterranean-montane species, probably more widespread in Tyrrhenian Italy.

- 102 Podetia not phyllopodiate, squamulose or not, pycnidia mostly on the podetia. Not very rare, found both in lowland and upland areas 103
- 103 Soredia farinose, podetia non-squamulose, or squamulose only at the base

93 - *Cladonia coniocraea* (Flörke) Spreng.

Thallus fruticose, grey to whitish, K-, C-, KC-, P+ red, UV-.



Primary thallus squamulose, the squamules usually persisting, middle-sized, crenate to entire, convex to concave, grey, olive-green to brownish above, white below, often becoming sorediate. Podetia bacilliform, corticate only at base, 1-4 cm tall, 0.5-2 mm thick, usually unbranched, with pointed ends, only occasionally with very small cups, with a corticate and sometimes squamulose zone below, farinose-sorediate above. Apothecia terminal, brown, convex. Asci *Porpidia*-type. Spores 1-celled, hyaline, 8 per ascus. Photobiont chlorococcoid. With fumarprotocetraric acid. Note: a widespread, holarctic species, found on a wide variety of organic substrata, incl. bark, and then mostly on basal parts of boles, but mostly on soil rich in humus and rotten wood. Common throughout Italy.

103 Soredia granulose, podetia densely and minutely squamulose

see 64- Cladonia ramulosa (With.) J.R.Laundon

104 Thallus K+ red, with norstictic acid 105

104 Thallus K+ yellow or K-, without norstictic acid 106

105 Thallus K+ rapidly red, P+ red, without atranorin

94 - *Cladonia polycarpoides* Nyl.



Thallus fruticose, grey, rapidly K+ red, C-, KC-, P+ red. Primary thallus squamulose, the squamules persisting, prominent, 3-15 x 1-4 mm, olive-green above, white, but often becoming brownish below, ascending, forming dense mats. Podetia rather rare, thicker at apex, simple or sparsely ramified, sometimes squamulose. Apothecia rare, brown, convex. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Pycnidia dark, semi-immersed. Conidia cylindrical. Photobiont chlorococcoid. With norstictic acid. Note: a mainly temperate lichen, found on calcareous mineral soil in open grasslands and on soil pockets on large isolate boulders; probably somehow overlooked in Italy and more widespread, at least in the Alps.

105 Thallus K+ yellow, then slowly red, P+ orange-yellow, with atranorin

95 - *Cladonia symphyarpa* (Flörke) Fr.



Thallus fruticose, K+ yellow, then slowly red, C-, KC-, P+ orange-yellow. Primary thallus squamulose, the squamules persisting, prominent, often forming mats, 2-6 x 2-4 mm, horizontally spreading, with recurved margins, grey-green above, white below. Podetia to 1 cm tall, very rare, bluish- to olive-green, cupless, simple or branching toward the top and broadening upwards, and terminating with apothecia, or with irregular cups, with a verruculose-areolate, fissured cortex. Apothecia very rare, dark brown, larger than the tips of podetia. Asci *Porpidia*-type. Spores 1-celled, hyaline, 8 per ascus. Pycnidia dark brown to black, semi-immersed, often occurring on the primary squamules. Conidia cylindrical. Photobiont chlorococcoid. With norstictic acid and atranorin. Note: a widespread and common holarctic species, found on calcareous ground in dry grasslands or on the top of exposed

calcareous boulders; certainly occurring throughout S Italy.

- 106 Thallus K+ yellow 107
106 Thallus K- 114
107 Thallus P+ yellow, with baeomytic and squamatic acids

96 - *Thamnolia vermicularis* (Sw.) Schaer. var. subuliformis (Ehrh.) Schaer.



Thallus fruticose, pure white, remaining white in the herbarium, K+ yellowish, C-, KC-, P+ yellow, UV+ yellowish white, erect or decumbent, often forming tufts. "Podetia" 1-2(-3) mm thick (rarely to 8 mm), more or less cylindrical with pointed apices, smooth, non squamulose, usually to 5 (rarely to 10) cm tall. Medulla hollow. Apothecia not known. Photobiont chlorococcoid. With baeomytic and squamatic acids. Note: an arctic-alpine, circumpolar lichen, found in open, wind-exposed Alpine tundra-like stands above treeline; restricted to the Alps in Italy, where it is fairly common, but to be looked for on the highest peaks of the C Apennines.

- 107 Thallus P+ orange, P+ red or P-, with a different chemistry 108
108 Thallus P+ orange, with thamnolic acid 109
108 Thallus P+ red or P-, without thamnolic acid 110
109 Primary thallus present, podetia scabrid, squamulose, grey to greenish grey, not becoming pinkish in the herbarium
see 74 - Cladonia squamosa Hoffm. var. subsquamosa (Leight.) Vain.
109 Primary thallus absent, "podetia" smooth, non-squamulose, pure white, becoming pinkish in the herbarium

97 - *Thamnolia vermicularis* (Sw.) Schaer. var. vermicularis



Thallus fruticose, pure white, remaining white in the herbarium, K+ yellow, C-, KC-, P+ orange, UV-, erect or decumbent, often forming tufts. "Podetia" 1-2(-3) mm thick (rarely to 8 mm), more or less cylindrical with pointed apices, smooth, non squamulose, usually to 5 (rarely to 10) cm tall. Medulla hollow. Apothecia not known. Photobiont chlorococcoid. With thamnolic acid. Note: an arctic-alpine, circumpolar lichen, found on wind-exposed Alpine tundra-like stands, both on calcareous and siliceous substrata. Hitherto known only from the Alps, where it is fairly common above treeline; to be looked for on the highest peaks of the C Apennines

- 110 Thallus P+ red, with fumarprotocetraric acid 111
110 Thallus P-, without fumarprotocetraric acid 112
111 Podetia not very thick-walled, medullary hyphae not running parallel to the surface. Primary squamules large, conspicuous, 5-

20 mm long, to 7 mm broad

98 - *Cladonia turgida* Hoffm.

Thallus fruticose, greyish-green, somehow glaucescent, K+ yellow, C-, KC-, P+ red, UV-. Primary thallus squamulose, the squamules persistent, large, 5-20 mm long, 1-7 mm broad, coarse, with broad and rounded divisions, dark green to glaucescent above, cream-coloured below. Podetia simple to irregularly branched, the terminal branches usually subulate, cupless or with small, irregular cups, esorediate, with a smooth to areolate cortex, the areoles separated by white lines. Apothecia rare, brown, convex. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Photobiont chlorococcoid. With atranorin and fumarprotocetraric acid. Note: a mainly boreal-montane, circumpolar species, found on acid soil in open habitats; restricted to the Alps in Italy, and extremely rare.



111 Podetia very thick-walled, medullary hyphae running parallel to the surface. Primary squamules small to middle-sized, to 7 mm long and 2 mm broad

99 - *Cladonia cariosa* (Ach.) Spreng.

Thallus fruticose, grey, K+ yellow, C-, KC-, P- or rarely P+ red. Primary thallus squamulose, the squamules usually persistent, small to middle-sized, 1-4(-7) mm long and 1-2 mm broad, irregularly divided, entire to incised, concave to reflexed-convex, greenish white to olive-green above, white below. Podetia 0.5-2(-3) cm tall, up to 3 mm thick (often more below the apothecia), cupless, simple or sparingly branched above, often terminated by large apothecia, partly decorticate-granulose, longitudinally fissured, very thick-walled, with medullary hyphae running parallel to the surface. Apothecia frequent, terminal, brown, convex. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Pycnidia dark, semi-immersed in the primary squamules. Conidia cylindrical. Photobiont chlorococcoid. With atranorin and variable amounts of fumarprotocetraric acid. Note: a cool-temperate to subarctic-subalpine, circumpolar lichen, found on disturbed mineral, often sandy soil over calcareous or base-rich substrata; most frequent in the Alps, but generally very rare; several records outside the Alps require re-confirmation.



112 Thallus KC+ yellowish, with usnic acid. Apothecia and pycnidia pale yellowish brown

100 - *Cladonia botrytes* (K.G.Hagen) Willd.

Thallus fruticose, yellowish-green, K- or K+ yellowish, C-, KC+ yellowish, P-, UV-. Primary thallus squamulose, the squamules persistent or ephemeral, small, up to 1.5(-2) mm long, widening and crenate to lacinate at apex, ascending, yellowish green above, whitish below, esorediate. Podetia subcylindrical, widening toward the tip below the apothecia, to 5(-20) mm tall, simple or sparingly branched toward apices, cupless, corticate to the base, becoming verrucose-areolate, often terminated with one or more confluent apothecia, without squamules or rarely with a few small squamules at the base. Cortex of podetia smooth at first, becoming verrucose-



areolate, sometimes longitudinally fissured. Apothecia frequent, terminal, pale yellowish brown, often grouped in small clusters, convex, 0.5-4 mm broad. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Pycnidia semi-immersed on the upper side of the primary squamules or on the sides of the podetia, pale brown. Conidia cylindrical. Photobiont chlorococcoid. With usnic and barbatic acids. Note: a circumpolar, boreal-montane lichen, found on decaying wood, mostly on horizontal faces of stumps and fallen trunks, esp. of conifers, more rarely on decaying bark. Most frequent, but not common in the Alps, to be looked for along the Apennines, being also known from the mountains of Sardegna.

112 Thallus KC-, without usnic acid. Apothecia dark brown 113

113 Primary thallus squamulose. Podetia >0.5 mm diam., very thick-walled, with medullary hyphae running parallel to the surface

see 99 - Cladonia cariosa (Ach.) Spreng.

113 Primary thallus crustose. Podetia <0.5 mm diam., thin-walled

101 - *Pycnothelia papillaria (Ehrh.) Dufour*

Thallus fruticose, developing from a persistent, crustose primary thallus of grey-white granules, K+ yellow, C-, KC-, P- or P+ yellowish, UV+ blue-white. Pseudopodetia wart-like to cylindrical, grey to brownish, <0.5 mm thick, 2-5(-10) mm tall, smooth, non squamulose, with rounded, darkened apices, mostly simple but sometimes sparingly branched above, with frequent dark pycnidial ostioles. Apothecia extremely rare (never found in Italian material), terminal, brown, convex. Spores 1-2-celled, hyaline, fusiform, thin-walled, 8 per ascus, 9-15 x 2-3.5 µm. Pycnidia dark, immersed. Conidia filiform, curved. Photobiont chlorococcoid. With atranorin, and variable amounts of lichesterinic, protolichesterinic and squamatic acids. Note: an arctic-alpine to cool-temperate lichen, found on clay soil, often in *Calluna*-heaths, most frequent in the Alps, becoming much rarer in the Apennines, where however, it is certainly present in all areas with siliceous substrata, south to Sicily.



114 Apothecia and pycnidia scarlet red 115

114 Apothecia and pycnidia brown 116

115 Thallus KC+ yellow, with usnic and squamatic acids, yellowish green. Podetia densely squamulose, 3-5 cm tall

see 65 - Cladonia bellidiflora (Ach.) Schaer.

115 Thallus KC-, with barbatic and (rarely) thamnolic acids, greenish grey. Podetia non-squamulose, or only at the base, 1-3 cm tall

102 - *Cladonia macilenta Hoffm. subsp. floerkeana (Fr.) V. Wirth*

Thallus fruticose, greenish grey, K- or K+ yellowish, C-, KC-, P-, UV- or UV+ bluish. Primary thallus squamulose, the squamules



persistent, scattered or forming small mats, small to middle-sized, up to 2 mm long, undivided to crenate or slightly lobed, glaucous to olivaceous above, white below, sometimes pale orange-coloured near the attachment point. Podetia subcylindrical to bacilliform, 3-10 mm tall (rarely more, up to 40 mm), simple or branched in the upper part, the cortex variable, from smooth and unbroken to areolate, corticate, or without cortex in upper part, sometimes squamulose or granulose, the granules simulating very coarse soredia. Apothecia frequent, scarlet red, terminal. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Pycnidia scarlet red, semi-immersed in the primary squamules, rarely on the podetia. Conidia cylindrical. Photobiont chlorococcoid. With barbatic and (rarely) thamnolic acids. Note: a circumboreal-montane species, found on organic soil and peat, but also on siliceous sand, more rare on lignum. Known from the Alps and the highest siliceous mountains of Sardegna, much rarer than the typical subspecies.

116 Thallus C+ bright emerald green, with baeomycesic and squamatic acids, and strepsilin. Extremely rare, presence in Italy dubious

103 - *Cladonia strepsilis* (Ach.) Grognot



Thallus fruticose (mainly squamulose), brownish-greenish grey, K-, KC-, C+ bright emerald green, P+ yellow, UV+ whitish. Primary thallus squamulose, the squamules prominent, to 4 mm long, rounded or elongate, indented, forming cushions, bronze-green above, white below. Podetia very rare, small, with irregular cups or with a few thick branches, corticate, often squamulose at the base. Apothecia extremely rare, dark brown, convex. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Pycnidia brown, semi-immersed in the basal squamules. Photobiont chlorococcoid. With baeomycesic and squamatic acids, and strepsilin. Note: a cool-temperate to boreal-montane lichen, found on organic soil overlaying siliceous rocks and amongst bryophytes in humid depressions periodically filled by water, in open situations. There are only a few records, from Italy (Alps), and these need re-confirmation, see Nimis (1993: 245).

116 Thallus C-, with a different chemistry

117

117 Thallus P+ yellow, with psoromic acid

104 - *Cladonia macrophylla* (Schaer.) Stenh.



Thallus fruticose, greenish grey to brownish grey, K-, C-, KC-, P+ yellow, UV-. Primary thallus squamulose, the squamules persistent, large to rarely middle-sized, 3-8 mm long and broad, round or elongate, lobate to incised, glaucescent to rarely olive-green above, white below, sometimes darkening towards the attachment point. Podetia elongate, 2-4(-6) cm tall, up to 5 mm in diam. (usually less), cupless, simple or branched, with blunt apices and a fissured surface with numerous peltate squamules up to 1 mm broad (usually less) and black-grey decorticated areas at the base. Apothecia brown, convex, terminal on podetia. Asci *Porpidia*-type. Spores 1-celled,

hyaline, ellipsoid, 8 per ascus. Pycnidia dark, semi-immersed on the tips of podetia and on their squamules. Conidia cylindrical. Photobiont chlorococcoid. With psoromic acid. Note: a northern-alpine species found on organic soil and weathered siliceous rocks; certainly restricted to the Alps; most Italian records need re-confirmation.

- 117 Thallus P+ red or P-, without psoromic acid 118
 118 Thallus P-, without fumarprotocetraric acid 119
 118 Thallus P+ red, with fumarprotocetraric acid 120
 119 Podetia thin, non squamulose, greenish-yellowish, to 5 mm tall. Apothecia and pycnidia very pale yellowish brown. With usnic acid, without squamatic acid. Medulla UV-

see 100 - Cladonia botrytes (K.G.Hagen) Willd.

- 119 Podetia thick, densely squamulose, whitish grey, to 5 cm tall. Apothecia and pycnidia medium to dark brown. Without usnic acid, with squamatic acid. Medulla UV+ white

see 74 - Cladonia squamosa Hoffm. var. squamosa

- 120 Podetia thick (2-5 mm), very tall (to 12 cm)

see 80 - Cladonia macroceras (Delise) Hav.

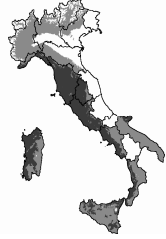
- 120 Podetia (if present) thinner, much smaller 121
 121 Primary squamules large, cream-coloured below 122
 121 Squamules small to middle-sized, pure white below 123
 122 Mostly on calcareous substrata. Primary squamules 15-40 x 2-10 mm

105 - Cladonia convoluta (Lam.) Anders



Thallus - when with podetia - fruticose, but mostly squamulose, greenish grey, K-, C-, KC+ yellowish, P+ red, UV-. Primary thallus squamulose, the squamules very large 15-40 x 2-10 mm, sometimes with black or white hairs at the margins, persistent, forming straggling clusters, greenish to greenish-grey above, cream-coloured (yellowish) below. Podetia extremely rare, to 1.5 cm tall, with pale brown, convex and often confluent apothecia. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Photobiont chlorococcoid. With fumarprotocetraric and usnic acids. Note: a mild-temperate, common calcicolous species, found on mineral soil in dry grasslands, or in intradunal depressions; also occurring in dry-continental Alpine valleys.

- 122 Mostly on base-rich siliceous substrata. Primary squamules 4-15 x 1-3 mm

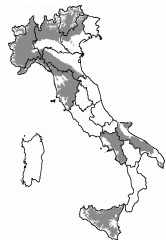


106 - *Cladonia foliacea* (Huds.) Willd.

Thallus - when with podetia - fruticose, but mostly squamulose greenish grey, K-, C-, KC+ yellowish, P+ red, UV-. Primary thallus squamulose, the squamules large, 4-15 x 1-3 mm, persistent, forming compact mats, sometimes with black hairs at the margins, greenish to greenish-grey above, cream-coloured (yellowish) below. Podetia extremely rare, to 1.5 cm tall, with pale brown, convex and often confluent apothecia. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Photobiont chlorococcoid. With fumarprotocetraric and usnic acids. Note: a mild-temperate lichen, an ecological vicariant of *C. convoluta* on more base-rich, non-calciferous ground. Common, esp. in Tyrrhenian Italy.

123 Podetia, when present, <3 mm tall. With fumarprotocetraric acid. Primary squamules middle-sized, to 7 mm long

107 - *Cladonia caespiticia* (Pers.) Flörke



Thallus fruticose, greenish grey, K-, C-, KC-, P+ red, UV-. Primary thallus squamulose, the squamules persistent, 2-8 mm long, to 1.5 mm wide, strongly divided and irregularly incised, ascending, mostly forming low cushions, pale greyish to brownish green above, white below. Podetia small, to 3 mm tall, partly without cortex. Apothecia rather rare, terminal, sessile or on short stalks lacking algae, single or clustered, pale brown, more or less translucent when wet, convex. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Pycnidia brown, semi-immersed on the upper surface of the basal squamules. Conidia cylindrical. Photobiont chlorococcoid. With fumarprotocetraric acid. Note: a cool-temperate to S boreal-montane, circumpolar lichen, found on mineral, generally sandy-clay soil, occasionally on rotting wood and on bases of ancient trunks, in sheltered situations. Certainly widespread throughout the country, but very rare.

123 Podetia >10 mm tall. With fumarprotocetraric acid and variable amounts of ursolic acid. Primary squamules very small (<1 mm long)

108 - *Cladonia peziziformis* (With.) J.R.Laundon



Thallus fruticose, grey, K-, C-, KC-, P+ red. Primary thallus squamulose, the squamules very small, granule-like to rounded and ear-shaped, with more or less entire margin, white below. Podetia areolate, to 2 cm tall, simple, sometimes fissured and sparsely squamulose. Apothecia frequent, brown, convex. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Pycnidia dark, semi-immersed. Conidia cylindrical. Photobiont chlorococcoid. With fumarprotocetraric acid and variable amounts of ursolic acid. Note: a mainly temperate lichen, found on soil in open woodlands (oak, pine), in areas with siliceous substrata; known only from Liguria, but perhaps overlooked in Italy.

Key 2 - Foliose lichens

- 1 Thallus bright yellow to orange 2
- 1 Thallus of other colours 5
- 2 Thallus K-, with vulpinic and pinastric acids

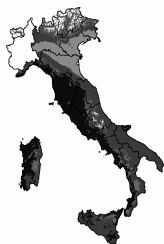
1 - *Vulpicida tubulosus* (Schaer.) J.E.Mattsson & M.J.Lai



Thallus foliose, golden yellow, loosely attached, K-, C-, KC- or KC+ yellow, P-. Lobes (2-)3-6 mm broad, elongate, ascending at least at the tips, sometimes suberect, smooth to slightly sulcate, the tips somehow dentate. Lower surface yellowish. Rhizines very rare to absent, pale, simple. Medulla yellow, K-, C-, KC-, P-. Upper and lower cortex paraplectenchymatous. Apothecia extremely rare (not seen in Italian material), lecanorine, sessile, strongly constricted. Disc dark brown, margin thick, golden yellow. Epithemium brownish. Hymenium colourless. Asci *Lecanora*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Pycnidia black, on marginal projections. Conidia lemon-shaped. Photobiont chlorococcoid. With usnic, vulpinic and pinastric acids. Note: a mainly arctic-alpine, circumpolar lichen, found on calciferous mineral soil in dry Alpine grasslands and on wind-exposed ridges, mostly above treeline. Ranging throughout the Alps, but rare; most certainly absent from the Apennines.

- 2 Thallus K+ red, with xanthonex 3
- 3 Lobes >3 mm broad, most frequent in lowland areas

2 - *Xanthoria calcicola* Oksner



Thallus foliose, orange, orbicular, often with convex knots at the centre, K+ red, C-, KC-, P-. Lobes (2-)3-6 mm broad, elongated, rounded at tips, weakly concave to flattened. Lower surface pale orange to yellowish grey, attached by scattered hapters. Apothecia rare, lecanorine, sessile, strongly constricted. Disc orange, margin thick, smooth to verruculose. Epithemium K+ red. Asci clavate, bitunicate, thickened at apex with a broad internal beak, I+ blue in the outer part of the apex. Spores 2-celled, hyaline, ellipsoid, polar-diblastic, 8 per ascus. Photobiont chlorococcoid. With anthraquinones (parietin). Note: a mainly mediterranean to mild-temperate lichen, found on the top of isolated calcareous and basic-siliceous boulders, and, limited to the W side of the Peninsula, abundant on roofing tiles; in strongly eutrophicated situations it can occasionally overgrow bryophytes and plant remains.

- 3 Lobes <2 mm broad, most frequent in the mountains 4
- 4 Lobes convex, 0.5-1 mm broad. Thallus deep orange to orange-red

3 - *Xanthoria elegans* (Link) Th.Fr. subsp. *elegans*

Thallus foliose to subcrustose, deep orange to orange-red, K+ red, C-, KC-, P-. Lobes 0.5-1 mm broad, elongate, convex, irregularly



branched, adpressed to the substratum, mostly forming rosettes. Apothecia rather common, rounded, lecanorine, sessile, strongly constricted, to 3 mm diam. Disc orange, flat, smooth, margin thin, smooth. Epithecium K+ red. Asci clavate, bitunicate, thickened at apex with a broad internal beak, I+ blue in the outer part of the apex. Spores 2-celled, hyaline, ellipsoid, polar-diblastic, 8 per ascus, 10-16 x 5-8 μ m. Photobiont chlorococcoid. With anthraquinones, mainly parietin. Note: a northern holarctic species, found both on natural rock outcrops and on man-made substrata (esp. tiles), mostly in upland areas, descending to lower elevations in continental sites; in strongly eutrophicated situations it can occasionally overgrow bryophytes and plant remains on the ground. Widespread throughout the country, but rare in the south.

4 Lobes flattened, 1-2 mm broad. Thallus orange

4 - *Xanthoria elegans* (Link) Th.Fr. subsp. orbicularis (Schaer.) Clauzade & Cl.Roux



Thallus foliose, orange, orbicular, K+ red, C-, KC-, P-. Lobes 1-2 mm broad, elongate, flattened, contiguous, adpressed to the substratum to slightly ascending at the tips, forming regular to irregular rosettes. Apothecia rather common, rounded, lecanorine, sessile, strongly constricted, to 4 mm diam. Disc orange, smooth, margin distinct, thin. Epithecium K+ red. Asci clavate, bitunicate, thickened at apex with a broad internal beak, I+ blue in the outer part of the apex. Spores 2-celled, hyaline, ellipsoid, polar-diblastic, 8 per ascus. Pycnidia immersed. Photobiont chlorococcoid. With anthraquinones (parietin). Note: most often growing together with *X. elegans*. We have the impression that, at least in the Alps, *X. elegans* is heterogeneous; some forms, provisionally treated under this name, might prove to belong to the *X. calcicola* complex, and well deserve further study. Italian distribution poorly known: certainly common in the Alps.

- | | | |
|---|---|----|
| 5 | Thallus dark, from black to dark brown | 6 |
| 5 | Thallus not dark | 22 |
| 6 | With soredia or isidia | 7 |
| 6 | Without soredia or isidia | 10 |
| 7 | With soredia. Thallus heteromerous, not gelatinous when wet (if thallus heteromerous, see nr. 9: <i>Massalongia carnososa</i>) | |

5 - *Nephroma parile* (Ach.) Ach.



Thallus foliose, bluish grey to dark brown, loosely attached, K-, C-, KC-, P-. Lobes rounded, 4-8(-15) mm broad, the upper surface smooth to rarely subfoveolate, with initially rounded to linear soralia, the latter more frequent at the margins, forming bluish-grey patches, the soredia granular. Lower surface brown, smooth to wrinkled, naked or in part somehow pubescent. Upper and lower cortex paraplectenchymatous. Medulla white, K- or K+ yellowish, P-. Apothecia rare, lecanorine, on the lower surface of thallus at tips of ascending lobes, to 8 mm diam., the margin prominent, often

sorediate, the disc brown. Asci *Peltigera*-type, fissitunicate, the thickened apex with a K/I+ blue ring. Spores 4-celled, pale brown, fusiform-elongate, 8 per ascus, (16-)18-20 x 6-7 μ m. Pycnidia rare, marginal, punctiform. Conidia bacilliform, 4-5 x 1 μ m. Photobiont cyanobacterial (*Nostoc*), in short chains. With different combinations of hopane triterpenoids. Note: a cool-temperate to circumboreal-montane lichen, found on bark, epiphytic mosses, basic siliceous rocks and soil in humid and sheltered situations. Widespread but rare in the mountains, more common in the Alps, but reaching the mountains of Calabria.

- 7 With isidia. Thallus homeomerous, gelatinous when wet 8
- 8 Isidia granulose, not flattened. Spores hyaline at maturity (if ripe spores yellowish brown see 17: *C. bachmanianum*)

6 - *Collema tenax* (Sw.) Ach.



Thallus foliose, gelatinous when wet, dark olive-green to brownish black, thick, K-, C-, KC-, P-, UV-. Lobes 1-2(-3) mm broad, elongate, smooth, very variable in shape, from subterete and ascending, to concave, flattened or convex and adpressed to the substratum, with or without granulose isidia. Upper and lower cortex absent. Apothecia frequent, lecanorine, sessile, up to 3 mm diam. Disc brown to black, margin distinct, thick, smooth, with euthyplectenchymatous excipulum. Epihymenium brownish. Hymenium colourless, I+ blue. Hypothecium colourless. Paraphyses simple or sparingly branched, with clavate to subglobose tips. Asci clavate, the apex thick, with a I+ blue apical dome and a I+ blue annulus projecting downwardly. Spores 4- to many-celled (submuriform), usually constricted at septa, hyaline, ellipsoid, 8 per ascus, 15-25 x 6.5-13 μ m. Pycnidia common, globose, pale with a darker apex, appearing as small reddish dots. Conidia straight, slightly swollen at tips, 4.5-6 x 1-5-2 μ m. Photobiont cyanobacterial (*Nostoc*), in long chains. Without lichen substances. Note: a widespread, holarctic, almost cosmopolitan lichen, found on calciferous or base-rich siliceous soil in open habitats (e.g. in dry grasslands), on consolidating sand dunes and on terricolous bryophytes, more rarely directly on rock, often found also in disturbed habitats such as track sides in urban settlements (e.g. in the very centre of Rome); an extremely polymorphic and ecologically wide-ranging species, certainly the most common of the genus in Italy.

- 8 Isidia flattened, spatulate 9
- 9 Lobes brown, ascending, ear-like, not very thick when wet. Spores 4-7-celled, sometimes submuriform, >10 μ m broad

7 - *Collema crispum* (Huds.) F.H.Wigg.

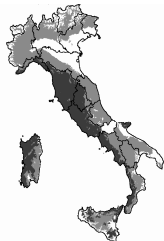
Thallus foliose, gelatinous and slightly swollen when wet, olive green-brown to brownish black, smooth to (mostly) isidiate, up to 5 cm diam., K-, C-, KC-, P-. Lobes rounded, contiguous, 1-6 mm broad, with and undulate, entire margin, ascending and ear-like, crowded, forming colonies to 6 cm diam. Isidia first granulose, but



soon flattened, spatulate, diffuse, simple. Lower surface brown, often with white hapters. Upper and lower cortex absent. Apothecia rare, lecanorine, sessile, not or slightly constricted, 1-2(-2.5) mm diam. Disc reddish brown to dark brown, mostly flat, margin thin, verruculose to isidiate-lobulate, with an euthyplectenchymatous excipulum. Epihymenium brownish. Hymenium colourless, I+ blue, 130-170 μm tall. Hypothecium colourless. Paraphyses simple or sparingly branched, 1.5-2 μm thick, with clavate to subglobose tips. Asci narrowly clavate, the apex thick, with a I+ blue apical dome and a I+ blue annulus projecting downwardly. Spores 4-celled to submuriform, constricted at septa, hyaline, oblong-obtuse, 8 per ascus, 20-34 x 10-16 μm . Pycnidia rare to common, visible as reddish, paler, somehow prominent dots. Conidia straight, slightly swollen at tips, 4.5-6 x 1.5-1.8 μm . Photobiont cyanobacterial (*Nostoc*), in long chains. Without lichen substances. Note: a mainly mild-temperate lichen, found both on calcareous rocks and soil, often in rather disturbed habitats such as walls; most common in C and S Italy; the mostly saxicolous, smaller var. *metzleri* (Arnold) Degel. - in our opinion - is hardly worthy of taxonomic recognition.

- 9 Lobes blackish brown to black, not ascending and ear-like, very thick when wet. Spores 5-6-celled, never submuriform, <10 μm broad

8 - *Collema flaccidum* (Ach.) Ach.



Thallus foliose, gelatinous when wet, blackish brown to black, thick, smooth, loosely attached, to 6 cm diam. (mostly less), broadly lobate, K-, C-, KC-, P-, UV-. Lobes (0.5-)1-3(-4) mm broad, rounded, flattened, contiguous, adpressed to the substratum, with an entire, undulated, never swollen margin. Isidia globular when young, but soon becoming squamiform, diffuse, mostly simple. Upper and lower cortex absent. Apothecia rare, lecanorine, sessile, to 2.5 mm diam. Disc reddish brown, flat to convex with age, margin thin, entire, with pseudocorticate exciple. Epihymenium brownish. Hymenium colourless, I+ blue, 90-130 μm tall. Hypothecium colourless. Paraphyses simple or sparingly branched, 2(-4) μm thick, with clavate to subglobose tips. Asci narrowly clavate, the apex thick, with a I+ blue apical dome and a I+ blue annulus projecting downwardly. Spores 5-6-celled, hyaline, fusiform-elongate, 8 per ascus, 25-40 x 6-7 μm . Pycnidia common, usually thicker than thallus. Conidia straight, (3-)4-4.5(-6) x 1-1.5(2) μm . Photobiont cyanobacterial (*Nostoc*), in long chains. Without lichen substances. Note: a mainly temperate to southern boreal-montane lichen with a fragmented holarctic range, found on bark, epilithic mosses, base-rich siliceous and slightly calciferous rocks in sheltered, humid situations. More common in the past and now absent from urban areas and the Po-Plain; optimum in Tyrrhenian Italy, but still locally frequent in humid Alpine and pre-Alpine areas.

- 10 Thallus stratified, not gelatinous when wet. Upper cortex composed by 3-8 layers of cells

9 - *Massalongia carnosa* (Dicks.) Körb.



Thallus tiny foliose to subsquamulose, red brown to blackish brown, paler when wet, K-, C-, KC-, P-, UV-. Lobes initially rounded, then elongate, flattened, 0.5-1.5(-2) mm broad, 0.5-3(-10) mm long, irregularly branched and overlapping, often forming rosettes 1-3 cm in diam., the margin dissected by numerous, flattened, usually paler lobes or warts simulating isidia. Underside whitish to brown, with sparse brown rhizines. Upper cortex paraplectenchymatous, 25-30 μm thick. Lower cortex of longitudinally arranged hyphae. Apothecia rare, rounded, without a thalline margin, sessile to substipitate, up to 2 mm diam. Disc red-brown to flesh-coloured, margin thin, pale brown, sometimes with short hairs. Epithecium brownish, K-. Hymenium colourless, I+ blue. Hypothecium colourless. Paraphyses simple, slightly thickened above, adglutinated. Asci *Peltigera*-type, fissitunicate, the thickened apex with a K/I+ blue ring. Spores 2-(4-)celled, hyaline, fusiform to narrowly ellipsoid, thin-walled, 8 per ascus, 11-25(-32) x 4.5-7(-8.5) μm . Pycnidia dark, paler below, semi-immersed, to 0.6 mm diam. Conidia slightly bifusiform, 4-6 x 1 μm . Photobiont cyanobacterial (*Nostoc*), in short chains. Without lichen substances. Note: a circumpolar arctic-alpine to boreal-montane lichen found on bryophytes and soil rich in humus. Present both in the Alps and in the mediterranean mountains, but rare.

- 10 Thallus not stratified, gelatinous when wet. Upper cortex absent, or composed by 1(-3) layers of cells 11
- 11 Thallus with thin transparent hairs, esp. at the margin 11

10 - *Leptochidium albociliatum* (Desm.) M.Choisy



Thallus foliose to squamulose, gelatinous when wet, dark brownish-greenish black, K-, C-, KC-, P-, UV-. Lobes flattened, ascending, 3-5 mm broad, smooth, with rounded ends and undulate to crenulate margins bearing abundant thin transparent hairs. Lower surface with sparse fasciculate rhizines. Upper and lower cortex paraplectenchymatous, formed by 1-3 layers of cells, 10-40 μm thick. Apothecia rare, lecanorine, adnate, 0.3-0.7(-1.2) mm diam. Disc brown, smooth, concave to flat; margin thick, paraplectenchymatous in section, covered by hairs. Epithecium brownish. Hymenium and hypothecium colourless. Paraphyses branched, septate, swollen at apices. Asci clavate. Spores 2-celled, hyaline, narrowly ellipsoid, 8 per ascus, 18-26 x 5-7(-9) μm . Photobiont cyanobacterial (*Scytonema*). Without lichen substances. Note: a cool-temperate to arctic-alpine lichen found amongst bryophytes on rocks or on soil in open shrublands and grasslands on basic siliceous substrata, mostly in the mountains. Present both in the Alps and in the mediterranean mountains, where it is locally abundant (e.g. on the Aspromonte Massif, Calabria).

- 11 Thallus without hairs 12
- 12 Thallus thin, with an evident cortex composed by a single layer of angular cells (observe a lobe under the microscope from above) 13

- 12 Thallus thick, without cortex 15
- 13 Lobes suberect, cucullate, with revolute, entire margin, appearing tube-like esp. above, with antler-like tips

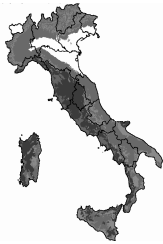
11 - *Leptogium corniculatum* (Hoffm.) Minks



Thallus foliose, subgelatinous when wet, brown to olive-green, smooth to (mostly) wrinkled, the wrinkles running the length of the lobes, somehow shiny esp. at the tips, loosely attached, K-, C-, KC-, P-, UV-. Lobes 3-8 mm broad, and to 3(-5) cm long, ascending, with revolute margins which curl inward, becoming more or less tubular, esp. above, usually with antler-like tips. Cortex composed by a single layer of angular cells. Apothecia very rare (not seen in Italian material), lecanorine, sessile, strongly constricted, to 0.7 mm diam. Disc brown, concave to flat, smooth, margin thin. Epithecium pale brownish. Hymenium and hypothecium colourless. Paraphyses adglutinated, mostly simple, the apices swollen. Asci clavate, the wall K/I+ blue, apical dome pale blue with a dark blue axial tube. Spores many-celled, hyaline, broadly ellipsoid, submuriform, thin-walled, 8 per ascus, 30-56 x 10-20 μm . Photobiont cyanobacterial (*Nostoc*), in long chains. Without lichen substances. Note: a mainly mild-temperate lichen, found amongst terricolous or epilithic mosses in areas with siliceous substrata; mainly western and Tyrrhenian in Italy, restricted to warm-humid, natural areas.

- 13 Margin of lobes not revolute-cucullate, tips never antler-like 14
- 14 Edge of lobes more or less entire

12 - *Leptogium gelatinosum* (With.) J.R.Laundon



Thallus small-foliose to squamulose, gelatinous when wet, bluish grey to dark brown, often paler in the basal, less exposed parts, dull or somehow shiny, thin, loosely attached, of ascending lobes forming cushions, K-, C-, KC-, P-, UV-. Lobes (1-)3-4 mm broad and to 1.5 cm long, ascending, often imbricate, wrinkled, with entire to irregularly lobulate margins. Cortex composed by a single layer of angular cells. Apothecia rare, adnate to sessile, rounded, lecanorine, sessile, strongly constricted, to 2 mm diam. Disc brown, concave to flat, smooth; margin thick, sometimes concentrically wrinkled. Epithecium pale brownish. Hymenium and hypothecium colourless. Paraphyses adglutinated, mostly simple, the apices swollen. Asci clavate, the wall K/I+ blue, apical dome pale blue with a dark blue axial tube. Spores many-celled, hyaline, broadly ellipsoid, submuriform, thin-walled, 8 per ascus, 25-45 x 11-18 μm . Photobiont cyanobacterial (*Nostoc*), in long chains. Without lichen substances. Note: a widespread holarctic lichen, most common on base-rich siliceous substrata, esp. in open grasslands, and apparently well-distinguished from the more calcicolous *L. lichenoides*.

- 14 Edge of lobes deeply dilacerate-fringed

13 - *Leptogium lichenoides* (L.) Zahlbr.

Thallus small-foliose to squamulose, gelatinous when wet, bluish grey to dark brown, often paler in the basal, less exposed parts, thin,



loosely attached, of ascending crowded lobes, often forming a cushion, K-, C-, KC-, P-, UV-. Lobes 0.3-3(-4) mm broad and to ca. 1 cm long, more or less imbricate, the surface distinctly wrinkled, the edges deeply dilacerate-fimbriate, the divisions sometimes almost coralloid. Cortex composed by a single layer of angular cells. Apothecia rare, rounded, lecanorine, sessile, strongly constricted, 0.4-1 mm diam. Disc brown, concave to flat, smooth; margin often with lobulate to coralloid outgrowths. Epithecium pale brownish. Hymenium and hypothecium colourless. Paraphyses adglutinated, mostly simple, the apices swollen. Asci clavate, the wall K/I+ blue, apical dome pale blue with a dark blue axial tube. Spores many-celled, hyaline, broadly ellipsoid, submuriform, thin-walled, 8 per ascus, 25-50 x 11-16 μm . Photobiont cyanobacterial (*Nostoc*), in long chains. Without lichen substances. Note: a widespread holarctic lichen, the most common species of *Leptogium* in Italy; mostly found on soil and amongst mosses in dry grasslands, more rarely on basal parts of trunks, but also on walls in urban areas.

15 Spores 2-celled

14 - *Collema coccophorum* Tuck.



Thallus foliose, gelatinous when wet, black, thick, up to 2.5 cm diam., K-, C-, KC-, P-, UV-. Lobes elongate, radiating or sometimes imbricate, more or less smooth, 0.5-3 mm broad, plane to concave, more or less swollen, resembling those of typical *C. tenax*. Upper and lower cortex absent. Apothecia frequent, lecanorine, sessile, up to 3 mm diam. Disc reddish brown to brown, flat to convex; margin thick, smooth to lobulate, with an euthyplectenchymatous excipulum. Epihymenium brownish. Hymenium colourless, I+ blue, 70-90(-100) μm tall. Hypothecium colourless. Paraphyses simple or sparingly branched, with clavate to subglobose tips. Asci clavate, the apex thick, with a I+ blue apical dome and a I+ blue annulus projecting downwardly. Spores 2-celled, hyaline, ellipsoid to fusiform, 8 per ascus, 15-22 x 6.5-8.5 μm . Conidia slightly swollen toward ends, 4.5-6 x 1.5-18 μm . Photobiont cyanobacterial (*Nostoc*), in long chains. Without lichen substances. Note: on calciferous soil in dry grasslands; the only locality is in Croatia (Istria), not far from the Italian border, but this almost cosmopolitan species of dry areas - which can be easily mistaken for *C. tenax* - might be more widespread in Italy, esp. in dry mediterranean areas of the south.

15 Spores not 2-celled 16

16 Spores 4-celled

see 6 - *Collema tenax* (Sw.) Ach.

16 Spores not 4-celled 17

17 Spores 1-celled 18

17 Spores more than 4-celled 19

18 Spores ellipsoid, 20-33 x 10-13 μm

15 - *Lempholemma chalazanum* (Ach.) de Lesd.



Thallus foliose, gelatinous when wet, dark olivaceous brown to black, wrinkled to granulose, K-, C-, KC-, P-, UV-. Lobes 1-2(-3) mm broad, elongate, flattened, adpressed to the substratum, with irregular ridges, ecorticate on both sides. Apothecia frequent, rounded, lecanorine, semi-immersed, 0.2-0.4 mm diam., often located along the ridges. Disc brown, concave, to flat, smooth, pore-like; margin indistinct. Epithecium brownish. Hmenium and hypothecium colourless. Paraphyses simple, not apically thickened, adglutinated. Asci cylindrical, without a distinct apical apparatus. Spores 1-celled, hyaline, ellipsoid, 8 per ascus, with a gelatinous perispore which dissolves in K, 20-33 x 10-13 μm . Pycnidia dark, immersed. Conidia bacilliform. Photobiont cyanobacterial (*Nostoc*), in long chains. Without lichen substances. Note: a mainly temperate lichen, found in dry grasslands on calciferous substrata, sometimes overgrowing bryophytes and plant debris, but also on walls; probably overlooked, being easily confused with a *Collema*, and certainly more widespread.

18 Spores globose, 9-14 x 9-14 μm

16 - *Lempholemma polyanthes* (Bernh.) Malme



Thallus foliose, gelatinous when wet, dark olivaceous brown to black, loosely attached, K-, C-, KC-, P-, UV-. Lobes 1-2(-3) mm broad, elongate, flattened, wrinkled to granulose, ecorticate on both sides. Apothecia frequent, lecanorine, semi-immersed, 0.2-0.4 mm diam. Disc brown, flat to concave, smooth, pore-like; margin indistinct. Epithecium brownish. Hymenium and hypothecium colourless. Paraphyses simple, not apically thickened, adglutinated. Asci cylindrical, without a distinct apical apparatus. Spores 1-celled, hyaline, globose, 8 per ascus, 9-14 x 9-14 μm . Pycnidia dark, immersed. Conidia bacilliform. Photobiont cyanobacterial (*Nostoc*) in long chains. Without lichen substances. Note: a cool-temperate to arctic-alpine, circumpolar lichen, found on terricolous or epilithic bryophytes, over soil or on plant debris, sometimes on walls; much overlooked or confused with *Collema*-species, probably more widespread.

19 Spores yellowish brown at maturity (a very rare species restricted to alpine areas)

17 - *Collema bachmanianum* (Fink) Degel.



Thallus foliose, gelatinous and strongly swollen when wet, dark olive-green to black, 2-6 cm diam., thick, rigid, adnate to the substratum, K-, C-, KC-, P-, UV-. Lobes 2-4(-6) mm broad, flattened to slightly concave, more or less lobulate, with somehow swollen, often verruculose margins, the verrucae simulating granulose isidia; central part of thallus with dense erect, divided, finger-like lobules. Lower surface usually paler, with dense white hapters. Upper and lower cortex absent. Apothecia frequent, lecanorine, sessile with a constricted basis, up to 3 mm diam. Disc brown to black, flat to mostly deeply concave; margin thick to thin, usually crenulate to lobulate, with an euthyplectenchymatous excipulum. Epihymenium

brownish. Hymenium colourless, I+ blue, 100-135 µm tall. Hypothecium colourless. Paraphyses simple or sparingly branched, ca. 2 µm thick, with clavate to subglobose tips. Asci narrowly clavate to subcylindrical, the apex thick, with a I+ blue apical dome and a I+ blue annulus projecting downwardly. Spores many-celled, hyaline when young, pale yellowish brown at maturity, submuriform, ellipsoid to oval, 8 per ascus, 22-34 x 8.5-15 µm. Pycnidia absent. Internal Conidia 10.5-13 x 2-3 µm. Photobiont cyanobacterial (*Nostoc*), in long chains. Without lichen substances. Note: a mainly arctic-alpine, circumpolar species, found on calciferous or base-rich siliceous soil; restricted to the Alps in Italy, near of above treeline.

- 19 Spores hyaline 20
 20 Spores 8 per ascus

see 6 - Collema tenax (Sw.) Ach.

- 20 Spores (2-)4 per ascus 21
 21 Above or near treeline. Thallus to 1 cm thick, subfruticulose, with erect, subterete lobules forming cushions. Spores ovoid to almost cubical

18 - Collema ceraniscum Nyl.

Thallus foliose to subfruticulose, very thick, pulvinate, gelatinous when wet, dark blackish brown to black, deeply lobate, up to 4 cm diam., K-, C-, KC-, P-, UV-. Lobes 0.5-2 mm broad, ascending to erect, the lower ones more or less flattened and broader, smooth to knotty, the upper ones subcylindrical, terete, 0.1-0.2 mm thick, densely packed and of ca. the same height, forming a cushion up to 1 cm thick. Upper and lower cortex absent. Apothecia frequent, lecanorine, sessile, 0.4-0.8(-1) mm diam. Disc red-brown to black, usually strongly concave; margin distinct, smooth to papillose-lobulate, with a paraplectenchymatous excipulum. Epihymenium brownish. Hymenium colourless, I+ blue, 150-190 µm tall. Hypothecium colourless. Paraphyses simple or sparingly branched, 1.5-2(-3) µm thick, with clavate to subglobose tips. Asci clavate to subcylindrical, the apex thick, with a I+ blue apical dome and a I+ blue annulus projecting downwardly. Spores many-celled, hyaline, ovoid to almost cubical when young, muriform, (2-)4 per ascus, 20-40 x 13-22 µm. Pycnidia not found. Photobiont cyanobacterial (*Nostoc*), in long chains. Without lichen substances. Note: an arctic-alpine, perhaps circumpolar lichen, found over frost-disturbed, weakly calcareous soil; to be looked for further in the Alps, where it is perhaps more widespread.



- 21 Mostly below treeline. Thallus thin, film-like, subcrustose. Spores ellipsoid

19 - Collema limosum (Ach.) Ach.

Thallus foliose to subcrustose, gelatinous when wet, dark olive-brown to bluish-blackish, thin and film-like, up to 5 cm diam., K-,



C-, KC-, P-, UV-. Lobes flattened, contiguous, adpressed to the substratum, poorly evident to absent, smooth to rugose, the margins somehow swollen. Upper and lower cortex absent. Apothecia frequent, rounded, lecanorine, innate to adpressed, 1-3(-4) mm diam. Disc brown to blackish brown, slightly concave to convex; margin thick to thin in old apothecia, smooth to (rarely) lobulate, with an euthyplectenchymatous excipulum. Epihymenium brownish. Hymenium colourless, I+ blue, 90-120 μm tall. Hypothecium colourless. Paraphyses simple or sparingly branched, with clavate to subglobose tips. Asci narrowly clavate, the apex thick, with a I+ blue apical dome and a I+ blue annulus projecting downwardly. Spores many-celled, hyaline, oblong to subovoid, submuriform, (2-)4 per ascus, 20-40 x 7-16 μm . Pycnidia very rare. Conidia straight, 4.5-6 x 1-1.8 μm . Photobiont cyanobacterial (*Nostoc*) in long chains. Without lichen substances. Note: a holarctic, temperate to boreal-montane, short-lived species of mineral, clay soil in disturbed habitats; certainly overlooked, but never common in Italy.

- | | | |
|----|--|----|
| 22 | Photobiont cyanobacterial (<i>Nostoc</i>) (photobiont layer bluish green in section) | 23 |
| 22 | Photobiont chlorococcoid (photobiont layer bright green in section) | 41 |
| 23 | With soredia or isidia | 24 |
| 23 | Without soredia or isidia | 26 |
| 24 | With soredia | |

20 - *Peltigera didactyla* (With.) J.R.Laundon



Thallus foliose, greenish grey to brownish, K-, C-, KC-, P-, UV-. Lobes 6-10 mm broad, rounded, concave, ear-shaped and sorediate when young, ascending, without soredia, and bearing vertically arranged apothecia when old. Soralia maculiform, laminar, flat, rounded at first, then becoming confluent, soredia grey to grey-brown. Upper surface tomentose, at least at margin. Lower surface whitish, with narrow (0.4-0.7 mm broad) whitish to brownish veins and simple rhizines. Upper cortex paraplectenchymatous. Lower cortex absent. Apothecia rare, saddle-shaped, brown, located at the tip of short ascending lobes. Paraphyses simple, distinctly thickened above. Asci *Peltigera*-type, fissitunicate, the thickened apex with a K/I+ blue ring. Spores 4-8-celled, hyaline, acicular, 8 per ascus, (36-)45-65(-80) x 3-5 μm . Pycnidia dark, immersed. Conidia fusiform. Photobiont cyanobacterial (*Nostoc*). Without lichen substances. Note: a cool-temperate to boreal-montane, ephemeral lichen of disturbed mineral soil, most common in the Alps, becoming much rarer, and restricted to upland areas in the south.

- | | | |
|----|---|----|
| 24 | With isidia | 25 |
| 25 | Isidia peltate (attached by a single point in the centre), scattered on the upper surface. Thallus usually <5 cm broad. Veins flattened | |

21 - *Peltigera lepidophora* (Vain.) Bitter

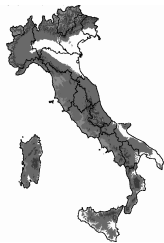
Thallus foliose, grey brown to brown, often with a yellowish hue,



loosely attached, K-, C-, KC-, P-, UV-. Lobes concave to flat, adpressed to the substratum, rounded, 5-10(-20) mm broad, to 35(-40) mm long, glabrous to sparsely tomentose at margin, somewhat scabrous, with darker, flattened, peltate isidia resembling the cephalodia of *P. aphthosa*, which are up to 1.5 mm broad. Lower surface whitish to pale brown, with rather indistinct, pale brownish, narrow and flat veins and simple to fibrillose, brown rhizines up to 5(-10) mm long. Upper cortex paraplectenchymatous. Lower cortex absent. Apothecia rare, small, saddle-shaped, terminal, brown. Paraphyses simple, distinctly thickened above. Asci *Peltigera*-type, fissitunicate, the thickened apex with a K/I+ blue ring. Spores 4-8-celled, hyaline, acicular, 8 per ascus, 49-59 x 4.5-5 μ m. Pycnidia dark, immersed. Conidia fusiform. Photobiont cyanobacterial (*Nostoc*). Without lichen substances. Note: a mainly boreal-montane, circumpolar pioneer species of base-rich mineral soil, not uncommon in the Alps, to be looked for in the highest mountains of the Apennines.

- 25 *Isidia* spathulate (flattened, and erect, attached by the basis), mostly located along cracks. Thallus usually >5 cm broad. Veins raised

22 - *Peltigera praetextata* (Sommerf.) Zopf



Thallus foliose, brownish, loosely attached, K-, C-, KC-, P-, UV-. Lobes elongate, flattened, contiguous, with rounded ends, 10-20(-40) mm broad, 5-7 cm long, tomentose at margin, becoming glabrous toward centre, generally with flattened, simple to lobulate isidia (phyllidia) mostly located along cracks. Lower surface whitish, with pale, raised veins becoming darker towards centre and long, pale, simple rhizines. Upper cortex paraplectenchymatous. Lower cortex absent. Apothecia rare, saddle-shaped, terminal, brown. Paraphyses simple, distinctly thickened above. Asci *Peltigera*-type, fissitunicate, the thickened apex with a K/I+ blue ring. Spores 4-6-celled, hyaline, acicular, thin-walled, 8 per ascus, (29-)38-58(-65) x 2.6-5.2 μ m. Pycnidia dark, immersed. Conidia fusiform. Photobiont cyanobacterial (*Nostoc*). Note: a holarctic, ecologically wide-ranging species, found both in open woodlands and in grasslands (but only in humid areas), on mosses, mineral or organic soil, lignum (on stumps) and bark (on basal parts of old trees); one of the most common species of the genus in Italy.

- 26 Veins on lower surface absent (either lower surface uniformly pale at the margin and dark in the centre, or lower surface black, with scattered white spots) 27
- 26 Veins on lower surface present (to observe the veins, carefully clean the entire lower surface!) 28
- 27 Lower surface black, with conspicuous white spots. Upper surface without hairs. Thallus shiny, often with some cracks above

23 - *Peltigera elisabethae* Gyeln.

Thallus foliose, grey-brown, large (to 15 cm in diam.), loosely



attached, K-, C-, KC-, P-, UV-. Lobes elongate, contiguous, with rounded ends, 1.5-2 cm broad and to 5 cm long; upper surface shiny, smooth, often with a few cracks; margins crisped, up-turned, often with lobules or flattened schizidia. Lower surface pale at margin, black-brown with rounded white spots in the centre. Rhizines dark, squarrose-fasciculate, to 3 mm long. Upper cortex paraplectenchymatous. Lower cortex absent. Apothecia rare, terminal, brown, horizontal, flat. Paraphyses simple, distinctly thickened above. Asci *Peltigera*-type, fissitunicate, the thickened apex with a K/I+ blue ring. Spores 4-celled, hyaline, acicular, thin-walled, 8 per ascus, (24-)27-34(-44) x 3-7 μ m. Pycnidia dark, immersed. Conidia fusiform. Photobiont cyanobacterial (*Nostoc*). Note: on terricolous bryophytes and soil rich in humus, mostly in the montane belt, from the Alps to Calabria.

- 27 Lower surface without white spots. Upper surface with thin transparent hairs (use lens!). Thallus matt, usually without cracks

24 - *Peltigera malacea* (Ach.) Funck



Thallus foliose, medium-sized to large, to 15(-20) cm in diam., up to 1.5 mm thick, bluish to greenish grey, dark green when wet, loosely attached, K-, C-, KC-, P-, UV-. Lobes elongate, contiguous, with rounded ends, up to 3 cm broad, to 10 cm long, often imbricate, with plane to ascending, often inrolled margins. Upper surface erect-tomentose near margins. Lower surface veinless, pale brown near margins, black in the centre, with sparse, bush-shaped, to 3 mm long, dark rhizines. Upper cortex paraplectenchymatous. Lower cortex absent. Apothecia extremely rare (not seen in Italian material), terminal, brown-black, convex. Paraphyses simple, distinctly thickened above. Asci *Peltigera*-type, fissitunicate, the thickened apex with a K/I+ blue ring. Spores 4-6-celled, hyaline, acicular, thin-walled, 8 per ascus, (45-)52-70(-90) x 2.6-6.5 μ m. Pycnidia dark, immersed. Conidia fusiform. Photobiont cyanobacterial (*Nostoc*). Note: a circumpolar, arctic-alpine lichen, found in oligotrophic grasslands and shrublands near and above treeline, often amongst mosses; probably restricted to the Alps in Italy.

- 28 Thallus with a clearly roughened, scabrous surface (lens!). Very rare and restricted to the Alps in Italy

25 - *Peltigera scabrosa* Th.Fr.



Thallus foliose, grey, often with a pale brown hue, matt, dark green when wet, loosely attached, K-, C-, KC-, P-, UV-. Lobes elongate, contiguous, with rounded ends, 1-3 cm broad, 10(-15) cm long, with a clearly roughened, scabrous surface. Lower surface whitish at the periphery, dark in the centre, with 0.8-1.2 mm broad veins darkening towards centre and dark, fibrillose to fasciculate rhizines. Upper cortex paraplectenchymatous. Lower cortex absent. Apothecia rare, terminal, brown, convex. Paraphyses simple, distinctly thickened above. Asci *Peltigera*-type, fissitunicate, the thickened apex with a K/I+ blue ring. Spores 4-6-celled, hyaline, acicular, thin-walled, 8 per ascus, (52-)75-90(-95) x 3-5 μ m. Pycnidia dark, immersed. Conidia fusiform. Photobiont cyanobacterial (*Nostoc*). Note: a very

rare circumpolar, mainly arctic-alpine lichen, found on mossy soil and rocks; restricted to the Alps in Italy, being known only from the C Alps (Lombardia).

- 28 Thallus more or less smooth. More common species 29
- 29 Thallus non tomentose 30
- 29 Thallus tomentose at least at the margin of lobes (lense!) 35
- 30 Veins and rhizines whitish to pale ochraceous brown 31
- 30 Veins and rhizines dark brown to black, at least at thallus centre 32
- 31 Veins distinctly raised, whitish, sometimes pale brown in the centre

26 - *Peltigera degenii* Gyeln.

Thallus foliose, bluish grey, loosely attached, K-, C-, KC-, P-, UV-. Lobes elongate, flattened, contiguous, rounded at the tips, 0.5-1 cm broad, 2-4 cm long, with a glossy, shiny, smooth upper surface. Lower surface whitish, pale brown in the centre, with whitish, raised veins becoming pale brown towards centre, and pale, simple rhizines up to 5-7 mm long. Upper cortex paraplectenchymatous. Lower cortex absent. Apothecia frequent, saddle-shaped, terminal, pale brown. Paraphyses simple, distinctly thickened above. Asci *Peltigera*-type, fissitunicate, the thickened apex with a K/I+ blue ring. Spores 4-6-celled, hyaline, acicular, thin-walled, 8 per ascus, (40-)45-60(-68) x 2.5-5 µm. Pycnidia dark, immersed. Conidia fusiform. Photobiont cyanobacterial (*Nostoc*). Without lichen substances. Note: a temperate to S boreal species, found on terricolous bryophytes, on soil rich in humus and on mossy rocks, sometimes on bark at the basal parts of trunks. Certainly more widespread, also in the south, where it is mostly restricted to the mountains, mainly in the beech belt.



- 31 Veins flattened, pale ochraceous brown

27 - *Peltigera hymenina* (Ach.) Delise

Thallus foliose, grey to brownish, often somehow maculate, matt, loosely attached, K-, C-, KC-, P-, UV-. Lobes elongate, flattened, contiguous, with rounded ends, 1-2 cm broad, with up-turned, undulate margins and a smooth upper surface. Lower surface pale, with flat, pale ochraceous veins and pale, simple rhizines to 5 mm long. Upper cortex paraplectenchymatous. Lower cortex absent. Apothecia frequent, saddle-shaped, terminal, brown. Paraphyses simple, distinctly thickened above. Asci *Peltigera*-type, fissitunicate, the thickened apex with a K/I+ blue ring. Spores 4-6-celled, hyaline, acicular, thin-walled, 8 per ascus, (47-)57-71(-90) x 3-5 µm. Pycnidia dark, immersed. Conidia fusiform. Photobiont cyanobacterial (*Nostoc*). Note: on mineral soil in open, but never fully sun-exposed habitats, often associated with mosses; certainly more widespread, esp. in the beech belt.



- 32 Lobes >3 cm broad, rhizines slender, >5 mm long

28 - *Peltigera neopolydactyla* (Gyeln.) Gyeln.



Thallus foliose, bluish- to brownish grey, greyish blue to greenish when wet, loosely attached, K-, C-, KC-, P-, UV-. Lobes elongate, flattened, contiguous, with rounded ends, 2-4 cm broad, shiny, smooth, with up-turned, undulate edge. Lower surface pale at the margin, darker in the centre, with slender to rarely fasciculate, dark, 5-7(-11) mm long rhizines and flat, dark veins. Upper cortex paraplectenchymatous. Lower cortex absent. Apothecia frequent, saddle-shaped, terminal, pale to dark brown. Paraphyses simple, distinctly thickened above. Asci *Peltigera*-type, fissitunicate, the thickened apex with a K/I+ blue ring. Spores 4-6-celled, hyaline, acicular, thin-walled, 8 per ascus, 50-90(-100) x 3-5 µm. Pycnidia dark, immersed. Conidia fusiform. Photobiont cyanobacterial (*Nostoc*). With tenuiorin and triterpenoids. Note: a forest floor species, occurring amongst and over mosses, more rarely on rock or on bark, on basal parts of old trees. Hitherto known only from the Alps; to be looked for along the Apennines.

- 32 Lobes <3 cm broad, rhizines <5 mm long 33
33 Lower surface pale at margin, dark in the centre, with indistinct venation. Lobes often faintly pruinose at margin

29 - *Peltigera neckeri* Müll.Arg.

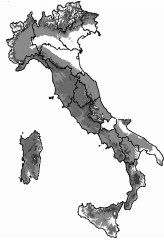


Thallus foliose, bluish- to brownish grey, loosely attached, K-, C-, KC-, P-, UV-. Lobes elongate, flattened, contiguous, with rounded ends, 0.7-1.5 cm broad, 3-4 cm long, often faintly pruinose at margin, shiny, smooth, the upper surface often with cracks, the edge up-turned, undulate. Lower surface pale at the margin, darker in the centre, with a network of reticulated dark and raised veins and diffuse to fasciculate, 3-6 mm long, dark rhizines. Upper cortex paraplectenchymatous. Lower cortex absent. Apothecia frequent, saddle-shaped, terminal, dark brown to black. Paraphyses simple, distinctly thickened above. Asci *Peltigera*-type, fissitunicate, the thickened apex with a K/I+ blue ring. Spores 4-6-celled, hyaline, acicular, thin-walled, 8 per ascus, (31-)49-61 x 3.9-5.2 µm. Pycnidia dark, immersed. Conidia fusiform. Photobiont cyanobacterial (*Nostoc*). Note: on soil, on terricolous, epiphytic and silicicolous mosses; most frequent in humid-warm beech forests and certainly more widespread.

- 33 Lower surface with a very distinct pattern of reticulated, dark veins. Lobes not pruinose at margin 34
34 Apothecia horizontal, rounded. Rhizines fasciculate, separate, arranged in concentric lines (clean carefully the lower face!)

30 - *Peltigera horizontalis* (Huds.) Baumg.

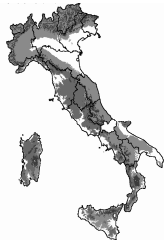
Thallus foliose, bluish- to brownish grey, loosely attached, K-, C-, KC-, P-, UV-. Lobes elongate, flattened, contiguous, 1-1.5(-3) cm broad, to 5 cm long, with ascending margins, the upper surface shiny, smooth. Lower surface pale, darker in the centre, with a very distinct pattern of flat, dark, reticulated veins, and fasciculate-



squarrose, 2-3 mm long rhizines arranged in concentric lines. Upper cortex paraplectenchymatous. Lower cortex absent. Apothecia frequent terminal, brown, horizontal, flat. Paraphyses simple, distinctly thickened above. Asci *Peltigera*-type, fissitunicate, the thickened apex with a K/I+ blue ring. Spores 4-celled, hyaline, acicular, thin-walled, 8 per ascus, (25-)33-41(-47) x 3-7 μ m. Pycnidia dark, immersed. Conidia fusiform. Photobiont cyanobacterial (*Nostoc*). With terpenoids. Note: on mosses (also epiphytic and epilithic) and humic soil in the openings of humid forests, from the lowlands to the subalpine belt.

- 34 Apothecia erect, saddle-shaped. Rhizines becoming confluent, not arranged in concentric lines

31 - *Peltigera polydactyla* (Neck.) Hoffm.



Thallus foliose, bluish- to brownish grey, loosely attached, K-, C-, KC-, P-, UV-. Lobes elongate, flattened, contiguous, 10-15 mm broad, 40-50(-120) mm long, with crisped, often phyllidiate margins, the upper surface shiny, smooth. Lower surface brownish at the margin, darker in the centre, with flat, brown veins and fasciculate, to 5 mm long rhizines becoming confluent, not arranged in concentric lines. Upper cortex paraplectenchymatous. Lower cortex absent. Apothecia frequent, saddle-shaped, terminal, brown. Paraphyses simple, distinctly thickened above. Asci *Peltigera*-type, fissitunicate, the thickened apex with a K/I+ blue ring. Spores hyaline, acicular, thin-walled, 8 per ascus, (40-)51-66(-73) x 2.6-5.2 μ m. Pycnidia dark, immersed. Conidia fusiform. Photobiont cyanobacterial (*Nostoc*). With tenuiorin and terpenoids. Note: an ecologically wide-ranging species of both mineral and organic, often base-rich soil, and on basal parts of mossy trunks and stumps in open forests. Widespread and rather common, especially in the Alps.

- 35 Lobes 6-10 mm broad 36
 35 Lobes >10 mm broad 38
 36 Rhizines and veins long remaining pale

32 - *Peltigera ponojensis* Gyeln.



Thallus foliose, whitish grey, often more brownish and glossy in the centre, loosely attached, K-, C-, KC-, P-, UV-. Lobes flattened, contiguous, with rounded ends, to 1 cm broad, 5-6 cm long, with an up-turned, crisped, entire margin, the upper surface smooth, densely tomentose. Lower surface whitish, with raised, pale veins 0.8-0.3 mm broad, and 3-7(-12) mm long, pale, simple rhizines. Upper cortex paraplectenchymatous. Lower cortex absent. Apothecia frequent, saddle-shaped, terminal, brown. Paraphyses simple, distinctly thickened above. Asci *Peltigera*-type, fissitunicate, the thickened apex with a K/I+ blue ring. Spores 4-6-celled, hyaline, acicular, thin-walled, 8 per ascus, (29-)38-58(-65) x 2.6-5.2 μ m. Pycnidia dark, immersed. Conidia fusiform. Photobiont cyanobacterial (*Nostoc*). Without lichen substances. Note: often confused with *P. rufescens* in the past, this lichen, quite frequent in the Alps, is probably more widespread, also along the Apennines.

36 Rhizines and veins soon darkening

37

37 Rhizines near the margin slender, simple, or with a few branches only. Veins flat

33 - *Peltigera monticola* Vitik.

Thallus foliose, grey-brownish, with upturned, curled and somewhat phyllidiate, margins, tomentose near margin, somewhat scabrid towards centre, loosely attached, K-, C-, KC-, P-, UV-. Lobes flattened to concave, contiguous, with rounded ends, ca. 5 mm broad. Lower surface pale, with diffuse veins which are pale towards margin, darker in the centre, and, short, subsimple rhizines near margin, which become dark and tufted in the centre. Upper cortex paraplectenchymatous. Lower cortex absent. Apothecia frequent, saddle-shaped, terminal, brown. Paraphyses simple, distinctly thickened above. Asci *Peltigera*-type, fissitunicate, the thickened apex with a K/I+ blue ring. Spores 4-celled, hyaline, acicular, thin-walled, 8 per ascus, 39-52 x 3.9-5.2 μm . Pycnidia dark, immersed. Conidia fusiform. Photobiont cyanobacterial (*Nostoc*). Without lichen substances. Note: a recently-described and still rarely collected taxon, related to *P. rufescens* and *P. ponojensis*, found on soil and amongst mosses over calcareous substrata. Probably more widespread throughout Italy, in upland areas.



37 Rhizines conspicuously and richly branched also at margin. Tomentum appressed (if tomentum erect see 35: *P. kristinssonii*)

34 - *Peltigera rufescens* (Weiss) Humb.

Thallus foliose, brownish to grey-whitish, smooth, loosely attached, tomentose, with ascending, crisped margins which sometimes bear adventitious lobules, K-, C-, KC-, P-, UV-. Lobes 6-10 mm broad, elongate, flattened, contiguous, to 40 mm long. Lower surface whitish, with ca. 5 mm long, dark, squarrose rhizines and raised, dark veins. Upper cortex paraplectenchymatous. Lower cortex absent. Apothecia rare, saddle-shaped, terminal, brown. Paraphyses simple, distinctly thickened above. Asci *Peltigera*-type, fissitunicate, the thickened apex with a K/I+ blue ring. Spores 4-6-celled, hyaline, acicular, thin-walled, 8 per ascus, (36-)49-63(-78) x 2.6-5.2 μm . Pycnidia dark, immersed. Conidia fusiform. Photobiont cyanobacterial (*Nostoc*). Without lichen substances. Note: a widespread holarctic lichen, most common in dry grasslands, esp. in upland areas, but also in the Mediterranean belt, where it is generally rare due to intensive grazing and trampling; one of the most common species of the genus throughout Italy.



38 Rhizines slender, more or less simple

see 22 - Peltigera praetextata (Sommerf.) Zopf

38 Rhizines squarrose

39

39 Upper surface with sparse erect tomentum (binocular!) at the margin, glossy towards centre. Veins flat

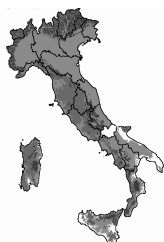
35 - *Peltigera kristinssonii* Vitik.



Thallus foliose, grey-brown to brown, often with a yellowish hue, loosely attached, K-, C-, KC-, P-, UV-. Lobes elongated, flattened, contiguous, with rounded ends, 1-1.5 cm broad, 5-7 cm long; margins up-turned, with erect tomentum, glabrous toward centre, smooth or mostly somewhat scabrous esp. in the centre. Lower surface with dark flat veins coated with dark tomentum; interstices between veins white and rounded. Rhizines dark brown to black, squarrose. Upper cortex paraplectenchymatous. Lower cortex absent. Apothecia frequent, terminal, brown. Paraphyses simple, distinctly thickened above. Asci *Peltigera*-type, fissitunicate, the thickened apex with a K/I+ blue ring. Spores 4-6-celled, hyaline, acicular, thin-walled, 8 per ascus, (40-)44-59(-73) x 3-4(-5.2) μm . Pycnidia dark, immersed. Conidia fusiform. Photobiont cyanobacterial (*Nostoc*). Without lichen substances. Note: a slightly calciphilous species, probably more widespread, both in the Alps and the Apennines.

- 39 Tomentum not erect. Veins raised 40
40 Rhizines confluent, penicillated (brush-like). Veins soon darkened towards centre

36 - *Peltigera canina* (L.) Willd.



Thallus foliose, grey to brownish grey, smooth, loosely attached, tomentose, K-, C-, KC-, P-, UV-. Lobes elongate, flattened, contiguous, with rounded ends, 1-3 cm broad, to 10 cm long. Edge often down-turned, entire. Lower surface whitish, with whitish (at the margin) to brownish (in the centre), raised veins and richly penicillated (brush-like), to 4 mm long rhizines which are white at the margins, dark toward the centre. Upper cortex paraplectenchymatous. Lower cortex absent. Apothecia frequent, saddle-shaped, terminal, dark brown to black. Paraphyses simple, distinctly thickened above. Asci *Peltigera*-type, fissitunicate, the thickened apex with a K/I+ blue ring. Spores 4-6-celled, hyaline, acicular, thin-walled, 8 per ascus, Spores (36-)42-53(-65) x 2.6-5.2 μm . Pycnidia dark, immersed. Conidia fusiform. Photobiont cyanobacterial (*Nostoc*). Without lichen substances. Note: a widespread holarctic species, found on terricolous mosses and soil in open forests, sometimes on bark on basal parts of old trees; certainly rarer than *P. praetextata*, with which it was often confused in the past.

- 40 Rhizines separate, with numerous branches perpendicular to the main axis (bottle-brush-like). Veins conspicuously erect-tomentose and pale, also in thallus centre

37 - *Peltigera membranacea* (Ach.) Nyl.

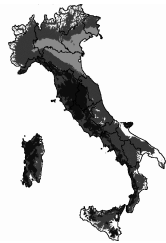
Thallus foliose, grey to brownish grey, loosely attached, K-, C-, KC-, P-, UV-. Lobes elongate, flattened, contiguous, 1-4 cm broad, to 10 cm long, glabrescent and shiny towards centre, tomentose at the margins, which are usually down-turned, entire. Lower surface whitish, with white to pale brownish, raised veins which are 0.5-0.7 mm broad, and dispersed simple rhizines with short ramifications



perpendicular to the main axis (bottle-brush-like). Upper cortex paraplectenchymatous. Lower cortex absent. Apothecia frequent, saddle-shaped, terminal, brown to reddish brown. Paraphyses simple, distinctly thickened above. Asci *Peltigera*-type, fissitunicate, the thickened apex with a K/I+ blue ring. Spores 4-6-celled, hyaline, acicular, thin-walled, 8 per ascus, (40-)49-64(-80) x 2.5-5 μ m. Pycnidia dark, immersed. Conidia fusiform. Photobiont cyanobacterial (*Nostoc*). Without lichen substances Note: on mossy rocks and at the base of boles in old woodlands, on base-rich substrata; probably widespread throughout Italy, but often confused with related species.

- | | | |
|----|--|----|
| 41 | With soredia or isidia | 42 |
| 41 | Without soredia or isidia | 45 |
| 42 | Without pseudocyphellae | 43 |
| 42 | With linear pseudocyphellae | 44 |
| 43 | With isidia. Thallus K+ yellow, with atranorin. Medulla KC+ red, with lecanoric acid | |

38 - *Parmelina tiliacea* (Hoffm.) Hale



Thallus foliose, grey, K+ yellow, C-, KC-, P- or P+ yellowish, UV-. Lobes usually broad (6-10 mm), flattened, very smooth, with rounded ends and an undulate edge, bearing diffuse, cylindrical, simple or rarely weakly ramified isidia, which are often denser and longer in the centre; the colour of the isidia ranges to (mostly) grey to almost black, esp. at the tips. Lower surface black, brown at margin. Rhizines dark, mostly simple, abundant but shorter at margin. Medulla K-, C+ red, KC+ red, P-, UV-. Apothecia very rare, rounded, lecanorine, sessile, strongly constricted, to 8 mm diam. Disc brown, margin thick, smooth, grey. Asci *Lecanora*-type, thick-walled, the apex I+ blue with a wide, divergent axial body. Spores 1-celled, hyaline, broadly ellipsoid, 8 per ascus, 9-10 x 6-8 μ m. Conidia bacilliform. Photobiont chlorococcoid. With atranorin in the upper cortex and lecanoric acid in the medulla. Note: a mainly mild-temperate lichen, mostly found on broad-leaved trees, sometimes on mossy rocks and on terricolous bryophytes; rare only in somehow continental areas, as along the E part of the peninsula.

- | | | |
|----|--|--|
| 43 | With soredia. Thallus K-, without atranorin. Medulla KC- | |
|----|--|--|

39 - *Phaeophyscia hispidula* (Ach.) Essl.



Thallus foliose, greenish grey to brownish-grey, non-pruinose, orbicular, loosely attached, 2-6 cm broad, forming rosettes, K-, C-, KC-, P-, UV-. Lobes elongate, concave, 2-5 mm broad surrounded by numerous, long, black, projecting rhizines. Soredia farinose, whitish, K-, C-, KC-, P-. Soralia maculiform, later becoming convex, laminar to mostly marginal. Lower surface black, with long, black, simple rhizines. Upper and lower cortex paraplectenchymatous. Medulla white, K-. Apothecia extremely rare, rounded, lecanorine. Asci *Lecanora*-type, thick-walled, the apex I+ blue with a wide, divergent axial body. Spores 2-celled, pigmented, 8 per ascus.

Photobiont chlorococcoid. Without lichen substances. Note: a very rare, subtropical-oceanic-montane, mostly sterile species, found on terricolous or saxicolous bryophytes, restricted to the Alps in Italy.

44 With isidia

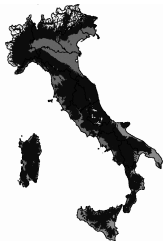
40 - *Parmelia saxatilis* (L.) Ach.



Thallus foliose, grey to greyish-green, sometimes darker with age, K+ yellow, C-, KC-, P- or P+ yellowish, UV-. Lobes 3-8 mm broad, elongate, contiguous or radiating, truncate, with an angular edge, with slight netting and sulcation. Pseudocyphellae linear, on upper surface, often more evident at the tip of lobes. Isidia cylindrical, simple to ramified, diffuse, often darker at the tip. Lower surface black, brown and shining at margin. Rhizines dark, mostly simple, abundant at margin. Medulla white, K+ yellow changing to red, C-, KC+ orange, P+ orange-red, UV-. Apothecia rare, rounded, lecanorine, sessile, strongly constricted, to 1 cm diam. Margin distinct, thick, isidiose. Asci *Lecanora*-type, thick-walled, the apex I+ blue with a wide, divergent axial body. Spores 1-celled, hyaline, ellipsoid, 8 per ascus, 13-19 x 8-12 μ m. Pycnidia dark, immersed. Conidia rod-shaped. Photobiont chlorococcoid. With atranorin (cortex), salazinic acid and variable amounts of lobaric and norstictic acids (medulla). Note: mainly epiphytic, more rarely saxicolous or overgrowing terricolous mosses in humid areas; somehow heterogeneous in Italy; some populations near the Tyrrhenian coast might deserve further study; in humid situations, this species can also occur in the Mediterranean belt.

44 With soredia

41 - *Parmelia sulcata* Taylor



Thallus foliose, grey to greyish-green, sometimes darker with age, K+ yellow, C-, KC-, P- or P+ yellowish, UV-. Lobes (1-)3-8 mm broad, flattened, truncate at the tips and margins, with slight netting and sulcation due linear pseudocyphellae which give rise to linear soralia. Lower surface black, brown and shiny at margin. Rhizines dark, mostly simple or bifurcate, abundant but much shorter at margin. Medulla K+ yellow changing to orange-red, KC+ orange, P+ orange-red, UV-. Apothecia rare, lecanorine, strongly constricted. Disc brown, margin thick, usually sorediate. Asci *Lecanora*-type, thick-walled, the apex I+ blue with a wide, divergent axial body. Spores 1-celled, hyaline, ellipsoid, 8 per ascus, 11-15 x 6-8 μ m. Pycnidia dark, immersed. Conidia rod-shaped. Photobiont chlorococcoid. With atranorin (cortex), and salazinic acid (medulla). Note: mainly epiphytic, but sometimes overgrowing terricolous mosses, esp. in humid areas; certainly the most common and wide-ranging *Parmelia* in Italy, also present near large urban settlements in the north, rare only in the eu-Mediterranean belt.

45 With linear pseudocyphellae

42 - *Parmelia omphalodes* (L.) Ach.

Thallus foliose, grey to almost black in exposed situations, with a dense network of white pseudocyphellae, loosely attached, K+ yellow, C-, KC-, P- or P+ yellowish. Lobes (2-)3-8 mm broad,



flattened, angular in outline, with a slight to prominent netting and sulcation, without isidia or soredia. Pseudocyphellae linear, on upper surface. Lower surface black in the centre, brown and shiny at margins. Rhizines dark, mostly simple or bifurcate, abundant but shorter at margin. Medulla white, K+ yellow changing to orange-red or K-, C-, KC+ orange, P+ orange-red, UV+ indistinctly glaucous. Apothecia rare, lecanorine, strongly constricted. Asci *Lecanora*-type, thick-walled, the apex I+ blue with a wide, divergent axial body. Spores 1-celled, hyaline, ellipsoid, 8 per ascus, 10-20 x 7-12 μm . Pycnidia dark, immersed. Conidia rod-shaped. Photobiont chlorococcoid. With atranorin (cortex), salazinic, protolichesterinic and lobaric acids (medulla). Note: an arctic-alpine circumpolar lichen, found on siliceous rocks, epilithic bryophytes, more rarely on soil. Common in the Alps. rarer in the siliceous mountains of the south (Gennargentu and Sila Massives, Madonie Mountains); almost absent in the C Apennines for the scarcity of suitable substrata. The subsp. *discordans* (Nyl.) Skult, with a K- medulla without salazinic acid, is likely to occur in the Italian Alps.

45 Without pseudocyphellae

46

46 Lower surface orange

43 - *Solorina crocea* (L.) Ach.



Thallus foliose, forming rosettes, ashy to reddish brown when dry, olive-green when wet, sometimes densely white-reticulated, K-, C-, KC-, P-. Lobes large, to 30 mm broad (usually less), rounded, flat to concave, smooth to roughened. Lower surface orange, with brownish-orange veins and yellow to orange interspaces, more or less tomentose. Rhizines black. Upper cortex paraplectenchymatous, lower cortex absent. Medulla orange, K+ red, C-, KC-, P-. Apothecia frequent, rounded, without a thalline margin, semi-immersed, up to 10 mm diam. Disc brown to black. Margin indistinct. Epiphysemium brownish, hymenium and hypothecium colourless. Paraphyses not anastomosing, simple, not apically thickened, adglutinated. Asci clavate, of the *Peltigera*-type, fissitunicate, the thickened apex with a K/I+ blue ring. Spores 2-celled, pigmented, ellipsoid, not constricted at septa, 6-8 per ascus, 34-45 x 10-14 μm . Photobiont chlorococcoid (*Coccomyxa*). Cephalodia internal, immersed in the thallus (in section, two photobiont layers, a green alga above, *Nostoc* below). With solorinic acid. Note: an arctic-alpine, circumpolar lichen, found on acid mineral soil with a long snow-lie; restricted to the Alps and the N Apennines in Italy.

46 Lower surface not orange

47

47 With conspicuous marginal cilia

44 - *Anaptychia ciliaris* (L.) Körb.

Thallus subfoliose to subfruticose, grey to grey-brown, lead grey to almost blackish in sun-forms, somehow shrubby, loosely attached, K-, C-, KC-, P-, UV-. Lobes (2-)3-6 mm broad, several cm long, linear, sometimes densely and finely tomentose, with prominent marginal cilia. Lower surface whitish to (rarely) whitish, channelled, ecorticate. Upper cortex prosoplectenchymatous. Apothecia



frequent, rounded, lecanorine, substipitate and strongly constricted, up to 8 mm diam. Disc black, often faintly pruinose. Margin grey to grey brown, smooth to crenulate. Epithecium brown. Hymenium and hypothecium colourless. Paraphyses mostly simple. Asci *Lecanora*-type, thick-walled, the apex I+ blue with a wide, divergent axial body. Spores 2-celled, pigmented, ellipsoid, constricted at septa, thin-walled (*Physconia*-type), ornamented, 8 per ascus, 30-45 x 17-24 μm . Pycnidia dark, semi-immersed. Conidia short-bacilliform. Photobiont chlorococcoid. Without lichen substances. Note: a mild-temperate species, found on bark of more or less isolated trees, more rarely on rock and amongst terricolous mosses in open situations; locally common in the Apennines and on the islands south of Marche, much rarer - and almost menaced of extinction- in the North.

- | | | |
|----|--|----|
| 47 | Without marginal cilia | 48 |
| 48 | Lower surface dark, from black to dark brown, esp. in the centre | 49 |
| 48 | Lower surface pale throughout | 52 |
| 49 | Lobes <3 mm broad | 50 |
| 49 | Lobes >3 mm broad | 51 |
| 50 | Medulla white, K-, KC- | |

45 - *Physconia muscigena* (Ach.) Poelt var. *muscigena*



Thallus foliose, grey to brownish grey, but often densely white-pruinose, loosely attached, K-, C-, KC-, P-, UV-. Lobes 1-2(-3) mm broad, elongate, flattened, ascending, often imbricate and divided in smaller lobules, usually forming dense mats. Lower surface whitish at margin, black in the centre. Rhizines black, squarrose. Upper cortex paraplectenchymatous, lower cortex prosoplectenchymatous. Medulla white, K-. Apothecia very rare, lecanorine, to 5 mm broad, often lobulate at the margin. Epithecium brown. Hymenium and hypothecium colourless. Paraphyses simple or poorly ramified, swollen at tips. Asci *Lecanora*-type, thick-walled, the apex I+ blue with a wide, divergent axial body. Spores 2-celled, pigmented, ellipsoid, 8 per ascus, 22-33 x 12-17 μm . Photobiont chlorococcoid. Without lichen substances. Note: an arctic-alpine, circumpolar lichen, found on mosses and plant debris in open situations, such as in grasslands and on mosses growing on isolated calcareous boulders, from the subalpine and alpine belts of the Alps, throughout the Apennines, to the mountains of Sicilia.

- | | | |
|----|--|--|
| 50 | Medulla yellowish, K+ yellowish, KC+ yellow-orange | |
|----|--|--|

46 - *Physconia muscigena* (Ach.) Poelt var. *bayeri* (Nád.) Poelt

Thallus foliose, grey to brownish grey, often densely white-pruinose, loosely attached, K-, C-, KC-, P-. Lobes 1-2(-3) mm broad, elongate, flattened, ascending, often forming dense mats. Lower surface whitish at margin, black in the centre. Rhizines black, squarrose. Upper cortex paraplectenchymatous, lower cortex



prosoplectenchymatous. Medulla yellowish, K+ yellowish, KC+ yellowish-orange. Apothecia very rare (not observed in Italian material), lecanorine. Asci *Lecanora*-type, thick-walled, the apex I+ blue with a wide, divergent axial body. Spores 2-celled, pigmented, ellipsoid, 8 per ascus. Photobiont chlorococcoid. With variolaric acid. Note: a critical taxon, characterised by the yellow medulla, which needs further study; restricted to the Alps in Italy. Very rare.

- 51 Lobes >1.5 cm broad. Thallus shiny, reticulately ridged. Lower surface with conspicuous white spots. Cephalodia internal, near the upper surface

47 - *Lobaria linita* (Ach.) Rabenh.



Thallus broadly foliose, to 30 cm in diam., pale olive-brown to grey, somehow shiny, loosely attached, K-, C-, KC-, P-, UV-. Lobes flattened, truncate, to 4 cm broad, rounded, the tips often ascending, reticulately ribbed. Lower surface dark, frown to black-brown, with pale naked swellings separated by smooth, blackened veins, tomentose. Rhizines dark, to 4 mm long. Cephalodia internal, appearing at the surface as 2 mm broad swellings, with *Nostoc*. Upper and lower cortex paraplectenchymatous. Medulla K+ yellow or K-, C-, KC- P-. Apothecia very rare (not seen in Italian material), to 4 mm broad, lecanorine, the disc brown. Epihymenium brownish. Hymenium and subhymenium colourless. Paraphyses mostly simple. Asci *Peltigera*-type, fissitunicate, the thickened apex with a K/I+ blue ring. Spores 2(-4)-celled, hyaline, fusiform-elliptical, 8 per ascus, 21-34 x 6-9 µm. Pycnidia immersed, laminar and marginal. Conidia bacilliform, 4.5-5.5 x 1-1.5 µm. Photobiont chlorococcoid. With tenuiorin. Note: a circumpolar, arctic-alpine species found on bryophytes and soil rich in humus over siliceous substrata; restricted to the Alps in Italy, where it is rare.

- 51 Lobes <1.5 cm broad. Thallus matt, smooth to wrinkled. Lower surface without white spots. Cephalodia internal, near the lower surface

48 - *Nephroma expallidum* (Nyl.) Nyl.



Thallus foliose, yellowish green to pale yellowish/greenish brown, bright olive-green when wet, somewhat more brown towards margins, bifacial, loosely attached, K-, C-, KC-, P-, UV-. Lobes to 1.8 cm broad, elongate, contiguous, the edges entire to crisped, often ascending and with regeneration lobules, sometimes faintly pruinose or finely tomentose, esp. at the margins, smooth to wrinkled. Cephalodia internal, with *Nostoc*, protruding as small warts from the upper surface. Lower surface dark brown, paler at margins, finely tomentose or not, with protruding dark cephalodia which are smaller but more prominent than in the upper surface. Upper and lower cortex paraplectenchymatous. Medulla white, compact. Apothecia extremely rare (not seen in Italian material), lecanorine, on the lower surface of thallus at tips of ascending lobes, to 10 mm diam., sessile, the margin prominent, the disc brown. Asci *Peltigera*-type, fissitunicate, the thickened apex with a K/I+ blue ring. Spores 4-

celled, hyaline. Photobiont chlorococcoid (*Coccomyxa*). With nephrin and zeorin. Note: an arctic-alpine species, found on soil and amongst bryophytes over siliceous substrata; extremely rare and restricted to the Alps in Italy.

- 52 Veins on lower surface present 53
 52 Veins on lower surface absent 57
 53 Apothecia laminal, rounded, semi-immersed in the upper surface 54
 53 Apothecia absent, or if present not semi-immersed in the thallus 55
 54 Spores 8 per ascus, 35-40 x 18-21 μm

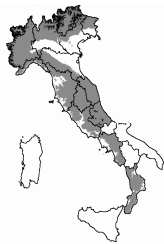
49 - *Solorina octospora* (Arnold) Arnold



Thallus foliose, pale greyish-green, tinged brown when dry, bright green when wet, well developed, K-, C-, KC-, P-, UV-. Lobes (2-)3-6 mm broad, rounded, flattened to concave, contiguous, with raised margins. Lower surface white, indistinctly veined, tomentose, with pale to dark rhizines. Upper cortex paraplectenchymatous, lower cortex absent. Medulla white, K-, C-, KC-, P-. Apothecia frequent, without a thalline margin, semi-immersed, up to 7 mm diam. Disc brown to black, concave. Epihymenium brownish, hymenium and hypothecium colourless. Paraphyses not anastomosing, simple, not apically thickened, adglutinated. Asci clavate, *Peltigera*-type, fissitunicate, the thickened apex with a K/I+ blue ring. Spores 2-celled, pigmented, ellipsoid, constricted at septa, 8 per ascus, 35-40 x 18-21 μm . Photobiont chlorococcoid (*Coccomyxa*). Note: an arctic-alpine to boreal-montane, probably circumpolar lichen, found on soil rich in humus and on terricolous mosses, often in rock fissures. Hitherto known only from the Alps in Italy.

- 54 Spores 4 per ascus, 30-60 x 18-28 μm

50 - *Solorina saccata* (L.) Ach.



Thallus foliose, pale greyish-green, tinged brown when dry and becoming reddish in the herbarium, bright green when wet, very well developed, to 7 cm broad, K-, C-, KC-, P-, UV-. Lobes 3-10(-15) mm broad, rounded, sometimes densely white-pruinose, flat to convex. Lower surface white, indistinctly veined, tomentose, with scattered pale rhizines. Upper cortex paraplectenchymatous, lower cortex absent. Medulla white, K-, C-, KC-, P-. Apothecia frequent, without a thalline margin, rounded, semi-immersed, to 8 mm diam. Disc brown to black, concave. Epihymenium brownish, hymenium and hypothecium colourless. Paraphyses not anastomosing, simple, not apically thickened, adglutinated. Asci clavate, *Peltigera*-type, fissitunicate, the thickened apex with a K/I+ blue ring. Spores 2-celled, pigmented, ellipsoid, constricted at septa, thick-walled, ornamented, 4 per ascus, 30-60 x 16-28 μm . Photobiont chlorococcoid (*Coccomyxa*). Without lichen substances. Note: a cool-temperate to arctic-alpine, circumpolar lichen, found on calciferous soil rich in humus and terricolous mosses, often in cracks of the rock; most common in the Alps, rarer in the Apennines, but descending - albeit rarely - to the submediterranean belt in

Tyrrhenian Italy.

- 55 Apothecia common, disc flattened-horizontal, lobes fan-shaped, small (1-2 cm diam.), attached by a single stout rhizine

51 - *Peltigera venosa* (L.) Hoffm.

Thallus foliose, grey to greenish-grey, green when wet, smooth, loosely attached, with cephalodia, K-, C-, KC-, P-, UV-. Lobes flattened, smooth, rounded to fan-shaped, up to 20 mm across, smooth, somehow shining. Lower surface pale, with a very evident network of dark, flat, reticulate, villose veins. Cephalodia granular-warty, with *Nostoc*, located on the veins. Attached by a single, stout rhizine. Upper cortex paraplectenchymatous. Lower cortex absent. Apothecia frequent, rounded, flat, to 5 mm diam., dark brown to black, the lower side with a thick, dark, pseudoparenchymatous cortex. Paraphyses simple, distinctly thickened above. Asci *Peltigera*-type, fissitunicate, the thickened apex with a K/I+ blue ring. Spores usually 4-celled, hyaline, acicular, thin-walled, 8 per ascus, (29)35-43 x 4-8 μ m. Photobiont chlorococcoid (*Coccomyxa*). With tenuiorin and triterpenoids. Note: an arctic-alpine to boreal-montane, circumpolar lichen, found to on soil rich in humus in cold-humid sites; more frequent in the Alps, very rare in the mountains of the south.



- 55 Apothecia rare, saddle-shaped. Lobes elongated, very broad (>5 cm diam.), with numerous rhizines

56

- 56 On acid siliceous substrata. Lower surface whitish at the margin, dark in the centre, with a few, indistinct, broad veins, or without veins. Apothecial cortex continuous to warty

52 - *Peltigera aphthosa* (L.) Willd.

Thallus foliose, grey to greenish-grey, green when wet, smooth, loosely attached, K-, C-, KC-, P-, UV-. Lobes elongate, concave, smooth, contiguous, with rounded ends, 1.5-3(-5) cm broad and to 10 cm long, usually obtuse to boat-shaped, with ascending, entire to crenate edges. Upper surface smooth, with numerous, scattered, dark grey, warty cephalodia containing *Nostoc*, to 1 mm diam. Lower surface whitish at the margin, dark in the centre, with a few, indistinct, broad veins, or without veins, tomentose. Rhizines dark, fasciculate. Upper cortex paraplectenchymatous. Lower cortex absent. Apothecia rare, saddle-shaped, terminal, brown. Apothecial cortex continuous to warty. Paraphyses simple, distinctly thickened above. Asci *Peltigera*-type, fissitunicate, the thickened apex with a K/I+ blue ring. Spores 4-8-celled, hyaline, acicular, thin-walled, 8 per ascus, (47-)53-67(-75) x 4-5 μ m. Photobiont chlorococcoid (*Coccomyxa*). With tenuiorin and triterpenoids. Note: a mainly boreal-montane, circumpolar lichen, found on terricolous mosses and soil rich in humus, mostly in forests. An acidophytic vicariant of *P. leucophlebia*, common in the Alps, much rarer in the Apennines.



- 56 On calcareous substrata. Lower surface whitish at the margin, dark in the centre, with reticulate, distinct, brown to black veins.

Apothecial cortex disrupted into green patches

53 - *Peltigera leucophlebia* (Nyl.) Gyeln.



Thallus foliose, grey to greenish-grey, green when wet, smooth, loosely attached, K-, C-, KC-, P-, UV-. Lobes elongate, concave, smooth, contiguous, with rounded ends, 1.5-3(-5) cm broad and to 10 cm long, usually obtuse to boat-shaped, with ascending, entire to crenate edges. Upper surface smooth, with numerous, scattered, dark grey, warty cephalodia containing *Nostoc*, to 1 mm diam. Lower surface whitish at the margin, dark brown to blackish in the centre, with reticulate, distinct, brown to black veins. Rhizines pale to dark, simple to tufted, to 5 mm long. Upper cortex paraplectenchymatous. Lower cortex absent. Apothecia rare, saddle-shaped, terminal, brown. Apothecial cortex disrupted into green patches. Paraphyses simple, distinctly thickened above. Asci *Peltigera*-type, fissitunicate, the thickened apex with a K/I+ blue ring. Spores 4-8-celled, hyaline, acicular, thin-walled, 8 per ascus, 50-70 x 4-6 µm. Photobiont chlorococcoid (*Coccomyxa*). With tenuiorin and triterpenoids. Note: the calcicolous vicariant of *P. aphthosa*, rather common, also in the Apennines, and certainly present also in the mountains of the south, mainly in the beech belt.

- 57 Lobes long and narrow (<1 mm broad); thallus brownish 58
- 57 Lobes not long and narrow, generally >1 mm broad; if less, reduced to a broad collar around the apothecia; thallus usually greenish 59
- 58 On siliceous substrata. Lobes with numerous, small adventitious lobules. Upper cortex of interwoven hyphae (section!)

54 - *Anaptychia bryorum* Poelt



Thallus foliose, olive-brown to chestnut brown, darker in sun-forms, lobulate, bifacial, loosely attached, K-, C-, KC-, P-, UV-. Lobes linear, flattened, smooth, ascending, to 0.2 mm broad and 7 mm long, often with small (0.1 mm) adventitious marginal lobules. Lower surface whitish to pale brown, corticate. Rhizines scarce, brown. Upper cortex of interwoven hyphae. Apothecia not known. Photobiont chlorococcoid. Without lichen substances Note: an arctic-alpine to boreal-montane, probably circumpolar species, found amongst mosses and muribund plants on siliceous substrata; restricted to the Alps in Italy.

- 58 On more or less calciferous or base-rich siliceous substrata. Lobes ciliate at margin, without adventitious lobules. Upper cortex paraplectenchymatous

55 - *Phaeophyscia constipata* (Norrl. & Nyl.) Moberg

Thallus foliose, brownish, becoming distinctly greenish when wet, thin, loosely attached, very fragile when dry, not pruinose, K-, C-, KC-, P-, UV-. Lobes to 0.3 (-0.5) mm broad, linear, flattened, ascending, the tips broadened and lacerate-divided, richly and irregularly branched, ciliate at margin, sometimes forming small



cushions. Lower surface whitish to pale brown in the centre. Upper and lower cortex paraplectenchymatous. Rhizines mostly pale (but sometimes darkening, esp. in the centre) and marginal. Apothecia very rare, lecanorine, sessile. Disc flat, brown, margin smooth. Asci *Lecanora*-type, thick-walled, the apex I+ blue with a wide, divergent axial body. Spores 2-celled, pigmented, ellipsoid, 8 per ascus, 17-23 x 7-11 µm. Pycnidia dark, immersed. Conidia straight, cylindrical, 3-4 µm. Photobiont chlorococcoid. Without lichen substances. Note: a mainly circumboreal-montane species found on mosses and plant debris on basic siliceous substrata, sometimes on soil; in Italy probably restricted to the Alps, in dry-warm situations.

- 59 Thallus K+ yellow, with atranorin. Medulla K+ yellow changing to red, with salazinic acid. Apothecia lecanorine, sessile, strongly constricted

56 - *Xanthoparmelia somloënsis* (Gyeln.) Hale



Thallus foliose, yellowish green, loosely attached, K+ yellow, C-, KC-, P- or P+ yellowish. Lobes (0.5-)2-3(-5) mm broad, flattened, isotomic-dichotomously ramified, more or less imbricate. Lower surface tan at margins, pale brown in the centre. Rhizines pale-coloured, mostly simple, sparse at margin. Upper and lower cortex paraplectenchymatous. Medulla white, K+ yellow changing to red, C-, KC-, P+ orange. Apothecia frequent, lecanorine, strongly constricted, to 8(-10) mm broad. Disc brown, smooth, margin smooth, concolour with thallus. Epihymenium brownish, hymenium and subhymenium colourless. Asci *Lecanora*-type, thick-walled, the apex I+ blue with a wide, divergent axial body. Spores 1-celled, hyaline, ellipsoid, 8 per ascus, 8-11 x 5-6 µm. Pycnidia common, appearing like black dots on the upper surface. Conidia cylindrical. Photobiont chlorococcoid. With usnic acid (cortex) and salazinic acid (medulla). Note: on weathered siliceous rocks and mineral soil in open, dry situations, with a very wide altitudinal range, throughout the country.

- 59 Thallus and medulla K-, without atranorin and salazinic acid. Apothecia non lecanorine, semi-immersed in the thallus 60

- 60 Spores 8 per ascus

see 49 - *Solorina octospora* (Arnold) Arnold

- 60 Spores 2 to 4 per ascus 61

- 61 Spores 2 per ascus 62

- 61 Spores 4 per ascus 63

- 62 Internal pseudo-cephalodia well-developed, forming a thallus with *Nostoc*. Spores 60-100 x 27-60 µm

57 - *Solorina bispora* Nyl. subsp. *bispora*

Thallus foliose, pale grey to brown-grey, often white-pruinose, K-, C-, KC-, P-, UV-. Lobes 0.5-1 mm broad, rounded, flattened, smooth, poorly developed, irregular, with a single urceolate



apothecium at the centre of each lobe. Lower surface white. Upper cortex paraplectenchymatous, lower cortex absent. Medulla white, K-, C-, KC-, P-. Internal pseudo-cephalodia well-developed, forming a thallus with *Nostoc*. Apothecia frequent, without a thalline margin, semi-immersed, to 5 mm diam. Disc brown to black, concave. Epihymenium brownish, hymenium and hypothecium colourless. Paraphyses not anastomosing, simple, not apically thickened, adglutinated. Asci clavate, *Peltigera*-type, fissitunicate, the thickened apex with a K/I+ blue ring. Spores 2-celled, pigmented, ellipsoid, constricted at septa, 2 per ascus, 60-100 x 27-60 μm . Photobiont chlorococcoid (*Coccomyxa*). Without lichen substances. Note: an arctic-alpine, circumpolar lichen, found on humid soil rich in humus with a long snow-lie; common only in the Alps, but also occurring in the highest mountains of the Apennines.

- 62 Internal pseudo-cephalodia absent, or very scarce. Spores 95-140 x 45-60 μm

**58 - *Solorina bispora* Nyl. subsp. *macrospora* (Harm.)
Burgaz & I. Martínez**



Thallus foliose, pale grey to brown-grey, often white-pruinose, K-, C-, KC-, P-, UV-. Lobes 0.5-1 mm broad, often reduced to a collar around the apothecia, rounded, flattened, poorly developed, irregular, with a single urceolate apothecium at the centre of each lobe. Lower surface white, tomentose. Upper cortex paraplectenchymatous, lower cortex absent. Medulla white, K-, C-, KC-, P-. Internal pseudo-cephalodia absent, or very scarce. Apothecia frequent, without a thalline margin, semi-immersed, to 5 mm diam. Disc brown to black, concave. Epihymenium brownish, hymenium and hypothecium colourless. Paraphyses not anastomosing, simple, not apically thickened, adglutinated. Asci *Peltigera*-type, fissitunicate, the thickened apex with a K/I+ blue ring. Spores 2-celled, pigmented, ellipsoid, constricted at septa, 2 per ascus, 95-140 x 45-60 μm . Photobiont chlorococcoid (*Coccomyxa*). Without lichen substances. Note: rarely distinguished, and probably more widespread in the Alps.

- 63 Lobes 0.5-1 mm broad. Thallus reduced to a collar around the urceolate apothecia

59 - *Solorina spongiosa* (Ach.) Anzi



Thallus foliose, pale grey, often white pruinose, green when wet, K-, C-, KC-, P-, UV-. Lobes 0.5-1 mm broad, rounded, reduced to a collar around the urceolate apothecia, on a dark layer of coralloid to nodulose cephalodia containing *Nostoc*. Lower surface white, tomentose. Upper cortex paraplectenchymatous, lower cortex absent. Medulla white, K-, C-, KC-, P-. Apothecia frequent, without a thalline margin, semi-immersed, to 5 mm diam. Disc brown to black, urceolate. Epihymenium brownish, hymenium and hypothecium colourless. Paraphyses not anastomosing, simple, not apically thickened, adglutinated. Asci clavate, *Peltigera*-type, fissitunicate, the thickened apex with a K/I+ blue ring. Spores 2-celled, pigmented, ellipsoid, constricted at septa, ornamented, 4 per ascus, 30-60 x 18-28 μm . Photobiont chlorococcoid (*Coccomyxa*). Without

lichen substances. Note: an arctic-alpine, circumpolar lichen, found on moist calciferous soil; to be looked for also on the highest peaks of the Apennines.

63 Lobes 4-8 mm broad. Thallus well developed, of elongated lobes

see 50 - Solorina saccata (L.) Ach.

Key 3 - Squamulose lichens

This key includes also the most common species of *Cladonia* which most frequently occur without podetia.

- 1 Photobiont cyanobacterial (photobiont layer bluish green in section) 2
- 1 Photobiont chlorococcoid (photobiont layer bright green in section) 19
- 2 Thallus dark, from black to dark brown 3
- 2 Thallus not dark 12
- 3 Thallus thick, inflated to round in section

1 - *Leptogium schraderi* (Bernh.) Nyl.



Thallus squamulose to subfruticulose, thick, somehow gelatinous when wet, glossy brown, more or less shiny, loosely attached, K-, C-, KC-, P-, UV-. Squamules (lobes) 0.5-1 mm broad, to 5(-7) mm long, subcylindrical, sometimes with a few dichotomous ramifications in upper part, ascending to erect, heavily wrinkled, often forming small tufts, sometimes with a few globular isidia. Cortex formed by regular layers of angular cells. Apothecia rare, lecanorine, almost terminal, sessile, strongly constricted, to 1.5 mm diam. Disc brown, concave, smooth. Margin distinct, thin. Epithecium brownish. Hymenium and hypothecium colourless. Paraphyses adglutinated, mostly simple, the apices swollen. Asci clavate, the wall K/I+ blue, the apical dome I+ pale blue with a dark blue axial tube. Spores hyaline, ellipsoid, submuriform, thin-walled, 8 per ascus, 23-33 x 10-14 µm. Photobiont cyanobacterial (*Nostoc*), in long chains. Without lichen substances. Note: on calciferous rocks, soil, often on other lichens (e.g. *Mycobilimbia lurida*), sometimes on terricolous mosses, rather common throughout the country below the subalpine belt, except in the Po-plain, where it is very rare.

- 3 Thallus thin, flat in section 4
- 4 Thallus not gelatinous when wet. Photobionts restricted to a well-delimited layer (section!) 5
- 4 Thallus more or less gelatinous when wet. Photobionts homogeneously spread throughout the thallus (section!) 6
- 5 Squamules <0.4 mm broad. Thallus brownish with a bluish tinge. Edge of squamules white. Spores 1-celled, thick-walled, <22 µm long. Hymenium I+ blue, turning brownish

2 - *Fuscopannaria praetermissa* (Nyl.) M.Jørg.

Thallus squamulose, brown with a bluish tinge, forming a continuous crust several cm in diam., usually without hypothallus,



K-, C-, KC-, P-, UV-. Squamules 2(-3) mm long, to 1.5 mm broad, rounded, incised, flattened, contiguous or mostly imbricate. Edge of squamules white-felted due to terpenoid crystals, with erect, finger-like lobules looking like isidia. Upper cortex paraplectenchymatous, 20-30 μm thick. Lower surface felted. Apothecia rare, cryptolecanorine, to 1.5 mm diam. Disc brown, usually convex. Thalline margin often absent, granulose, proper margin dark. Hymenium I+ blue-green, turning brownish, 100-120 μm thick. Paraphyses simple, slightly thickened above. Asci clavate to subcylindrical, with a I+ blue tholus, with an internal, more intensely I+ blue ring structure. Spores 1-celled, hyaline, ovoid to broadly ellipsoid, thick-walled, often with a single, large oil droplet, 8 per ascus, 18-22 x 9-11 μm . Photobiont cyanobacterial (*Nostoc*) in short chains. With unidentified aliphatic acids and triterpenoids. Note: an arctic-alpine to boreal-montane, circumpolar lichen, found on calciferous soil, mosses and plant debris. Perhaps restricted to the Alps in Italy, but to be looked for in the highest mountains of the C Apennines.

- 5 Squamules >0.5 mm broad. Thallus reddish- to blackish brown, without a bluish tinge. Edge of squamules not white. Spores 2-celled, thin-walled, >25 μm long. Hymenium I+ blue

3 - *Massalongia carnosa* (Dicks.) K rb.



Thallus tiny foliose to subsquamulose, red brown to blackish brown, paler when wet, K-, C-, KC-, P-, UV-. Lobes initially rounded, then elongate, flattened, 0.5-1.5(-2) mm broad, 0.5-3(-10) mm long, irregularly branched and overlapping, often forming rosettes 1-3 cm in diam., the margin dissected, with numerous, flattened, usually paler lobes or warts simulating isidia. Underside whitish to brown, with sparse brown rhizines. Upper cortex paraplectenchymatous, 25-30 μm thick. Lower cortex of longitudinally arranged hyphae. Apothecia rare, rounded, without a thalline margin, sessile to substipitate, up to 2 mm diam. Disc red-brown to flesh-coloured, margin thin, pale brown, sometimes with short hairs. Epithecium brownish, K-. Hymenium colourless or brownish above, I+ blue. Hypothecium colourless. Margin (section) composed of more or less isodiametric cells. Paraphyses simple, slightly thickened above, adglutinated. Asci cylindrical, *Peltigera*-type, thickened at apex, I+ blue. Spores 2-(4)-celled, hyaline, fusiform to narrowly ellipsoid, thin-walled, 8 per ascus, 11-25(-32) x 4.5-7(-8.5) μm . Pycnidia dark, paler below, semi-immersed, to 0.6 mm diam. Conidia slightly bifusiform, 4-6 x 1 μm . Photobiont cyanobacterial (*Nostoc*), in short chains. Without lichen substances. Note: a circumpolar arctic-alpine to boreal-montane lichen found on bryophytes and soil rich in humus. Present both in the Alps and in the mediterranean mountains, but generally rare.

- 6 Thallus with thin transparent hairs (lens!)

4 - *Leptochidium albociliatum* (Desm.) M.Choisy

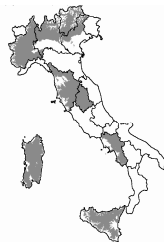
Thallus foliose to subsquamulose, gelatinous when wet, dark brownish-greenish black, K-, C-, KC-, P-, UV-. Lobes flattened, ascending, 3-5 mm broad, smooth, with rounded ends and undulate



to crenulate margins bearing abundant thin transparent hairs. Lower surface with sparse fasciculate rhizines. Upper and lower cortex paraplectenchymatous, formed by 1-3 layers of cells, 10-40 μm thick. Apothecia rare, lecanorine, adnate, 0.3-0.7(-1.2) mm diam. Disc brown, smooth, concave to flat; margin thick, paraplectenchymatous in section, covered by hairs. Epithecium brownish. Hymenium and hypothecium colourless. Paraphyses branches, septate, swollen at apices. Asci clavate. Spores 2-celled, hyaline, narrowly ellipsoid, 8 per ascus, 18-26 x 5-7(-9) μm . Photobiont cyanobacterial (*Scytonema*). Without lichen substances. Note: a cool-temperate to arctic-alpine lichen found amongst bryophytes on rocks or on soil in open shrublands and grasslands on basic siliceous substrata, mostly in upland areas. Present both in the Alps and in the Mediterranean mountains, where it is locally abundant (e.g. on the Aspromonte Massif, Calabria).

- | | | |
|---|--|----|
| 6 | Thallus without thin transparent hairs | 7 |
| 7 | Squamules very small, <1 mm broad (measure the squamules in the central part!) | 8 |
| 7 | Squamules larger, >1 mm broad | 11 |
| 8 | Thallus not entirely paraplectenchymatous, i.e. the cortex not extending throughout its thickness (section!) | |

5 - *Leptogium intermedium* (Arnold) Arnold



Thallus squamulose, somewhat gelatinous when wet, bluish grey to dark brown, often paler in the basal, less exposed parts, thin, loosely attached, K-, C-, KC-, P-, UV-. Squamules smooth to slightly wrinkled, 0.5-1 mm broad, elongate, ascending, contiguous to imbricate, with a usually down-turned, entire or shallowly incised edge. Upper and lower cortex of a single layer of angular, more or less isodiametric cells. Apothecia rare, lecanorine, sessile, strongly constricted, 0.5-0.8 mm diam. Disc brown, concave, smooth. Margin distinct, thin. Epithecium pale brownish. Hymenium and hypothecium colourless. Paraphyses adglutinated, mostly simple, the apices slightly swollen. Asci clavate, the wall K/I+ blue, apical dome pale blue with a dark blue axial tube. Spores hyaline, broadly ellipsoid, submuriform, thin-walled, 8 per ascus, 20-35 x 8-13 μm . Photobiont cyanobacterial (*Nostoc*), in short chains. Without lichen substances. Note: a mainly temperate species, found on soil, occasionally on the bases of ancient trunks, more rarely on calcareous rocks. The Italian distribution is poorly known, since this recently resurrected species is easily confused with related taxa, esp. *L. gelatinosum*.

- | | | |
|---|--|---|
| 8 | Thallus entirely paraplectenchymatous, i.e. the cortex extending throughout its thickness (section!) | 9 |
| 9 | Lobes subcylindrical, <0.1 mm wide, stellately arranged around the apothecia. Apothecia subglobose, 0.2-0.5 mm diam. | |

6 - *Leptogium subtile* (Schrad.) Torss.



Thallus squamulose, somewhat gelatinous when wet, dark brown, thin, loosely attached, K-, C-, KC-, P-. Squamules (0.1-) mm broad, elongate, subcylindrical, stellately arranged around the apothecia, smooth, often forming small cushions. Cortex composed by a single layer of angular cells, thallus paraplectenchymatous throughout. Apothecia rare, lecanorine, characteristically globose, sessile, strongly constricted, 0.2-0.5 mm diam. Disc orange-brown, concave, smooth. Margin distinct, smooth, paler than disc. Epithecium brownish. Hymenium and hypothecium colourless. Paraphyses adglutinated, mostly simple, the apices slightly swollen. Asci clavate, the wall K/I+ blue, apical dome pale blue with a dark blue axial tube. Spores hyaline, ellipsoid, submuriform, thin-walled, 8 per ascus, 20-35 x 7-15 µm. Photobiont cyanobacterial (*Nostoc*), in short chains. Without lichen substances. Note: a mild-temperate lichen, found on the base of old trees with a base-rich bark, esp. *Juglans*, sometimes on wood, rarely on plant debris on the ground

9

Lobes, at least in part, not subcylindrical, >0.1 mm wide. Apothecia flat to concave, but not subglobose, usually >0.5 mm diam.

10

10

Alpine to subalpine. Thallus composed of densely imbricate, 0.5-1 mm broad, flattened squamules with entire to dissected, but never coralloid margins. Apothecia 0.5-1 mm diam.

7 - *Leptogium imbricatum* M.Jørg.



Thallus squamulose, somewhat gelatinous when wet, dark brown to blue-grey, often paler in the basal, less exposed parts, thin, loosely attached, K-, C-, KC-, P-. Squamules (0.1-)0.2-0.5(-1) mm broad, elongate, imbricate, often lobulate, smooth, with indented to incised margins, often forming cushions. Cortex composed by a single layer of angular cells, thallus paraplectenchymatous throughout. Apothecia rare, lecanorine, sessile, strongly constricted, 0.5-1 mm diam. Disc brown, concave, smooth. Margin distinct, smooth, paler than disc. Epithecium brownish. Hymenium and hypothecium colourless. Paraphyses adglutinated, mostly simple, the apices slightly swollen. Asci clavate, the wall K/I+ blue, apical dome pale blue with a dark blue axial tube. Spores hyaline, ellipsoid, submuriform, thin-walled, 8 per ascus, 20-35 x 7-15 µm. Photobiont cyanobacterial (*Nostoc*), in short chains. Without lichen substances. Note: on more or less calciferous ground in alpine grasslands. A recently-described species, certainly widespread throughout the Alps; easily confused with pulvinate forms of *L. lichenoides* or *L. gelatinosum*

- 10 Mostly below the Alpine belt. Thallus composed of small (<0.5 mm broad) squamules with strongly dissected margins which tend to become coralloid. Apothecia 1-4 mm diam.

8 - *Leptogium tenuissimum* (Dicks.) Körb.



Thallus squamulose, somewhat gelatinous when wet, dark brown to blue-grey, often paler in the basal, less exposed parts, thin, loosely attached, K-, C-, KC-, P-. Squamules less than 0.5 mm broad, elongate, densely imbricate, with strongly dissected margins whose divisions tend to become cylindrical-coralloid. Cortex composed by a single layer of angular cells, thallus paraplectenchymatous throughout. Apothecia rare, lecanorine, sessile, strongly constricted, 1-4 mm diam. Disc brown, deeply concave, smooth. Margin distinct, smooth. Epithecium brownish. Hymenium and hypothecium colourless. Paraphyses adglutinated, mostly simple, the apices slightly swollen. Asci clavate, the wall K/I+ blue, the apical dome pale blue with a dark blue axial tube. Spores hyaline, ellipsoid, submuriform, thin-walled, 8 per ascus, 20-35 x 7-15 μm . Photobiont cyanobacterial (*Nostoc*), in short chains. Without lichen substances. Note: on base-rich soil, but also on bark, in the basal parts of old trunks, rarely on base-rich rocks; occurring throughout the country, but never common.

- 11 Edge of lobes not entire, deeply fringed-dilacerate

9 - *Leptogium lichenoides* (L.) Zahlbr.

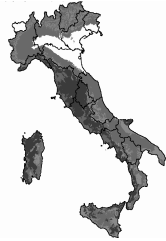


Thallus small-foliose to squamulose, somewhat gelatinous when wet, bluish grey to dark brown, often paler in the basal, less exposed parts, thin, loosely attached, of ascending crowded lobes, often forming cushions, K-, C-, KC-, P-, UV-. Lobes 0.3-3(-4) mm broad and to ca. 1 cm long, more or less imbricate, the surface distinctly wrinkled, the edges deeply dilacerate-fimbriate, the divisions sometimes almost coralloid. Cortex composed by a single layer of angular cells. Apothecia rare, rounded, lecanorine, sessile, strongly constricted, 0.4-1 mm diam. Disc brown, concave to flat, smooth; margin often with lobulate to coralloid outgrowths. Epithecium brownish. Hymenium and hypothecium colourless. Paraphyses adglutinated, mostly simple, the apices swollen. Asci clavate, the wall K/I+ blue, apical dome pale blue with a dark blue axial tube. Spores many-celled, hyaline, broadly ellipsoid, submuriform, thin-walled, 8 per ascus, 25-50 x 11-16 μm . Photobiont cyanobacterial (*Nostoc*), in long chains. Without lichen substances. Note: a widespread holarctic lichen, the most common species of *Leptogium* in Italy; mostly found on soil and amongst mosses in dry grasslands, more rarely on basal parts of trunks, but also on walls in urban areas.

- 11 Edge of lobes more or less entire. Surface heavily wrinkled, most lobes >2 mm broad (if surface more or less smooth, and lobes <2 mm broad, cf. nr. 5: *Leptogium intermedium*)

10 - *Leptogium gelatinosum* (With.) J.R.Laundon

Thallus small-foliose to subsquamulose, more or less gelatinous when wet, brown, often paler in the basal, less exposed parts, dull or somehow shiny, thin, loosely attached, of ascending lobes often forming cushions, K-, C-, KC-, P-, UV-. Lobes (2-)3-4 mm broad and to 1 cm long, often imbricate, heavily wrinkled, with entire to irregularly lobulate margins. Cortex composed by a single layer of



angular cells. Apothecia rare, adnate to sessile, rounded, lecanorine, sessile, strongly constricted, to 2 mm diam. Disc brown, concave to flat, smooth; margin thick, sometimes concentrically wrinkled. Epithecium very pale brownish. Hymenium and hypothecium colourless. Paraphyses adglutinated, mostly simple, the apices slightly swollen. Asci clavate, the wall K/I+ blue, the apical dome pale blue with a dark blue axial tube. Spores many-celled, hyaline, broadly ellipsoid, submuriform, thin-walled, 8 per ascus, 25-45 x 8-18 μm . Photobiont cyanobacterial (*Nostoc*), in long chains. Without lichen substances. Note: a widespread holarctic lichen, most common on base-rich siliceous substrata, esp. in open grasslands, and apparently well distinguished from the more calcicolous *L. lichenoides*. More frequent than *L. lichenoides* in areas with siliceous substrata, much rarer in urban environments.

- 12 Thallus forming rosettes, with radiating, fan-shaped, small marginal lobes

11 - *Pannaria hookeri* (Sm.) Nyl.



Thallus squamulose, the centre almost areolate-subcrustose, more or less orbicular, pale grey to whitish, sometimes tinged pale brownish, often white-maculate, K-, C-, KC-, P- or P+ faintly orange-red, UV-. Squamules ca. 2 x 3 mm long, crenate, convex, contiguous to scattered or imbricate, on a dark hypothallus. Upper cortex thick (>55 μm) paraplectenchymatous, lower cortex absent. Apothecia frequent, cryptolecanorine, crowded, especially in the centre, rounded, sessile, to 2 mm diam. Disc black to rarely dark brown, flat. Proper margin distinct, thick, thalline margin crenulate, often ephemeral. Epithecium greenish black. Hymenium colourless, I+ blue only around the asci, 100-200 μm thick. Asci clavate, without internal I+ blue structures, reacting to I only near the outer wall. Spores 1-celled, hyaline, broadly ellipsoid to globular, not ornamented, 8 per ascus, 12-16 x 8-11 μm . Pycnidia dark, immersed. Conidia bacilliform. Photobiont cyanobacterial (*Nostoc*) in short chains. With traces of pannarin (thallus faintly P+ orange). Note: on slightly calciferous soil (mostly deriving from metamorphic rocks) in sites with periodical water seepage, near or above treeline; probably restricted to the Alps in Italy.

- 12 Thallus never forming rosettes, without marginal lobes 13
 13 Apothecia lecanorine, with a thalline margin containing algal cells 14
 13 Apothecia non lecanorine, without a thalline margin 15
 14 Montane to alpine. Spores 8 per ascus

12 - *Protopannaria pezizoides* (Weber) M.Jørg. & S.Ekman

Thallus small-squamulose to subcrustose, pale bluish grey, ochraceous, or reddish brown in sun-forms, bluish-green to blackish when moist, thick, K-, C-, KC-, P-, UV-. Squamules 0.2(-1) mm broad, to 0.2 mm thick, toward the centre, crenate to lobulate, flattened, contiguous, closely adpressed to the substratum to form a compact crust. Lower surface pale. Upper cortex paraplectenchymatous, 40-50 μm thick. Lower cortex absent.



Apothecia frequent, lecanorine, sessile, up to 2.5 mm diam. Disc orange-brown to dark brown, flat to slightly convex. Margin thick, granular to verruculose. Epithecium brownish, inspersed. Hymenium colourless, 95-150 μm tall, I+ dark blue. Hypothecium colourless. Paraphyses simple, septate, slightly swollen at apices. Asci cylindrical-clavate, without internal amyloid structures, but with a I+ deep blue external cap. Spores 1-celled, hyaline, ellipsoid, somewhat pointed at the ends, thick-walled, ornamented with a mammillose epispore, 8 per ascus, 19-25 x 8-10 μm , incl. perispore 25-30 x 9-12 μm . Photobiont cyanobacterial (*Nostoc*) in clumps. Without lichen substances. Note: an arctic-alpine to boreal-montane lichen, circumpolar lichen, found on mosses, plant debris, organic soil in open habitats; most common in the Alps (from the montane belt, where it is rare, to above treeline), but occurring, albeit more rarely, throughout the Apennines and on the mountains of Sardegna.

14 Mainly mediterranean. Spores many per ascus

13 - *Peltula patellata* (Bagl.) Swinscow & Krog



Thallus squamulose, pale to olivaceous brown or greyish-green, rarely with a faint whitish pruina, dull, thick, K-, C-, KC-, P-. Squamules 0.5-4 mm broad, rounded to somewhat lobulate, concave, dispersed to contiguous, with an up-turned, undulate, often darker edge, attached by a dense mat of rhizohyphae. Upper cortex poorly developed, substituted by an epinecral layer. Medulla paraplectenchymatous. Lower cortex paraplectenchymatous, 40-60 μm thick, composed by (2-)4-8 layers of more or less isodiametrical cells. Apothecia frequent, lecanorine, semi-immersed in the squamules, 1-20 per squamule, 0.5-1.5 mm diam. Disc reddish to dark brown, smooth, margin indistinct, thin. Epithecium dark yellowish brown, K+ violet-red. Hymenium colourless, I+ blue-green turning wine-red. Hypothecium colourless. Paraphyses anastomosing, simple, slightly thickened above. Asci unitunicate-rostrate (lecanorean type), obclavate, the wall I+ orange, K/I+ blue. Spores 1-celled, hyaline, subglobose, thin-walled, more than 100 per ascus, 3-8(-9) x (3-)5-7 μm . Pycnidia dark, immersed. Conidia fusiform, 3.7-4.3 x 1.2-2.8 μm . Photobiont: an unicellular cyanobacterium. Without lichen substances. Note: on soil in dry grasslands over siliceous substrata; hitherto known only from Liguria and Sardegna, to be looked for in dry areas of the south, also known from Alpine dry valleys outside Italy.

15 Apothecia perithecioid, opening by a small narrow pore. Most spores <15 μm long

14 - *Gloeoheppia turgida* (Ach.) Gyeln.

Thallus squamulose, olivaceous green to brownish, sometimes weakly whitish-pruinose, thick, K-, C-, KC-, P-, UV-. Squamules (2-)3-7 mm broad, rounded, strongly convex, smooth to weakly fissured, contiguous, with a down-turned edge, attached to the substratum by a dense net of rhizinoids. Upper cortex weakly differentiated, covered by a 8-16 μm thick epinecral layer. Lower cortex absent. Apothecia frequent, one to many per squamule,



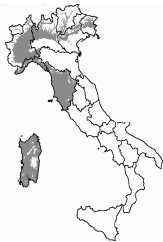
without a thalline margin, immersed, urceolate-perithecioid (opening through a narrow pore), 0.2-0.4 mm diam. when young, up to 1 mm diam. when old (several apothecia tending to coalesce). Disc dark reddish brown to blackish, not evident from above. Epithecium brownish, K-. Hymenium colourless, 70-120 μm thick, I+ blue. Hypothecium colourless, I+ blue. Paraphyses simple, distinctly thickened above, free. Asci prototunicate, cylindrical to obclavate, thin-walled, I-. Spores 1-celled, hyaline, ellipsoid, thin-walled, 8 per ascus, 10-15(-18) \times 6-8 μm . Pycnidia black, immersed in the squamules. Conidia ca. 1.5-2.5 \times 1 μm , formed terminally. Photobiont cyanobacterial (probably a member of Chroococcales), unicellular. Without lichen substances. Note: a mainly mediterranean lichen, found on calciferous soil in dry grasslands, occasionally on weathered basic siliceous rocks; known only from Sicilia, probably present also in Sardegna and Puglia, and to be looked for there.

15 Apothecia non perithecioid, with exposed disc. Most spores >15 μm long

16

16 Without upper and lower cortex (section!). Thallus never pruinose

15 - *Heppia lutosa* (Ach.) Nyl.



Thallus squamulose to subcrustose, olive-brown to brown-black, thick, K-, C-, KC-, P-. Squamules (1-)3-5 mm broad, to 200 μm thick, concave at least when young, often granulose, mostly contiguous, adpressed to the substratum, attached by a dense mat of rhizohyphae. Upper and lower cortex absent. Apothecia frequent, without a thalline margin, semi-immersed, up to 2 mm diam. Disc dark reddish brown, urceolate, concave. Margin indistinct. Epithecium brownish, K-. Hymenium I+ blue, 110-150 μm thick. Hypothecium colourless. Paraphyses simple, distinctly thickened above, free. Asci prototunicate, thin-walled, cylindrical to ovoid. Spores 1-celled, hyaline, ellipsoid, thin-walled, 8 per ascus, 15-24 \times 7-10 μm . Pycnidia dark. Conidia bacilliform. Photobiont cyanobacterial (*Scytonema*-like). Without lichen substances. Note: on more or less calciferous soil in dry grasslands; probably more widespread, but certainly not common, also in the south, with optimum in submediterranean areas.

16 With upper and/or lower cortex (section!). Thallus pruinose or not

17

17 Thallus heavily pruinose, with a thick white layer of clustered crystals

16 - *Heppia solorinoides* (Nyl.) Nyl.



Thallus squamulose, brownish under a thick white layer of clustered crystals (pruina) which tends to accumulate in areolate patches, giving the surface a reticulate appearance, K-, C-, KC-, P-, UV-. Squamules (2-)3-7 mm broad, elongate, first flat, then concave, contiguous, with rounded ends and up-turned, undulate edges, attached by a mat of rhizohyphae. Upper and lower cortex paraplectenchymatous. Apothecia frequent, without a thalline margin, semi-immersed in the squamules, 0.5-1.5(-2.5) mm diam. Disc dark reddish brown, first concave, then flat. Margin indistinct.

Epithecium brownish, K-. Hymenium and hypothecium colourless. Paraphyses simple, distinctly thickened above, free. Asci prototunicate, thin-walled, subcylindrical, the wall I+ blue. Spores 1-celled, hyaline, ellipsoid, thin-walled, 8 per ascus, 16-26(-29) x (6-)8-12(-13) μm . Pycnidia dark. Conidia bacilliform. Photobiont cyanobacterial (*Scytonema*-like). Without lichen substances. Note: restricted to very dry grasslands in Mediterranean Italy (Puglia, Calabria, Sicilia); to be looked for in Sardegna.

17 Thallus non-pruinose

18

18 Restricted to upland areas. Hymenium I+ red. Lower cortex well-developed, formed by periclinally arranged hyphae

17 - *Heppia adglutinata* (Kremp.) A.Massal.

Thallus squamulose, yellowish-olive-green to brown, thick, K-, C-, KC-, P-, UV-. Squamules (2-)3-6 mm broad, concave, contiguous, adpressed to the substratum. Upper cortex partially developed, paraplectenchymatous, 15-50 μm thick, covered by an epinecral layer. Lower cortex 13-40 μm thick, formed by 1-4 rows of mainly periclinally arranged hyphae. Apothecia frequent, without a thalline margin, semi-immersed in the squamules, to 2 mm diam. Disc dark reddish brown, flat to mostly deeply concave, margin indistinct. Epithecium brownish, K-. Hymenium colourless, I+ red. Hypothecium colourless. Paraphyses simple, distinctly thickened above, free. Asci prototunicate, thin-walled, subcylindrical. Spores 1-celled, hyaline, ellipsoid, thin-walled, 8 per ascus, (15-)18-24(-30) x 6-10.5(-12) μm . Pycnidia dark. Conidia bacilliform. Photobiont cyanobacterial (*Scytonema*-like). Without lichen substances. Note: a cool-temperate to boreal-montane, circumpolar, ephemeral lichen of disturbed calciferous soil in dry, open grasslands, mostly found near or above treeline. Probably occurring throughout the Alps.



18 Restricted to lowland areas. Hymenium I+ blue. Lower cortex absent or restricted to the margins

18 - *Heppia despreauxii* (Mont.) Tuck.

Thallus squamulose, ochraceous brown with pale punctiform depressions in a reticulate pattern, thick, K-, C-, KC-, P-. Squamules 1.5-2(-3) mm broad, first flat, then concave, smooth, contiguous, with rounded ends and a down-turned edge, attached by a mat of 10-14 μm thick, colourless rhizohyphae. Upper cortex paraplectenchymatous, 25-70 μm thick, covered by a 10-15 μm thick epinecral layer. Lower cortex absent or restricted to the margins. Apothecia rather rare, without a thalline margin, semi-immersed in the squamules, up to 2 mm diam. Disc dark reddish brown, concave, margin indistinct. Epithecium brownish, K-. Hymenium colourless, I+ blue. Hypothecium colourless. Paraphyses simple, distinctly thickened above, free. Asci prototunicate, thin-walled, cylindrical to obovoid. Spores 1-celled, hyaline, ellipsoid, thin-walled, 8 per ascus, (18-)20-29(-31) x (7-)9-12 μm . Pycnidia dark. Conidia bacilliform. Photobiont cyanobacterial (*Scytonema*-like). Without lichen substances. Note: the Italian record (Liguria) is the northernmost known for this mediterranean-macaronesian lichen of clay soil in



dry, open grasslands. To be looked for further in the south, esp. in the Tyrrhenian region.

- 19 Squamules subfoliose, ascending, bifacial (*Cladonia*) 20
- 19 Squamules of different forms, but not subfoliose, ascending, and bifacial 36
- 20 Squamules with soredia, or isidia-like structures 21
- 20 Squamules without soredia 22
- 21 Squamules whitish grey, <3 mm long, <1 mm broad, deeply incised, granulose-“sorediose”. With thamnolic acid and variable amounts of barbatic acid. Apothecia and pycnidia (when present) brown

19 - *Cladonia parasitica* (Hoffm.) Hoffm.



Thallus fruticose, whitish grey to pale grey-brown, K+ yellow, C-, KC- P+ yellow-orange, UV-. Primary thallus squamulose, the squamules persisting, whitish to pale greenish grey, very finely divided, granulose-sorediose, to 5 mm long, 0.2-1 mm broad, white below. Podetia densely squamulose, to 2 cm tall (usually less), deformed and very irregularly branched, often covered by isidioid granules and partly decorticated with scattered to numerous squamules, fissured, with gaping holes. Apothecia rare, dark brown, convex, often clustered. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Pycnidia dark, semi-immersed in the upper part of the squamules. Photobiont chlorococcoid. With thamnolic acid and variable amounts of barbatic acid. Note: a mainly temperate, probably holarctic species; normally lignicolous, on stumps, sometimes on basal parts of old trunks; present throughout the country, with optimum in *Castanea* stands.

- 21 Squamules greenish, >5 mm long, >1 mm broad, rounded, with marginal soredia. With thamnolic acid only. Apothecia and pycnidia (when present) bright red

20 - *Cladonia digitata* (L.) Hoffm.



Thallus fruticose, grey-green to olive-green, K+ yellow, C-, KC- or rarely KC+ yellowish, P+ deep orange. Primary thallus squamulose, the squamules prominent, large, to 1.5 cm diam., rounded, entire, lobed or weakly incised, horizontally spreading, with farinose soredia along the up-turned margin, grey-green to olive-green above, white and farinose below, often pale orange near the attachment point. Podetia corticate only at base, to 1.5 cm tall, pointed or with irregular small cups gradually broadening toward the base. Apothecia rare, scarlet red. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Pycnidia scarlet red, semi-immersed at the top of podetia or along the margins of cups. Conidia cylindrical. Photobiont chlorococcoid. With thamnolic acid. Note: a cool-temperate to boreal-montane, circumpolar species, found on strongly weathered lignum, mosses, on the bases of trunks, sometimes on soil rich in humus; common only in the Alps, in the

montane-subalpine belts, much rarer along the Apennines, south to the mountains of Sicily.

- 22 Thallus K+ red 23
 22 Thallus K-, or K+ yellow 24
 23 Squamules K+ rapidly deep red. With norstictic acid, without atranorin

21 - *Cladonia polycarpoides* Nyl.

Thallus fruticose, grey, rapidly K+ red, C-, KC-, P+ red. Primary thallus squamulose, the squamules persisting, prominent, 3-15 x 1-4 mm, olive-green above, white, but often becoming brownish below, ascending, forming dense mats. Podetia rather rare, thicker at apex, simple or sparsely ramified, sometimes squamulose. Apothecia rare, brown, convex. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Pycnidia dark, semi-immersed. Conidia cylindrical. Photobiont chlorococcoid. With norstictic acid. Note: a mainly temperate lichen, found on calcareous mineral soil in open grasslands and on soil pockets on large isolated boulders; probably somehow overlooked in Italy and more widespread, at least in the Alps.



- 23 Squamules K+ yellow, then slowly red. With norstictic acid and atranorin

22 - *Cladonia symphycarpa* (Flörke) Fr.

Thallus fruticose, K+ yellow, then slowly red, C-, KC-, P+ orange-yellow. Primary thallus squamulose, the squamules persisting, prominent, often forming mats, 2-6 x 2-4 mm, horizontally spreading, with recurved margins, grey-green above, white below. Podetia to 1 cm tall, very rare, bluish- to olive-green, cupless, simple or branching toward the top and broadening upwards, and terminating with apothecia, or with irregular cups, with a verruculose-areolate, fissured cortex. Apothecia very rare, dark brown, larger than the tips of podetia. Asci *Porpidia*-type. Spores 1-celled, hyaline, 8 per ascus. Pycnidia dark brown to black, semi-immersed, often occurring on the primary squamules. Conidia cylindrical. Photobiont chlorococcoid. With norstictic acid and atranorin. Note: a widespread and common holarctic species, found on calcareous ground in dry grasslands or on the top of exposed calcareous boulders; certainly occurring throughout S Italy.



- 24 Thallus K+ yellow 25
 24 Thallus K- 29
 25 Thallus P+ orange, with thamnolic acid, without fumarprotocetraric acid

23 - *Cladonia squamosa* Hoffm. var. *subsquamosa* (Leight.) Vain.

Thallus fruticose, grey, K+ yellow, C-, P+ orange, UV-. Primary thallus squamulose, the squamules persistent to rarely ephemeral, 2-



5 mm long and 1 mm broad, irregularly subpinnate or subdigitate or wedge-shaped, scattered to crowded, sometimes forming dense mats, white below. Podetia very variable, usually densely squamulose with small, fragile squamules, very variable in shape and size, to 5(-8) cm tall, irregularly branched, with pointed apices or with irregular, small, perforated cups with often proliferating margins, the surface scabrid, usually partly decorticated, but sometimes subcontinuous. Apothecia frequent, brown, convex. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Pycnidia dark, semi-immersed. Conidia cylindrical. Photobiont chlorococcoid. With thamnolic and barbatic acids. Note: more hygrophytic than the typical variety, and more bound to higher altitudes, widespread from the Alps to the mountains of Sicily.

- 25 Thallus P+ red, without thamnolic acid, with fumarprotocetraric acid 26
- 26 Squamules grey below 27
- 26 Squamules white below (except sometimes near the attachment point) 28
- 27 Lower surface of squamules reddish grey

24 - *Cladonia firma* (Nyl.) Nyl.



Thallus fruticose (but mostly reduced to the primary squamules), greenish grey, K+ yellow, C-, KC-, P+ red, UV-. Primary thallus squamulose, the squamules prominent, persistent, forming dense mats, 0.5-1.5 cm long, mostly ascending, entire to slightly indented, often recurved at apices when dry, forming dense mats, grey-green above, reddish grey below, darker towards the base. Podetia very rare, funnel-shaped, sometimes proliferating from the centre, with a continuous to shallowly areolate cortex. Apothecia extremely rare, dark brown, convex. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Pycnidia dark, semi-immersed. Photobiont chlorococcoid. With fumarprotocetraric acid, atranorin, and variable amounts of rangiformic acid. Note: a mild-temperate lichen, found on mineral, often base-rich siliceous soil in open Mediterranean grasslands; certainly occurring throughout Tyrrhenian Italy, in areas with siliceous substrata.

- 27 Lower surface of squamules lead grey

25 - *Cladonia subcervicornis* (Vain.) Kernst.



Thallus fruticose (but mostly reduced to the primary squamules), K+ yellow, C-, KC-, P+ red, UV-. Primary thallus squamulose, the squamules prominent, persistent, large, 0.5-2 cm long and 2-4(-5) mm broad, with an entire to weakly indented margin, ascending, forming cushions, bluish-green to lead-greyish-green above, lead grey below, often with black spots near the attachment point. Podetia rare, with funnel-shaped, rapidly flaring cups which sometimes proliferate from the centre or from the margins, lacking squamules, with a more or less continuous or areolate cortex. Apothecia rare, dark brown, convex, often clustered, originating from the margins of the cups. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8

per ascus. Pycnidia dark, semi-immersed on the margins of cups. Conidia cylindrical. Photobiont chlorococcoid. With fumarprotocetraric acid and atranorin. Note: on siliceous rocks and on soil rich in humus in open habitats; probably more widespread, especially in Tyrrhenian Italy, but certainly not common.

- 28 Squamules with a bluish tinge above, white below. Podetia (when present) with cups

26 - *Cladonia macrophyllodes* Nyl.

Thallus fruticose (but primary squamules prominent!), greenish grey, K+ yellow, C-, KC-, P+ red. Primary thallus squamulose, the squamules very large, 8-30 mm long and 5-10 mm broad, lobate to incised, concave to involute, greenish grey above, white below. Podetia rare, to 10 mm tall (usually much less), and to ca. 2 mm broad, with funnel-shaped cups which are up to 7 mm in diam., with a continuous to areolate cortex. Apothecia rare, brown, convex. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Pycnidia dark, semi-immersed in the margins of the cups or in the primary squamules. Photobiont chlorococcoid. With atranorin and fumarprotocetraric acid. Note: an arctic-alpine, circumpolar species found on soil in open sites with a long snow-lie; optimum in the siliceous Alps. Much overlooked or misunderstood in the past.



- 28 Squamules greyish-green, without a bluish tinge above, pale cream-coloured below. Podetia (when present) usually cupless

27 - *Cladonia turgida* Hoffm.

Thallus fruticose, greyish-green, somehow glaucescent, K+ yellow, C-, KC-, P+ red, UV-. Primary thallus squamulose, the squamules persistent, large, 5-20 mm long, 2-7 mm broad, coarse, with broad and rounded divisions, dark green to glaucescent above, pale cream-coloured below. Podetia simple to irregularly branched, the terminal branches usually subulate, cupless or with small, irregular cups, esorediate, with a smooth to areolate cortex, the areoles separated by white lines. Apothecia rare, brown, convex. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Photobiont chlorococcoid. With atranorin and fumarprotocetraric acid. Note: a mainly boreal-montane, circumpolar species, found on acid soil in open habitats; restricted to the Alps in Italy, where it is extremely rare.



- 29 Thallus C+ bright emerald green, with baeomycesic and squamatic acids and strepsilin

28 - *Cladonia strepsilis* (Ach.) Grognot

Thallus fruticose (mainly squamulose), brownish-greenish grey, K-, KC-, C+ bright emerald green, P+ yellow, UV+ whitish. Primary thallus squamulose, the squamules prominent, to 4 mm long, rounded or elongate, indented, forming cushions, bronze-green above, white below. Podetia very rare, small, with irregular cups or with a few thick branches, corticate, often squamulose at the base. Apothecia extremely rare, dark brown, convex. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Pycnidia brown,



semi-immersed in the basal squamules. Photobiont chlorococcoid. With baeomycesic and squamatic acids, and strepsilin. Note: a cool-temperate to boreal-montane lichen, found on organic soil overlaying siliceous rocks and amongst bryophytes in humid depressions periodically filled by water, in open situations. There are only a few records, from Italy (Alps), and these need re-confirmation, see Nimis (1993: 245).

29 Thallus C-, with a different chemistry 30

30 Thallus P+ yellow, with psoromic acid

29 - *Cladonia macrophylla* (Schaer.) Stenh.



Thallus fruticose, greenish grey to brownish grey, K-, C-, KC-, P+ yellow, UV-. Primary thallus squamulose, the squamules persistent, large to rarely middle-sized, 3-8 mm long and broad, round or elongate, lobate to incised, glaucous to rarely olive-green above, white below, sometimes darkening towards the attachment point. Podetia elongate, 2-4(-6) cm tall, up to 5 mm in diam. (usually less), cupless, simple or branched, with blunt apices and a fissured surface with numerous peltate squamules up to 1 mm broad (usually less) and black-grey decorticated areas at the base. Apothecia brown, convex, terminal on podetia. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Pycnidia dark, semi-immersed on the tips of podetia and on their squamules. Conidia cylindrical. Photobiont chlorococcoid. With psoromic acid. Note: a northern-alpine species found on organic soil and weathered siliceous rocks; certainly restricted to the Alps; most Italian records need re-confirmation.

30 Thallus P- or P+ red, without psoromic acid 31

31 Thallus P-, without fumarprotocetraric acid

30 - *Cladonia squamosa* Hoffm. var. *squamosa*



Thallus fruticose, greyish, K-, C-, KC-, P-, UV+ white. Primary thallus squamulose, the squamules persistent or disappearing, middle-sized, indented, to 2 mm long, forming dense mats, white below. Podetia ramified, areolate, densely squamulose, to 5 cm tall, extremely variable in shape and size, irregularly branched, with pointed apices or with irregular small perforate cups, the surface scabrid, densely squamulose and partly decorticated. Medulla UV+ white. Apothecia frequent, brown, convex, located at the top of podetia, often clustered. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Pycnidia dark, semi-immersed on the top of podetia. Photobiont chlorococcoid. With squamatic acid and variable amounts of barbatic acid. Note: a widespread holarctic lichen, found on organic substrata in sheltered situations, rarely on bark, on basal parts of trunks; a very polymorphic taxon.

31 Thallus P+ red, with fumarprotocetraric acid 32

32 Squamules pure white below 33

32 Squamules lead grey to cream-coloured below 34

33 Squamules greenish grey, less than 0.4 mm thick, ascending

31 - *Cladonia caespiticia* (Pers.) Flörke



Thallus fruticose, greenish grey, K-, C-, KC-, P+ red, UV-. Primary thallus squamulose, the squamules persistent, 2-8 mm long, to 1.5 mm wide, strongly divided and irregularly incised, ascending, mostly forming low cushions, pale greyish to brownish green above, white below. Podetia small, to 3 mm tall, partly without cortex. Apothecia rather rare, terminal, sessile or on short stalks lacking algae, single or clustered, pale brown, more or less translucent when wet, convex. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Pycnidia brown, semi-immersed on the upper surface of the basal squamules. Conidia cylindrical. Photobiont chlorococcoid. With fumarprotocetraric acid. Note: a cool-temperate to S boreal-montane, circumpolar lichen, found on mineral, generally sandy-clay soil, occasionally on rotting wood and on bases of ancient trunks, in sheltered situations. Probably more widespread, but very rare.

33 Squamules more or less brownish, 1-2 mm thick, forming a subrosulate crust

32 - *Cladonia pocillum* (Ach.) O.J. Rich.



Thallus fruticose, more or less brownish, K-, C-, KC-, P+ red, UV-. Primary thallus squamulose, the squamules persistent, adnate, middle-sized, 1-5 mm long, 1-2 mm thick, flat to convex, forming a subrosulate crust around the base of podetia, brownish to greenish brown above, white below. Podetia funnel-shaped, mostly non squamulose, 0.5-3 cm tall, with broad cups and short stalks, gradually tapering toward base, regular or rarely proliferating from margin, the cortex disrupted into contiguous to scattered areoles (schizidia), esp. inside the cups. Medulla UV-. Apothecia rare, brown, convex, on the margins of cups. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Pycnidia brown, on the margins of cups. Conidia cylindrical. Photobiont chlorococcoid. With fumarprotocetraric acid. Note: a widespread holarctic species, found on calciferous soil and amongst bryophytes in dry, open grasslands, from the lowlands to above treeline; one of the most common Cladonias of Italy, esp. in calcareous areas.

34 Squamules bluish grey below. Without usnic acid

33 - *Cladonia cervicornis* (Ach.) Flot. subsp. *cervicornis*



Thallus fruticose, greyish to brownish green, K-, C-, KC-, P+ red, UV-. Primary thallus squamulose, the squamules persistent, large, to 1 cm long, contiguous, forming cushions grey-green above, bluish grey below, the margins entire to indented. Podetia rather rare, funnel-shaped, to ca. 1 cm tall, flaring from the base, often proliferating from the centre, with a continuous to areolate cortex, often sparingly squamulose at the base. Apothecia rare, brown, convex, on the margins of cups. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Pycnidia dark, semi-immersed in the margins of cups. Photobiont chlorococcoid. With fumarprotocetraric acid. Note: a temperate to southern boreal-montane lichen, found on mineral siliceous soil in open grasslands and garrigues; most

frequent in lowland areas of Tyrrhenian Italy.

- 34 Squamules pale yellowish (cream-coloured) below. With usnic acid

35

- 35 On calcareous substrata. Squamules 15-40 x 2-10 mm, sometimes with black or white hairs at the margins, forming straggling clusters

34 - *Cladonia convoluta* (Lam.) Anders

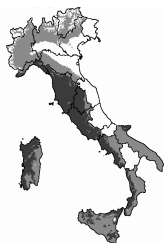
Thallus - when with podetia - fruticose, but mostly squamulose, greenish grey, K-, C-, KC+ yellowish, P+ red, UV-. Primary thallus squamulose, the squamules very large 15-40 x 2-10 mm, sometimes with black or white hairs at the margins, persistent, forming straggling clusters, greenish to greenish-grey above, cream-coloured (yellowish) below. Podetia extremely rare, to 1.5 cm tall, with pale brown, convex and often confluent apothecia. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Photobiont chlorococcoid. With fumarprotocetraric and usnic acids. Note: a mild-temperate, common species, found on mineral soil in dry grasslands, or in depressions between sand dunes, mostly in lowland areas; also occurring in dry-continental Alpine valleys.



- 35 On subneutral siliceous substrata. Squamules 4-15 x 1-3 mm, sometimes with black hairs at the margins, forming compact mats

35 - *Cladonia foliacea* (Huds.) Willd.

Thallus - when with podetia - fruticose, but mostly squamulose greenish grey, K-, C-, KC+ yellowish, P+ red, UV-. Primary thallus squamulose, the squamules large, 4-15 x 1-3 mm, persistent, forming compact mats, sometimes with black hairs at the margins, greenish to greenish-grey above, cream-coloured (yellowish) below. Podetia extremely rare, to 1.5 cm tall, with pale brown, convex and often confluent apothecia. Asci *Porpidia*-type. Spores 1-celled, hyaline, ellipsoid, 8 per ascus. Photobiont chlorococcoid. With fumarprotocetraric and usnic acids. Note: a mainly mild-temperate lichen, an ecological vicariant of *C. convoluta* on more base-rich, non-calciferous ground, mostly below the subalpine belt; rare along the eastern side of the Peninsula because of the scarcity of suitable substrata.



- 36 With soredia or isidia. Thallus with or without hairs

37

- 36 Without soredia or isidia. Thallus always without hairs

39

- 37 Squamules small, <0.5 mm broad, with thin transparent hairs. With soredia

36 - *Agonimia opuntiella* (Poelt & Buschardt) Vězda

Thallus squamulose, grey to brownish- or greenish-grey, loosely attached, K-, C-, KC-, P-, UV-. Squamules 0.1-0.4 mm broad, bullate to slightly flattened, entire to crenate, dispersed or grouped, often budding in a yeast-like manner, densely covered by thin transparent hairs, sometimes with labriform soralia. Thallus



paraplectenchymatous throughout, without a distinct cortex. Perithecia pyriform, very rare, without involucrellum, located among the squamules, 0.3-0.4 mm diam., the wall black, with a rugose surface. Paraphyses absent, substituted by periphyses. Asci thin-walled, not or very weakly thickened above, I-. Spores brownish when old, ellipsoid, muriform, 60-70 x 25-28 μm . Photobiont chlorococcoid. Without lichen substances. Note: a mild-temperate species, found on terricolous mosses and plant debris over calcareous substrata, sometimes amongst mosses on basal parts of old trees, mostly below the subalpine belt. Easily overlooked, certainly much more widespread, but not common.

- 37 Squamules much larger, without hairs. With isidia or isidia-like outgrowths

38

- 38 Thallus C-, KC+ yellowish, with usnic acid, without gyrophoric acid. Isidia knotty-granulose, marginal. Apothecia lecanorine

37 - *Squamarina concrescens* (Müll.Arg.) Poelt



Thallus squamulose to subcrustose, greenish white, paler at margin, thick, often forming rosettes, with radiating marginal lobes, several cm in diam., K-, C-. KC+ yellowish, P-, UV-. Medulla P- or P+ yellow. Squamules (2-)3-5 mm broad, elongate, mostly concave, closely adpressed to the substratum, with a usually up-turned margin covered by knotty, simple, whitish isidia-like outgrowths. Upper cortex paraplectenchymatous, well delimited against the thick medulla. Apothecia rare, lecanorine, sessile, strongly constricted, up to 4 mm diam. Disc smooth, pale brown to greenish-brown, margin thick, smooth. Paraphyses slightly thickened above. Epithecium brownish, hymenium (I+ blue) and hypothecium colourless. Asci clavate, the wall I+ blue, with a I+ blue apical dome, without axial mass. Spores 1-celled, hyaline, ellipsoid, thin-walled, 8 per ascus, 10-15 x 4-6 μm . Pycnidia dark, immersed. Conidia filiform. Photobiont chlorococcoid. With usnic and variable amounts of psoromic acids. Note: an often misunderstood species, with a southern distribution centred in dry areas, found on base-rich clay soil in clearings of grasslands and garrigues; mostly Tyrrhenian, but also found in the dry Alpine valleys.

- 38 Thallus KC+, C+ red, without usnic acid, with gyrophoric acid. Isidia flattened, spathulate, clustered in laminal rounded spots. Apothecia non lecanorine

38 - *Trapeliopsis wallrothii* (Spreng.) Hertel & Gotth.Schneid.



Thallus squamulose to subcrustose, whitish to pale grey, thick, K-, C+ red, KC+ red, P-. Squamules angular, flattened to somewhat convex, contiguous, areolate-subcrustose in the centre, elongated at the periphery to form a subrosulate thallus, the marginal lobes 0.5-1 mm wide, to ca. 3 mm long. Isidia laminal, simple, coarsely granular to spathulate, clustered in rounded patches which are evident also when the isidia have fallen. Apothecia rare, without a thalline margin, sessile, up to 1.5(-2) mm diam. Disc pink-brown to dull grey-green or almost black, paler when wet, often faintly pruinose,

flat to convex. Margin distinct, thin, often paler than disc. Epithecium and hypothecium brownish. Hymenium colourless. Paraphyses slender, anastomosing, ramified, not apically thickened, adglutinated. Asci clavate-cylindrical, thin-walled, I+ pale blue, with a small I+ blue cap inside the thickened apex. Spores 1-celled, hyaline, ellipsoid, thick-walled, 8 per ascus, 8-14 x 4-5 μm . Photobiont chlorococcoid. With gyrophoric acid. Note: on base-rich, non- or weakly calciferous soil, sometimes overgrowing mosses, mostly in open situations. More frequent in the south and in Tyrrhenian Italy (e.g. in Sardegna), very rare elsewhere.

- 39 With punctiform pseudocyphellae 40
 39 Without pseudocyphellae 41
 40 Thallus grey, weakly pruinose to epruinose, matt. Squamules elongate, columnar. Spores 11.5-18.5 x 3.5-5 μm

39 - *Toninia physaroides* (Opiz) Zahlbr.



Thallus squamulose to almost subfruticose, dark grey to dark greyish green, weakly pruinose to epruinose, K-, C-, KC-, P-, UV-. Squamules 1-2(-3) mm broad, to several mm long, scattered to usually contiguous and forming cushions, convex and bullate when young, then often becoming elongate and columnar, simple or branched above. Pseudocyphellae numerous, punctiform to slightly elongated. Medulla K-, C-, KC-, P-. Apothecia extremely rare, rounded, without a thalline margin, sessile, strongly constricted, up to 6(-8) mm diam. Disc black, faintly pruinose to usually epruinose, flat to convex, smooth. Margin distinct, smooth, concolorous with disc. Epithecium grey, K+ violet, C-, P-, N+ violet, KC-. Hypothecium pale brown to colourless. Paraphyses distinctly thickened above, free. Margin (section) dark grey in the rim, pale grey to colourless inside, K+ and N+ violet. Asci *Bacidia*-type, clavate, surrounded by a gelatinous I+ blue coat, with a well-developed I+ blue tholus with a I+ darker blue tube and a well-developed ocular chamber. Spores 2-celled, hyaline, fusiform, 8 per ascus, 11.5-18.5 x 3.5-5 μm . Photobiont chlorococcoid. Without lichen substances. Note: a mainly temperate species, most common on soil developing from calciferous sandstone, often found amongst mosses and associated to cyanobacterial lichens when young; rare in areas with pure limestone. Certainly occurring throughout the country, esp. in the mediterranean and submediterranean belts, but generally not common.

- 40 Thallus brown, epruinose, somehow shiny. Squamules more or less spherical, bullate. Spores 15-23 x 3-3.5 μm

40 - *Toninia toepfferi* (Stein) Navàs

Thallus squamulose, olivaceous brown to reddish brown, epruinose, somehow shiny, K-, C-, KC-, P-, UV-. Squamules scattered to contiguous, bullate, mostly simple, never columnar. Pseudocyphellae punctiform. Medulla K-, C-, KC-, P-. Apothecia frequent, rounded, without a thalline margin, sessile, strongly constricted, up to 4 mm diam. Disc black, epruinose to moderately pruinose, flat to convex,



smooth. Margin distinct, smooth, concolorous with disc. Epithecium grey, K+ violet, C-, P-, N+ violet, KC-. Hypothecium dark reddish brown in upper part, paler below. Paraphyses distinctly thickened above, free. Margin (section) dark grey in the rim, reddish brown inside, K+ and N+ violet. Asci *Bacidia*-type, clavate, surrounded by a gelatinous I+ blue coat, with a well-developed I+ blue tholus with a I+ darker blue tube and a well-developed ocular chamber. Spores 2-celled, hyaline, fusiform, 8 per ascus, 15-23 x 3-3.5 μm . Pycnidia dark, immersed. Conidia filiform. Photobiont chlorococcoid. Without lichen substances. Note: a mediterranean-macaronesian lichen, found on soil developing from basic siliceous substrata in dry-warm regions with a mild climate; extremely rare in Italy, being known from a few stations in Sardegna (Gennargentu Massif), Lazio and Calabria.

- 41 With apothecia (thallus with positive or negative reactions to K, C, KC and P) 42
- 41 With perithecia (thallus always K-, C-, KC-, P-) 74
- 42 Thallus bright-coloured: yellow, bright green, orange 43
- 42 Thallus not bright-coloured, of other colours 46
- 43 Thallus K+ red, yellow to orange-coloured 44
- 43 Thallus K-, bright yellowish green, or reddish-coloured 45
- 44 With radiating marginal lobes

go to key 4, option 20

- 44 Without radiating marginal lobes

go to key 4, option 24

- 45 Thallus bright yellow-green. Spores 2-4-celled, pigmented. On siliceous substrata above treeline

41 - *Catolechia wahlenbergii* (Ach.) Körb.

Thallus subcrustose to subfoliose, bright yellow-green, very thick, K-, C-, KC-, UV+ orange. Medulla P+ orange. Squamules convex, contiguous, wrinkled, to 3 mm broad, the marginal ones to ca. 1 cm long, developing on a black prothallus. Upper surface interspersed with yellowish granules, later covered by a thick epinecral layer. Lower surface black, attached by numerous bundles of black rhizoids. Apothecia frequent, without a thalline margin, rounded, sessile, up to 2 mm diam., developing among the squamules. Disc black, flat to convex. Margin indistinct, thin, black. Epithecium dark olive-green to blackish, K-, N+ red. Hymenium I+ blue. Hypothecium dark. Paraphyses anastomosing, densely ramified, not or slightly thickened above. Asci clavate, with a I+ blue outer gelatinous coat, thickened at apex, with an internal I+ deep blue cap. Spores 2-4-celled, pigmented, ellipsoid, 8 per ascus, (12-)13-17(-18) x 7-10 μm . Photobiont chlorococcoid. With rhizocarpic acid. Note: an arctic-alpine, probably circumpolar lichen, found on acid soil rich in humus



and over bryophytes in fissures of siliceous rocks in cold, perennially humid situations above treeline; restricted to the Alps in Italy.

- 45 Thallus red to bright brownish red, sometimes whitish-pruinose, UV-. Spores 1-celled, hyaline. On calciferous substrata from the lowlands to above treeline

42 - *Psora decipiens* (Hedw.) Hoffm.



Thallus squamulose, red, reddish-orange to bright brownish red, often white-pruinose esp. At the margin, K- or very rarely K+ yellowish, then reddish, C-, KC-, P-, UV-. Squamules (2-)3-6 mm broad, more or less rounded, concave to convex, usually with up-turned, crenulate, whitish edges, contiguous to scattered on the ground, the surface smooth to fissured. Lower surface whitish, ecorticate. Upper cortex 80-120 µm thick, composed of thin-walled hyphae with round lumina. Lower cortex absent or poorly developed. Apothecia frequent, without a thalline margin, sessile, to 1.5-2 mm diam. Disc black, sometimes white-pruinose, convex, smooth, margin indistinct. Epithecium reddish brown, K+ reddish. Hypothecium brownish. Paraphyses anastomosing, adglutinated. Asci *Porpidia*-type, clavate, with a well-developed I+ blue tholus and an internal, darker I+ tubular structure, lacking an ocular chamber. Spores 1-celled, hyaline, ellipsoid, thin-walled, 8 per ascus, 11-18 x 6-8 µm. Pycnidia dark, laminal, immersed. Conidia bacilliform, 6-7 x 1 µm. Photobiont chlorococcoid. Without lichen substances, or rarely with norstictic acid (thallus), with anthraquinones in the epihymenium. Note: a widespread holarctic species, with a broad altitudinal and latitudinal range, found on bare calciferous soil, esp. in dry grasslands; rare only in areas with intensive grazing, or frequent trampling.

- 46 Apothecia lecanorine, with a thalline margin containing algal cells 47
 46 Apothecia non lecanorine, without a thalline margin containing algal cells 54
 47 Spores 2-celled 48
 47 Spores 1-celled 49
 48 Near or above treeline. Spores pigmented

43 - *Phaeorrhiza nimbosa* (Fr.) H.Mayrhofer & Poelt



Thallus squamulose to subcrustose, from brownish to pale ochraceous yellowish in shade, sometimes faintly white-pruinose, thick, K-, C-, KC-, P-. Squamules more or less rounded, flattened, smooth, contiguous, usually non imbricate, forming a compact crust. Lower surface dark, with a dense mat of blackish, 4-5 µm thick rhizohyphae. Upper cortex paraplectenchymatous. Apothecia frequent, rounded, lecanorine, sessile to semi-immersed, to 1.2 mm diam. Disc black, sometimes faintly pruinose. Margin thin, smooth. Epithecium reddish brown. Hymenium and hypothecium colourless. Paraphyses distinctly thickened above, with a brown cap. Asci

Lecanora-type, broadly clavate, with a I+ blue tholus, a broad ocular chamber, and a cylindrical to short-conical axial mass. Spores 2-celled, pigmented, ellipsoid, rather thin-walled except at the ends, 8 per ascus, 18-22 x 8-10 μm . Pycnidia dark, immersed. Conidia bacilliform. Photobiont chlorococcoid. With variolaric acid, zeorin, and triterpenes. Note: common above treeline, mostly on calciferous substrata, especially in the Alps; occurring also in the Central Apennines (Gran Sasso and Majella Massives).

48 Below treeline, mainly coastal. Spores hyaline

44 - *Solenopsora holophaea* (Mont.) Samp.



Thallus squamulose to small-foliose, reddish-brown, olive-greenish when wet, K-, C-, KC-, P-, UV-. Squamules (0.5-)1-2(-3) mm broad, rounded, concave, smooth, contiguous, with an undulate edge. Lower surface pale, with scattered, pale, simple rhizines. Medulla white, K-, C-, KC-, P-, UV-. Apothecia rounded, lecanorine, sessile, to 1.5 mm diam. Disc red brown to blackish brown. Margin thin, smooth, proper margin excluded in old apothecia. Epithecium red-brown. Hymenium colourless, I+ blue. Hypothecium colourless to pale reddish brown. Paraphyses simple, distinctly thickened above. Asci *Catillaria*-type, clavate, with a I+ blue apical dome, without axial mass. Spores 2-celled, hyaline, fusiform-elongate, thin-walled, 8 per ascus, 12-16(-20) x 4-5 μm . Photobiont chlorococcoid. Without lichen substances, or rarely with traces of atranorin. Note: a mediterranean-atlantic lichen, found in sheltered crevices of basic siliceous rocks and on soil; exclusively Tyrrhenian and coastal in Italy; to be looked for also in Lazio, Calabria and Sicilia.

49 Squamules <0.5 mm broad. Spores thick-walled, >15 μm long. Restricted to above or near treeline

45 - *Psoroma hypnorum* (Vahl) Gray



Thallus crustose to subsquamulose, green-grey to yellowish brown in sun-forms, bright green when wet, thick, areolate-lobulate, K-, C-, KC-, P-, UV-. Areolae subgranular to mostly subsquamulose, contiguous to imbricate, 0.2-0.5 mm diam., with interspersed darker, more or less bluish, more granular squamules containing *Nostoc* (cephalodia). Upper and lower cortex paraplectenchymatous, 30-40 μm thick. Apothecia frequent, lecanorine, sessile, up to 5 mm diam. Disc brown, concave to flat, smooth. Margin thick, verruculose, with numerous squamules and thin transparent hairs in the lower part. Epithecium brownish. Hymenium colourless, I+ dark blue. Hypothecium colourless. Paraphyses simple, not apically thickened, short-celled. Asci clavate to subcylindrical, with a I+ blue tholus and an internal, darker I+ blue ring-structure. Spores 1-celled, hyaline, ellipsoid, thick-walled, with ornamented epispore, 8 per ascus, 19-28 x 8-10 μm . Pycnidia pale, semi-immersed. Conidia bacilliform, 5-6 x 12 μm . Photobiont chlorococcoid. Without lichen substances. Note: an arctic-alpine to boreal-montane, circumpolar lichen, found on soil, often in and amongst bryophytes, in moist habitats; most frequent in the Alps, mostly above the montane belt.

- 49 Squamules >0.5 mm broad. Spores thin-walled, <15 µm long. From the lowlands to above treeline 50
- 50 Thallus forming very regular rosettes, with radiating marginal lobes. Medulla always P-

46 - *Squamarina lentigera* (Weber) Poelt



Thallus squamulose to subcrustose, white-pruinose to brownish green, thick, orbicular and forming regular rosettes, to 8 cm in diam., K-, C-, KC- or KC+ yellowish, P-, UV-. Marginal squamules 1-4 mm broad, to 5 mm long, 1-2 mm thick, contiguous, flattened, more or less isodiametrical (0.5-2 mm) and subcrustose in the centre, clearly elongate at the margin, forming regular rosettes, closely adpressed to the substratum, the edges entire to crenate, most often up-turned, white. Upper cortex paraplectenchymatous, ca. 50 µm thick, well delimited against the thick medulla. Underside pale brown. Medulla white, P-. Apothecia frequent, rounded, lecanorine, sessile, strongly constricted, up to 4 mm diam. Disc pale to reddish brown, smooth, flat to finally convex. Margin smooth, thick, but often disappearing in old apothecia. Paraphyses slightly thickened above. Epithecium brownish. Hymenium colourless, ca. 120 µm thick, I+ blue. Hypothecium colourless. Asci clavate, the wall I+ blue, with a I+ blue apical dome, without axial mass. Spores 1-celled, hyaline, ellipsoid, thin-walled, 8 per ascus, (9-)10-13 x 4-5 µm. Pycnidia dark, immersed in the squamules. Conidia filiform, curved. Photobiont chlorococcoid. With usnic acid (cortex). Note: a species of dry-continental areas, with a broad altitudinal range; only locally common, esp. on gypsaceous or base-rich clayey soil in dry mediterranean grasslands and in openings of macchia-stands; also present in dry-warm Alpine valleys.

- 50 Thallus not forming regular rosettes, of irregular, more or less imbricate lobes. Medulla P- or P+ 51
- 51 Medulla P+ red

47 - *Squamarina cartilaginea* (With.) P. James f. *iberica* Mattick



Thallus squamulose, yellowish green to greenish-whitish grey, often white-pruinose, esp. at the margin of squamules, thick, loosely to firmly attached, K-, C-, KC+ yellowish, P-, UV-. Squamules slightly concave to convex, contiguous, often imbricate, usually aggregated to form a large thallus. Lower surface pale to dark brown. Upper cortex paraplectenchymatous, well delimited against the thick medulla. Medulla P+ red. Apothecia frequent, lecanorine, sessile, strongly constricted, up to 4 mm diam. Disc brownish to reddish brown, greenish brown in shade-forms, smooth, concave at first, but often convex in mature apothecia. Margin distinct, thick, but tending to disappear in mature apothecia. Paraphyses slightly thickened above. Epithecium brownish, hymenium (I+ blue) and hypothecium colourless. Asci clavate, the wall I+ blue, with a I+ blue apical dome, without axial mass. Spores 1-celled, hyaline, oblong-obtuse, thin-walled, 8 per ascus, (10-)12-14(-15) x (4-)4.5-6 µm. Pycnidia

dark, immersed. Conidia filiform. Photobiont chlorococcoid. Note: a chemical strain known from the Iberian peninsula. To be looked for in mediterranean Italy.

51 Medulla P- or P+ yellow

52

52 Medulla P-, without psoromic acid

48 - *Squamarina cartilaginea* (With.) P.James f. *pseudocrassa* Mattick



Thallus squamulose, yellowish green to greenish-whitish grey, often white-pruinose, esp. at the margin of squamules, rather thick, loosely to firmly attached, K-, C-, KC- or KC+ yellowish, P-, UV-. Squamules slightly concave to convex, contiguous, often imbricate, usually aggregated to form a large thallus. Lower surface pale to dark brown. Upper cortex paraplectenchymatous, well delimited against the thick medulla. Medulla P-. Apothecia frequent, lecanorine, sessile, strongly constricted, up to 4 mm diam. Disc brownish to reddish brown, greenish brown in shade-forms, smooth, concave at first, but often convex in mature apothecia. Margin distinct, thick, but tending to disappear in mature apothecia. Epithecium brownish, hymenium (I+ blue) and hypothecium colourless. Asci clavate, the wall I+ blue, with a I+ blue apical dome, without axial mass. Paraphyses slightly thickened above. Spores 1-celled, hyaline, oblong-obtuse, thin-walled, 8 per ascus, (10-)12-14(-15) x (4-)4.5-6 µm. Pycnidia dark, immersed. Conidia filiform. Photobiont chlorococcoid. With usnic acid (cortex), without psoromic acid in the medulla. Note: widespread throughout Italy in areas with calciferous rocks, with a wide altitudinal range; it can grow both directly on rock or on calciferous soil.

52 Medulla P+ yellow, with psoromic acid

53

53 Squamules yellowish green to greenish grey, non-pruinose or white-pruinose at the margin, not subcrustose in the centre, not or weakly elongate at margin. Apothecial disc greenish-brown to (rarely) reddish brown. Spores oblong-obtuse, (10-)12-14(-15) x (4-)4.5-6 µm.

49 - *Squamarina cartilaginea* (With.) P.James f. *cartilaginea*

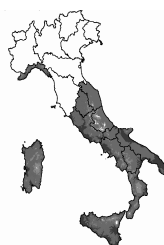


Thallus squamulose, yellowish green to greenish-whitish grey, often white-pruinose, esp. at the margin of squamules, thick, loosely to firmly attached, K-, C-, KC- or KC+ yellowish, P-, UV-. Squamules slightly concave to convex, contiguous to imbricate, usually aggregated to form a large thallus. Lower surface pale to dark brown. Upper cortex paraplectenchymatous. Medulla P+ yellow. Apothecia frequent, lecanorine, sessile, strongly constricted, up to 4 mm diam. Disc greenish-brownish to rarely reddish brown, smooth, concave at first, but often convex in mature apothecia. Margin distinct, thick, but tending to disappear in mature apothecia. Paraphyses slightly thickened above. Epithecium brownish, hymenium (I+ blue) and hypothecium colourless. Asci clavate, the wall I+ blue, with a I+ blue apical dome, without axial mass. Spores

1-celled, hyaline, oblong-obtuse, thin-walled, 8 per ascus, (10-)12-14(-15) x (4-)4.5-6 μm . Pycnidia dark, immersed. Conidia filiform. Photobiont chlorococcoid. With usnic acid (cortex) and psoromic acid (medulla). Note: a mainly southern, chemically variable lichen, found on calcareous rocks and soil, mostly in dry grasslands below treeline; the most common of the genus in Italy.

- 53 Squamules densely white-pruinose throughout, subcrustose in the centre, clearly elongate at margin. Apothecial disc reddish brown. Spores ellipsoid, 9-13(-16) x (3-)4-7 μm

50 - *Squamarina stella-petraea* Poelt



Thallus squamulose, densely white-pruinose, areolate in the centre, with elongated lobes at the margin, thick, forming regular rosettes when young, K-, C-, KC- or KC+ yellowish-, P-, UV-. Squamules (2-)3-4 mm broad, flattened, smooth, imbricate, the marginal ones often elongate, the edges usually not up-turned, the central ones almost subcrustose. Upper cortex paraplectenchymatous, well delimited against the thick medulla. Medulla P+ yellow. Apothecia frequent, rounded, lecanorine, sessile, strongly constricted, up to 4 mm diam. Disc reddish brown, smooth. Margin distinct, thick, smooth. Paraphyses slightly thickened above. Epithecium brownish, hymenium (I+ blue) and hypothecium colourless. Asci clavate, the wall I+ blue, with a I+ blue apical dome, without axial mass. Spores 1-celled, hyaline, ellipsoid, thin-walled, 8 per ascus, 9-13(-16) x (3-)4-7 μm . Pycnidia dark, immersed in the squamules. Conidia filiform. Photobiont chlorococcoid. With usnic acid (cortex) and psoromic acid (medulla). Note: a mainly mediterranean species, with outposts in dry-warm areas of the submediterranean belt, found on calcareous rocks, or more rarely on thin layers of soil over the rock in open situations. Overlooked, or confused with *S. cartilaginea* in the past; locally abundant, esp. in the south. To be looked for in dry-warm areas of the north.

- 54 Most spores more than 5-celled, needle-shaped 55
 54 Most spores less than 5-celled, not needle-shaped 56
 55 Hypothecium pale to colourless. Squamules not granulose, dark brown with a greyish tinge. Apothecia not bluish-pruinose

51 - *Toninia squalida* (Ach.) A.Massal.



Thallus subcrustose to squamulose, medium to dark brown, with a greyish tinge, epruinose, dull, often with shallow fissures in the cortex, K-, C-, KC-, P-, UV-. Squamules 1-2(-3) mm broad, often irregularly proliferating, weakly concave to weakly convex, sometimes forming a continuous crust. Lower surface pale brown. Medulla K-, C-, KC-, P-. Apothecia frequent, rounded, without a thalline margin, sessile, strongly constricted, up to 1.5 mm diam. Disc black, flat, smooth. Margin distinct, smooth, concolorous with disc. Epithecium olivaceous to bright green, K-, C-, KC-, P-, N+ violet. Hymenium colourless. Hypothecium pale brown to colourless. Paraphyses distinctly thickened above, free. Margin (section) dark brown to dark green in the rim, pale to colourless

inside. Asci *Bacidia*-type, clavate, surrounded by a gelatinous I+ blue coat, with a well-developed I+ blue tholus with a I+ darker blue tube and a well-developed ocular chamber. Spores (4-)-8-celled, hyaline, acicular, 8 per ascus, 23-41.5 x 2.5-4.5 μm . Pycnidia dark, immersed. Conidia filiform. Photobiont chlorococcoid. Without lichen substances. Note: an incompletely holarctic lichen with a very broad latitudinal range, found on soil, more rarely on weathered base-rich or weakly calciferous siliceous rocks in dry-warm areas; often associated to cyanobacteria or cyanobacterial lichens when young. Widespread from the Alps to the mountains of the south.

- 55 Hypothecium dark. Squamules granulose, pale greyish brown. Apothecia black, often bluish-pruinose

52 - *Toninia coelestina* (Anzi) Vězda



Thallus squamulose to subcrustose, greyish brown, dull, epruinose, K-, C-, KC-, P-. Squamules contiguous, mostly in the form of densely proliferating granules forming a thick, verrucose, more or less continuous crust. Medulla K-, C-, KC-, P-. Apothecia frequent, without a thalline margin, sessile, strongly constricted, up to 1.6 mm diam. Disc black, often bluish-pruinose, flat to weakly convex, smooth. Margin distinct, smooth. Margin (section) dark brown with a greenish-black rim, lacking crystals. Epithecium dark olivaceous green, K-, C-, P-, N+ violet, KC-. Hypothecium dark brown. Paraphyses anastomosing, distinctly thickened above, free. Asci *Bacidia*-type, clavate, surrounded by a gelatinous I+ blue coat, with a well-developed I+ blue tholus with a I+ darker blue tube and a well-developed ocular chamber. Spores (4-)-8-celled, hyaline, acicular, 8 per ascus, 19-40 x 2.5-3.5 μm . Photobiont chlorococcoid. Without lichen substances. Note: a rare species, found on cyanobacterial lichens or cyanobacterial colonies developing on weathered calciferous schist in upland areas; known only from the type locality in Lombardia; to be looked for in suitable habitats throughout the Alps.

- 56 Spores (2-)-4-celled 57
 56 Spores 1-2-celled 59
 57 Epithecium K+ red

53 - *Toninia lutosa* (Ach.) Timdal



Thallus squamulose, pale grey, dull, densely covered by a granulose white pruina, K-, C-, KC-, P-. Squamules (2-)-3-6 mm broad, mostly flattened, with deep fissures in the cortex and often with a central depression. Lower surface pale brown to white. Medulla K-, C-, KC-, P-. Apothecia frequent, without a thalline margin, sessile, strongly constricted, 1-3 mm diam. Disc black, rarely faintly pruinose, flat, smooth. Margin distinct, smooth, concolorous with disc. Epithecium dark reddish brown, K+ red, C-, P-, N-, KC-. Hypothecium pale brown to colourless. Paraphyses anastomosing, distinctly thickened above, free. Margin (section) dark reddish brown in the rim, paler inside, K+ red, N-. Asci *Bacidia*-type, clavate, surrounded by a gelatinous I+ blue coat, with a well-developed I+ blue tholus with a I+ darker blue tube and a well-

developed ocular chamber. Spores (2-)4-celled, hyaline, ellipsoid-cylindrical to bacilliform, 8 per ascus, 12-20 x 3-4.5 μm . Pycnidia dark, immersed. Conidia filiform. Photobiont chlorococcoid. Without lichen substances. Note: a probably incompletely holarctic species of continental areas, found on soil and calciferous rocks, often in association with cyanobacteria or cyanobacterial lichens when young. Reported from a few stations only, probably overlooked, or confused with other species, and more widespread, but certainly not common.

57 Epithecium K-

58

58 Squamules flattened, crenate-lobulate, forming a compact crust. Spores fusiform, 14-20(-26) x 3-5(-6) μm

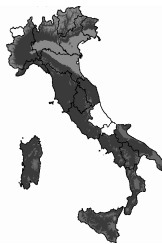
54 - *Myxobilimbia lobulata* (Sommerf.) Hafellner



Thallus small-squamulose to subcrustose, whitish grey to grey, darker in the centre of the squamules, K-, C-, KC-, P-, UV-. Squamules flattened, crenate to lobulate, smooth, contiguous to more or less overlapping, 0.2-1 mm broad, forming a compact crust. Apothecia frequent, without a thalline margin, sessile, 0.3-1 mm diam. Disc black to brown-black, convex. Margin indistinct. Epithecium pale greenish grey, K-, N+ red. Hypothecium red-brown. Paraphyses simple, slightly thickened above, adglutinated. Asci with a I+ blue tholus, the outer gelatinous coat I+ pale blue. Spores 2-4-celled, hyaline, fusiform, 8 per ascus, with a gelatinous, finely warted outer coat, 14-20(-26) x 3-5(-6) μm . Photobiont chlorococcoid. Without lichen substances. Note: a cool-temperate to arctic-alpine, circumpolar lichen, found on terricolous mosses and bare calciferous soil, from the Alps to the high Mediterranean mountains; most common above the submediterranean belt, throughout the country.

58 Squamules mostly convex, not crenate-lobulate, not forming a compact crust. Spores ellipsoid-cylindrical, 11-22.5 x 4-5.5 μm

55 - *Toninia aromatica* (Sm.) A.Massal.



Thallus squamulose, pale grey to greenish brown, often white-spotted, dull, rarely faintly pruinose, K-, C-, KC-, P-. Squamules up to 4 mm diam., mostly somewhat convex, orbicular to irregular, scattered to aggregated. Lower surface pale brown. Medulla K-, C-, KC-, P-. Apothecia frequent, without a thalline margin, sessile, strongly constricted, up to 1.5 mm diam. Disc black, rarely faintly pruinose, flat, smooth. Margin distinct, smooth, black. Epithecium dark olivaceous green to bright green, K-, C-, P-, N+ violet, KC-. Hymenium colourless. Hypothecium dark reddish brown in lower part, paler in upper part. Paraphyses anastomosing, distinctly thickened above, free. Margin (section) dark reddish brown, K-, N-. Asci *Bacidia*-type, clavate, surrounded by a gelatinous I+ blue coat, with a well-developed I+ blue tholus with a I+ darker blue tube and a well-developed ocular chamber. Spores (2-)4-celled, hyaline, ellipsoid-cylindrical, 8 per ascus, 11-22.5 x 4-5.5 μm . Pycnidia dark, immersed. Conidia filiform. Photobiont chlorococcoid. Without lichen substances. Note: a holarctic species with a wide latitudinal

range, found on horizontal to weakly inclined surfaces of calcareous to basic siliceous substrata, incl. Brick and roofing tiles in urban environments. Most common in Tyrrhenian Italy, below the montane belt.

- 59 Spores 1-celled 60
 59 Spores 2-celled 66
 60 Thallus yellowish green. With usnic acid

56 - *Psora rubiformis* (Ach.) Hook.

Thallus squamulose, yellowish brown, with paler, sometimes pruinose margins, K-, C-, KC+ yellowish, P-, UV-. Squamules (2-)3-6 mm broad, elongate, contiguous to imbricate. Medulla K-, KC- or KC+ red, P-. Apothecia without a thalline margin, sessile, up to 2 mm diam. Disc dark brown to black, convex. Margin indistinct, thin. Epithecium brownish, K+ red. Hymenium colourless, I+ blue. Hypothecium brown. Paraphyses anastomosing, adglutinated. Asci *Porpidia*-type, clavate, with a well-developed I+ blue tholus and an internal, darker I+ tubular structure, lacking an ocular chamber. Spores 1-celled, hyaline, ellipsoid, thin-walled, 8 per ascus, 9-14 x 5-7 µm. Pycnidia dark, immersed. Conidia bacilliform. Photobiont chlorococcoid. With usnic acid (cortex) and variable amounts of gyrophoric acid (medulla), with anthraquinones in the epihymenium. Note: on loess and calciferous soil, in fissures of calciferous siliceous rocks (e.g. calciferous schist), mainly in the Alps, rare.



- 60 Thallus not yellowish green. Without usnic acid 61
 61 Thallus pale pink-coloured

57 - *Psora saviczii* (Tomlin) Follmann & A. Crespo

Thallus squamulose, pale pinkish to pinkish white, often white-pruinose, K-, C-, KC-, P-, UV-. Squamules rounded, initially concave, then flattened, dispersed to contiguous, non imbricate, 2-4 mm diam., with down-turned edges. Lower cortex absent. Apothecia frequent, without a thalline margin, sessile, 1-1.5 mm diam. Disc black, sometimes white-pruinose, convex, smooth. Margin indistinct. Epithecium reddish brown. Hymenium colourless, I+ blue. Hypothecium brownish. Paraphyses anastomosing, adglutinated. Asci *Porpidia*-type, clavate, with a well-developed I+ blue tholus and an internal, darker I+ tubular structure, lacking an ocular chamber. Spores 1-celled, hyaline, ellipsoid, thin-walled, 8 per ascus, 11-18 x 6-8 µm. Pycnidia dark, immersed. Conidia bacilliform. Photobiont chlorococcoid. Without lichen substances (thallus), with anthraquinones in the epihymenium. Note: a mainly gypsicolous, southern species in Europe, in Italy known only from the gypsum outcrops of Emilia-Romagna, to be looked for in other areas with gypsum (e.g. in Sicilia).



- 61 Thallus not pale pink-coloured 62
 62 Epithecium K- 63
 62 Epithecium K+ red 64

- 63 Squamules flattened, densely imbricate. Epithecium brownish, N-. Spores 6-8 μm broad

58 - *Mycobilimbia lurida* (Ach.) Hafellner & Türk



Thallus squamulose, pale to dark brown, becoming greenish when wet, not pruinose, K-, C-, KC-, P-. Squamules 2-5 mm long, rounded at tips, flattened, smooth, clearly imbricate. Lower surface brown. Apothecia frequent, without a thalline margin, sessile, up to 2 mm diam. Disc dark brown to black, first flat, then rapidly strongly convex. Margin indistinct, thin. Epithecium brownish, K-, N-. Hymenium colourless, I+ blue. Hypothecium pale brown. Paraphyses anastomosing, adglutinated. Asci clavate, with a I+ blue tholus, the outer gelatinous coat I+ pale blue. Spores 1-celled, hyaline, narrowly ellipsoid, thin-walled, 8 per ascus, (10-)11-14 x 6-8 μm . Pycnidia dark, first immersed, then sessile, mostly at the margins of squamules. Conidia narrowly ellipsoid, 4-6 x ca. 2 μm . Photobiont chlorococcoid. Without lichen substances. Note: a calcicolous, ecologically and altitudinally wide-ranging, common species, whose development often starts in fissures of the rock; most common below the montane belt, throughout the country.

- 63 Squamules bullate, not imbricate. Epithecium greenish brown to bright green, N+ violet. Spores 4.5-6.5 μm broad

59 - *Toninia tristis* (Th.Fr.) Th.Fr. subsp. *pseudotabacina* Tindal



Thallus squamulose, chestnut brown to dark brown, shiny, K-, C-, KC-, P-, UV-. Squamules convex, contiguous to scattered, up to 3(-4) mm diam., bullate, but often with a central depression. Lower surface pale. Medulla K-, C-, KC-, P-. Apothecia frequent, without a thalline margin, sessile, strongly constricted, up to 2 mm diam. Disc black, flat to convex, smooth. Margin distinct, smooth, concolorous with disc. Epithecium brownish to bright green, K-, C-, P-, N+ violet, KC-. Hymenium colourless. Hypothecium brownish. Paraphyses distinctly thickened above, free. Asci *Bacidia*-type, clavate, surrounded by a gelatinous I+ blue coat, with a well-developed I+ blue tholus with a I+ darker blue tube and a well-developed ocular chamber. Spores 1-celled, hyaline, ellipsoid, 8 per ascus, 10-15.5 x 4.5-6.5 μm . Pycnidia dark, immersed. Conidia filiform. Photobiont chlorococcoid. Note: on basic siliceous soil in dry, sunny, open situations; probably more widespread in the Alps but generally rare, sometimes it reaches the oromediterranean belt (e.g. on the Gennargentu Massif in Sardegna).

- 64 Squamules with a conspicuous white margin

60 - *Psora vallesiaca* (Schaer.) Tindal

Thallus squamulose, brown. Squamules (2-)3-6 mm broad, concave, contiguous to dispersed, non imbricate, with an up-turned, mostly crenulate, prominent white margin. Lower surface pale brown. Medulla K+ yellow changing to red, P+ yellow. Lower cortex absent. Apothecia frequent, without a thalline margin, sessile, up to 1.5 mm diam. Disc black, convex. Margin indistinct, thin.



Epithecium brownish, K+ red. Hymenium colourless, I+ blue. Hypothecium pale brown. Paraphyses anastomosing, adglutinated. Asci *Porpidia*-type, clavate, with a well-developed I+ blue tholus and an internal, darker I+ tubular structure, lacking an ocular chamber. Spores 1-celled, hyaline, fusiform, thin-walled, 8 per ascus, 9-13 x 5-7 μ m. Pycnidia dark, immersed. Conidia bacilliform. Photobiont chlorococcoid. With variable amounts of norstictic acid (thallus), with anthraquinones in the epihymenium. Note: on bare soil and in fissures of the rock; locally not rare in the south, where suitable habitats are present (subcontinental conditions and base-rich, slightly calciferous siliceous substrata), extremely rare elsewhere.

64 Squamules without a conspicuous white margin

65

65 Mostly found in upland areas. Squamules chestnut brown, rarely faintly white-pruinose, greyish to brownish below. Spores 10-13 x 5-7 μ m

61 - *Psora globifera* (Ach.) A. Massal.



Thallus squamulose, chestnut brown, rarely faintly white-pruinose, dull to shiny, K-, C-, KC-, P-, UV-. Squamules (2-)3-5 mm broad, crenate, flattened, finely divided by small fissures, ascending, contiguous, to imbricate, with up-turned edge. Lower surface greyish to brownish. Upper cortex 60-120 μ m thick, composed of thick-walled hyphae with more or less angular lumina. Lower cortex of mainly periclinally arranged hyphae. Apothecia frequent, without a thalline margin, laminal, sessile, up to 1.5(-2) mm diam. Disc dark brown to black, strongly convex. Margin indistinct in mature apothecia, thin, when visible paler than disc. Epithecium reddish brown, K+ red. Hymenium colourless, I+ blue. Hypothecium pale brown. Paraphyses anastomosing, adglutinated. Asci *Porpidia*-type, clavate, with a well-developed I+ blue tholus and an internal, darker I+ tubular structure, lacking an ocular chamber. Spores 1-celled, hyaline, ellipsoid, thin-walled, 8 per ascus, 10-14 x 4-7 μ m. Pycnidia dark, laminal, immersed. Conidia bacilliform, 6-9 x 1 μ m. Photobiont chlorococcoid. Without lichen substances (thallus), with anthraquinones in the epihymenium. Note: on slightly calciferous or base-rich soil and weathered siliceous rocks, mostly above the submediterranean belt. Hitherto known only from the Alps in Italy.

65 Mostly found in lowland areas. Squamules greenish brown above, whitish below. Spores 12-15 x 6-8 μ m

62 - *Psora gresinonis* de Lesd.



Thallus squamulose, greenish brown, K- or rarely K+ red, C-, KC-, P-. Squamules (2-)3-6 mm broad, crenate, finely divided by small fissures, ascending, contiguous to imbricate. Lower surface whitish. Apothecia frequent, without a thalline margin, sessile, up to 5 mm diam. Disc dark brown to black, convex. Margin indistinct, thin. Epithecium reddish brown, K+ red. Hymenium colourless, I+ blue. Hypothecium dark brown. Paraphyses anastomosing, adglutinated. Asci *Porpidia*-type, clavate, with a well-developed I+ blue tholus and an internal, darker I+ tubular structure, lacking an ocular

chamber. Spores 1-celled, hyaline, ellipsoid, thin-walled, 8 per ascus, 12-15 x 6-8 μm . Photobiont chlorococcoid. Without lichen substances (thallus), with anthraquinones in the epihymenium. Note: a rather poorly known species which needs further study, found on soil, in fissures of base-rich or slightly calciferous siliceous rocks, with optimum in dry grasslands; chemically heterogeneous (with and without norstictic acid), with a probably Tyrrhenian range in Italy.

- 66 Thallus chestnut brown, often with punctiform depressions or pores. Epithecium K-. 67
- 66 Thallus not chestnut brown, without depressions or pores. Epithecium K+ violet 68
- 67 Hypothecium without orange and yellow pigments. Epithecium brown. Spores 13.5-20.5 x 3.5-5 μm

63 - *Toninia tristis* (Th.Fr.) Th.Fr. subsp. *tristis*

Thallus squamulose, chestnut brown to dark brown, K-, C-, KC-, P-. Squamules bullate, sometimes flattened or with a central depression above, scattered to contiguous, up to 2(-3) mm broad. Lower surface pale. Medulla K-, C-, KC-, P-. Apothecia frequent, rounded, without a thalline margin, sessile, strongly constricted, up to 2 mm diam. Disc black, flat, smooth. Margin distinct, smooth, concolorous with disc. Epithecium brown, K-, C-, P-, N+ violet, KC-. Hymenium colourless. Hypothecium brownish, without orange and yellow pigments. Paraphyses anastomosing, distinctly thickened above, free. Asci *Bacidia*-type, clavate, surrounded by a gelatinous I+ blue coat, with a well-developed I+ blue tholus with a I+ darker blue tube and a well-developed ocular chamber. Spores 2-celled, hyaline, narrowly ellipsoid, 8 per ascus, 13.5-20.5 x 3.5-5 μm . Pycnidia dark, immersed. Conidia filiform. Photobiont chlorococcoid. Note: hitherto known only from the Alps in Italy.



- 67 Hypothecium with orange (K+ red) and yellow (K-) pigments. Epithecium brownish to greenish brown. Spores 12.5-19 x 3.5-5.5 μm

64 - *Toninia tristis* (Th.Fr.) Th.Fr. subsp. *asiae-centralis* (H.Magn.) Tindal

Thallus squamulose, chestnut brown to dark brown, shiny, K-, C-, KC-, P-. Squamules 1-2(-3) mm broad, scattered to contiguous, bullate. Lower surface pale. Medulla K-, C-, KC-, P-, UV-. Apothecia frequent, without a thalline margin, sessile, strongly constricted, up to 2 mm diam. Disc black, flat, smooth. Margin distinct, smooth, concolorous with disc. Epithecium brownish to greenish brown, K-, C-, P-, N+ violet, KC-. Hymenium colourless. Hypothecium brownish, with orange (K+ red) and yellow (K-) pigments. Paraphyses distinctly thickened above, free. Asci *Bacidia*-type, clavate, surrounded by a gelatinous I+ blue coat, with a well-developed I+ blue tholus with a I+ darker blue tube and a well-developed ocular chamber. Spores 2-celled, hyaline, narrowly ellipsoid, 8 per ascus, 12.5-19 x 3.5-5.5 μm . Pycnidia dark,



immersed. Conidia filiform. Photobiont chlorococcoid. Note: on basic siliceous rock and soil in dry-warm areas; present both in the dry-warm alpine valleys and in the south, rare.

- 68 Hypothecium colourless to pale brown 69
 68 Hypothecium dark, at least in upper part 70
 69 Thallus densely covered by a white, granular pruina. Squamules forming a subrosulate crust

65 - *Toninia rosulata* (Anzi) H.Olivier



Thallus squamulose, pale grey, thick, densely covered by a white, granular pruina, dull, with shallow fissures in the cortex, K-, C-, KC-, P-. Squamules up to 6 mm diam., convex to bullate when young, then flattened, irregularly and often deeply lobed, forming a subrosulate crust. Lower surface pale brown to black. Medulla K-, C-, KC-, P-. Apothecia frequent, rounded, without a thalline margin, sessile, strongly constricted, up to 4 mm diam. Disc black, faintly pruinose, weakly concave to weakly convex, smooth. Margin distinct, rather thick, smooth, concolorous with disc. Epithecium grey, K+ violet, C-, P-, N+ violet, KC-. Hymenium colourless. Hypothecium pale brown to colourless. Paraphyses anastomosing, distinctly thickened above, free. Margin (section) grey in the rim, pale grey to colourless inside, K+ and N+ violet. Asci *Bacidia*-type, clavate, surrounded by a gelatinous I+ blue coat, with a well-developed I+ blue tholus with a I+ darker blue tube and a well-developed ocular chamber. Spores 2-celled, hyaline, fusiform, 8 per ascus, 14-21.5 x 3.5-5 µm. Photobiont chlorococcoid. Without lichen substances. Note: an arctic-alpine, mainly European species, found on soil and in fissures and crevices of calciferous rocks, often on cyanobacteria or cyanobacterial lichens when young. Probably restricted to the Alps in Italy, mostly above treeline.

- 69 Thallus olivaceous brown, not pruinose, with regular, evident fissures in the cortex. Squamules never forming a subrosulate crust

66 - *Toninia taurica* (Szatala) Oksner



Thallus squamulose, olivaceous brown, epruinose, somehow shiny, with regular, evident fissures in the cortex, K-, C-, KC-, P-. Squamules 2-3(-4) mm broad, contiguous to imbricate, orbicular or irregularly lobed, convex to bullate. Lower surface pale brown to black. Medulla K-, C-, KC-, P-. Apothecia frequent, without a thalline margin, sessile, strongly constricted, up to 3 mm diam. Disc black, but usually densely bluish-pruinose, weakly concave to weakly convex, smooth. Margin distinct, persistent, smooth, black, faintly or non-pruinose, concolorous with disc or (when not pruinose) darker. Margin (section) grey in the rim, colourless inside, K+ and N+ violet. Epithecium grey, K+ violet, C-, P-, N+ violet, KC-. Hymenium colourless. Hypothecium pale brown to colourless. Paraphyses anastomosing, distinctly thickened above, free. Asci *Bacidia*-type, clavate, surrounded by a gelatinous I+ blue coat, with a well-developed I+ blue tholus with a I+ darker blue tube and a well-developed ocular chamber. Spores 2-celled, hyaline, fusiform, 8

per ascus, 16.5-24.5 x 3-4.5 µm. Pycnidia dark, immersed. Conidia filiform. Photobiont chlorococcoid. Note: a mainly southern species with Eurasiatic distribution, found on calciferous soil and in fine crevices of the rocks; often associated with cyanobacterial lichens when young; widespread throughout the country, from the lowlands to above treeline, but rare in the eu-Mediterranean belt.

70 Thallus entirely pruinose. Pruina granular

67 - *Toninia diffracta* (A.Massal.) Zahlbr.



Thallus squamulose, pale grey, but densely covered by a white, granular pruina, more rarely partly epruinose, K-, C-, KC-, P-. Squamules up to 3(-4) mm diam., initially scattered, later contiguous, more or less orbicular, weakly to strongly convex. Lower surface pale grey to brownish. Medulla K-, C-, KC-, P-. Apothecia frequent, rounded, without a thalline margin, sessile, strongly constricted, to 1.5 mm diam. Disc black, more or less pruinose, flat to weakly convex, smooth. Margin distinct, smooth, concolorous with disc, persistent. Epithecium grey, K+ violet, C-, P-, N+ violet, KC-. Hypothecium brownish in upper part, paler brown to almost colourless below. Paraphyses anastomosing, distinctly thickened above, free. Margin (section) brown to dark reddish brown, sometimes with a dark grey rim, in which case it reacts K+ and N+ violet. Asci *Bacidia*-type, clavate, surrounded by a gelatinous I+ blue coat, with a well-developed I+ blue tholus with a I+ darker blue tube and a well-developed ocular chamber. Spores 2-celled, hyaline, fusiform, 8 per ascus, 14.5-26 x 3-4.5 µm. Photobiont chlorococcoid. Note: a mainly southern-eurasiatic species, found in small fissures of steeply inclined faces of calcareous rocks, often on cyanobacteria or cyanobacterial lichens when young, sometimes on soil; optimum at low altitudes, but reaching the Alpine belt. Certainly occurring throughout the country with the exception of the Po-plain.

70 Thallus non- or only partly pruinose, the pruina composed of very small crystals, not granular

71

71 Squamules more or less flat, with a white-pruinose rim

68 - *Toninia albilabra* (Dufour) H.Olivier



Thallus squamulose, reddish brown, often with greenish tinge, shiny, white pruinose at margin, K-, C-, KC-, P-. Squamules 1-2(-4) mm broad, flattened, contiguous, orbicular to slightly lobed, weakly convex to weakly concave, with regular and usually deep fissures in the cortex. Lower surface white to pale brown. Medulla K-, C-, KC-, P-. Apothecia frequent, without a thalline margin, sessile, strongly constricted, 1-1.5(-2.5) mm diam. Disc black, most often white-pruinose, more or less flat, smooth. Margin distinct, smooth, concolorous with disc. Epithecium grey, K+ violet, C-, P-, N+ violet, KC-. Hymenium colourless. Hypothecium brownish. Paraphyses anastomosing, distinctly thickened above, free. Margin (section) reddish brown, sometimes greyish near the rim, in which case it reacts N+ and K+ violet. Asci *Bacidia*-type, clavate, surrounded by a gelatinous I+ blue coat, with a well-developed I+ blue tholus with a

I+ darker blue tube and a well-developed ocular chamber. Spores 2-celled, hyaline, fusiform, 8 per ascus, 13.5-22.5 x 3-4 μm . Pycnidia dark, immersed. Conidia filiform. Photobiont chlorococcoid. Note: a mainly mediterranean species, found on calciferous ground, and in fissures of rocks and walls, often on cyanobacteria or cyanobacterial lichens when young; common only in dry areas, incl. continental Alpine valleys, and probably more widespread in Italy.

71 Squamules bullate, or - if flat - without white-pruinose rim 72

72 Squamules (2-)3-6 mm broad, bullate, vertically flattened when old

69 - *Toninia opuntioides* (Vill.) Tindal



Thallus squamulose to subfruticose, olivaceous grey-brown to reddish brown, whitish pruinose at the margin esp. near the tips, usually with shallow cracks in the cortex, K-, C-, KC-, P-. Squamules (2-)3-6 mm broad, ascending, convex to bullate when young, later vertically flattened and irregularly imbricate, often with swollen ends. Lower surface pale brown to white. Medulla K-, C-, KC-, P-. Apothecia frequent, without a thalline margin, sessile, strongly constricted, up to 4 mm diam. Disc black, sometimes weakly pruinose, more or less flat, smooth. Margin distinct, smooth, concolorous with disc. Epithecium grey, K+ violet, C-, P-, N+ violet, KC-. Hymenium colourless. Hypothecium medium brown to dark reddish brown in upper part, pale brown to colourless below. Margin (section) brownish to dark reddish brown, sometimes with a dark grey rim, in which case it reacts K+ and N+ violet. Paraphyses anastomosing, distinctly thickened above, free. Asci *Bacidia*-type, clavate, surrounded by a gelatinous I+ blue coat, with a well-developed I+ blue tholus with a I+ darker blue tube and a well-developed ocular chamber. Spores 2-celled, hyaline, fusiform, 8 per ascus, 16-24 x 3.5-4 μm . Photobiont chlorococcoid. Note: a widespread, arctic to temperate, circumpolar lichen, found often amongst bryophytes, and always associated to cyanobacterial lichens when young. Certainly occurring throughout the country, but often confused with *T. sedifolia*.

72 Squamules weakly convex to bullate, 1-2(-3) mm broad, not vertically flattened 73

73 Thallus dark greyish green to olivaceous brown, generally without pruina, rarely faintly pruinose, often shiny and with regular fissures in the cortex. Apothecia generally epruinose. Spores 10-16.5 μm long

70 - *Toninia massata* (Tuck.) Herre

Thallus squamulose, dark greyish green to olivaceous brown, generally without pruina, rarely faintly pruinose, often shiny and with regular fissures in the cortex, K-, C-, KC-, P-. Squamules up to 2 mm broad, scattered to contiguous, orbicular or irregularly lobed, weakly to medium convex. Lower surface pale. Medulla K-, C-, KC-, P-. Apothecia frequent, without a thalline margin, sessile, strongly constricted, to 1.5(-2) mm diam. Disc black, generally epruinose, more or less flat, smooth. Margin distinct, smooth,



concolorous with disc. Epithecium grey, K+ violet, C-, P-, N+ violet, KC-. Hymenium colourless. Hypothecium brownish. Margin (section) dark grey in the rim, brownish inside, K+ and N+ violet. Paraphyses anastomosing, distinctly thickened above, free. Asci *Bacidia*-type, clavate, surrounded by a gelatinous I+ blue coat, with a well-developed I+ blue tholus with a I+ darker blue tube and a well-developed ocular chamber. Spores 2-celled, hyaline, fusiform, 8 per ascus, 10-16.5 x 3.5-4.5 μm . Photobiont chlorococcoid. Note: an incompletely holarctic, mainly southern species, found on soil and in fissures of calciferous rocks with seepage of water after rain, often in association with cyanobacteria and cyanobacterial lichens, mostly below the montane belt. Known from a few localities in Tyrrhenian Italy.

- 73 Thallus olivaceous green to dark brown, often white-pruinose, smooth or with very shallow fissures in the cortex. Apothecia often pruinose. Spores 12-24 μm long

71 - *Toninia sedifolia* (Scop.) Tindal

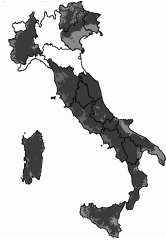


Thallus squamulose, olivaceous green to dark brown, often white-pruinose, smooth or with very shallow fissures in the cortex, K-, C-, KC-, P-. Squamules 1-2(-3) mm broad, weakly convex to bullate, scattered to contiguous or irregularly imbricate, round or weakly lobed. Lower surface pale. Medulla K-, C-, KC-, P-. Apothecia frequent, without a thalline margin, sessile, strongly constricted, up to 3 mm diam. Disc black, often pruinose, more or less flat, smooth. Margin distinct, smooth, concolorous with disc. Epithecium grey, K+ violet, C-, P-, N+ violet, KC-. Hymenium colourless. Hypothecium brownish. Paraphyses anastomosing, distinctly thickened above, free. Margin (section) medium to dark brown, sometimes with a grey rim, in which case it reacts K+ and N+ violet. Asci *Bacidia*-type, clavate, surrounded by a gelatinous I+ blue coat, with a well-developed I+ blue tholus with a I+ darker blue tube and a well-developed ocular chamber. Spores 2-celled, hyaline, fusiform, 8 per ascus, 12-24 x 3-5 μm . Photobiont chlorococcoid. Note: a widespread holarctic lichen, with a broad altitudinal and latitudinal range, found on soil and weathered calciferous, more rarely basic siliceous rocks, often overgrowing mosses and associated with cyanobacteria or cyanobacterial lichens when young. The most common species of *Toninia* throughout Italy.

- 74 Spores submuriform to muriform 75
 74 Spores 1-2-celled 78
 75 Squamules small, <0.5 mm long. Perithecia without hymenial algae

72 - *Agonimia tristicula* (Nyl.) Zahlbr.

Thallus squamulose, greyish-green to green-brown, green when wet, K-, C-, KC-, P-, UV-. Squamules small, adpressed to the substratum to more or less ascending, elongate, to 0.1-0.4 mm broad and to 0.5(-1) mm long, crenate to sublobate at margin, flattened to slightly convex, sometimes articulate in the form of a *Opuntia*, dispersed or



clustered, rarely imbricate. Thallus paraplectenchymatous throughout, with no true cortex, the lower surface pale. Perithecia frequent, semi-immersed among the squamules, 0.4-0.5 mm diam., black, barrel-shaped, plicate in upper part, the wall dark throughout in section, without involucrellum. Paraphyses absent, substituted by periphyses. Asci clavate, thin-walled, not or very weakly thickened above, I-. Spores hyaline to pale yellowish brown, ellipsoid, muriform, (1-)2 per ascus, (60-)80-120(-150) x (20-)25-50 μm . Photobiont chlorococcoid. Without lichen substances. Note: a probably holarctic species with a broad altitudinal and latitudinal range, found on terricolous mosses, but also, albeit rarely, on basal parts of old trunks in calcareous areas; largely overlooked in the past, and certainly present throughout Italy, from the lowlands to above treeline.

- 75 Squamules >0.5 mm long. Perithecia with hymenial algae 76
 76 Squamules densely imbricate, ascending. Lower surface black with a white margin, without rhizohyphae. Spores 1 per ascus

73 - *Endocarpon adscendens* (Anzi) Müll.Arg.



Thallus squamulose, brownish grey to pale brown, greenish when wet, matt, loosely attached, K-, C-, KC-, P-, UV-. Squamules ca. 2-7 x 1-3 mm, flattened, smooth, contiguous, ascending, imbricate, forming a compact pillow, black with a pale border below, without rhizines. Upper cortex paraplectenchymatous. Perithecia frequent, half immersed in the squamules, up to 0.4 mm diam., the upper part black, protruding around a depressed ostiole, without involucrellum. Perithecial wall (section) black above, pale-coloured below. Paraphyses absent, substituted by periphyses. Hymenial algae spherical to ellipsoid. Hymenium colourless. Asci bitunicate, thin-walled, clavate, the wall I-. Spores pigmented, ellipsoid, muriform, 1 per ascus, (25-)28-50 x (12-)14-22 μm . Pycnidia dark, immersed. Conidia crescent-shaped. 4-6 x 0.8 μm . Photobiont chlorococcoid. Without lichen substances. Note: a mainly temperate, perhaps holarctic lichen, found on terricolous mosses, often on cyanobacterial colonies, with optimum in upland areas with base-rich siliceous rocks. Italian distribution poorly known: certainly overlooked, or confused with related species.

- 76 Squamules scattered to contiguous, not overlapping. Lower surface either uniformly black or uniformly pale, with rhizohyphae. Spores usually 2 per ascus (some asci may contain a single spore) 77
 77 Lower surface of squamules pale throughout. Rhizines absent

74 - *Endocarpon pallidum* Ach.

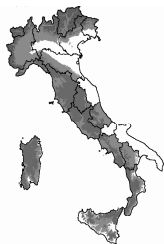
Thallus squamulose, pale greenish grey to brownish, green when wet, smooth, dull, closely adpressed to the substratum, K-, C-, KC-, P-, UV-. Squamules 1-4 mm broad, 0.2-0.3 μm thick, rounded to irregularly lobed, flattened, smooth, contiguous, usually non imbricate, with only slightly up-turned margin. Lower surface whitish to pale brown, with a few bundles of hyaline rhizohyphae which are ca. 2.5 μm thick. Upper cortex paraplectenchymatous,



lower cortex absent. Medulla composed of loosely interwoven, filamentous hyphae. Perithecia frequent, globose to broadly pyriform, fully immersed, to 0.4 mm diam., the apex concolourous with thallus or darker, without involucrellum. Perithecial wall dark throughout, brown to black, ca. 30 μm thick. Paraphyses absent, substituted by periphyses. Hymenium colourless, I+ brown-red. Hymenial algae ellipsoid to globose 3-5 μm in diam. Asci bitunicate, thin-walled, clavate to cylindrical-clavate, the wall I-. Spores pigmented, ellipsoid, muriform, (1-)2 per ascus, 28-40 x 11-16 μm , the apical spore smaller. Pycnidia black, immersed, inconspicuous. Conidia shortly bacilliform, 3-5 x <1 μm . Photobiont chlorococcoid. Without lichen substances. Note: a mainly southern lichen, found in open, dry, calcareous grasslands; the epithet "*pallidum*" was often used in the past to designate *E. adscendens*. Italian distribution poorly known:

77 Lower surface of squamules dark throughout. Rhizines present

75 - *Endocarpon pusillum* Hedw.



Thallus squamulose, pale greenish grey to brownish, green when wet, closely adpressed to the substratum, K-, C-, KC-, P-, UV-. Squamules 0.7-3 mm broad, 0.15-0.25 mm thick, usually weakly to deeply lobate, flattened, smooth, scattered to contiguous, non imbricate, fully adnate or rarely with a slightly up-turned margin. Lower surface black, with conspicuous black rhizines anchoring and linking the squamules, and colourless to dark rhizohyphae. Rhizines moderately to richly branched, to several mm long, with a carbonaceous envelope and a colourless core. Upper cortex paraplectenchymatous, 30-70 μm thick, overlain by a thin to thick amorphous layer. Lower cortex more or less paraplectenchymatous in upper part, brown-black. Medulla subparaplectenchymatous, composed of rounded cells. Perithecia frequent, subglobose, fully immersed, to 0.4 mm diam. Perithecial wall brown-black to black throughout, 20-30 μm thick. Paraphyses absent, substituted by periphyses. Hymenial algae subglobose to ellipsoid-oblong. Hymenium colourless, I+ brown-red. Asci bitunicate, thin-walled, clavate, the wall I-. Spores pigmented, ellipsoid, muriform, (1-)2 per ascus, 16-50(-60) x 13-26 μm , the apical spore smaller. Pycnidia immersed, to 0.3 mm broad. Conidia bacilliform, 3-5 x <1 μm . Photobiont chlorococcoid. Without lichen substances. Note: the genus *Endocarpon* badly needs revision; *E. pusillum* in the sense of most European authors is heterogeneous, and perhaps could be subdivided into several species. The Italian distribution is poorly known, due to problems in the delimitation towards related taxa.

78 Spores 2-celled 79

78 Spores 1-celled 86

79 Thallus attached by a central holdfast looking like a rhizine

76 - *Placidiopsis custnani* (A.Massal.) Krb.

Thallus squamulose, olive green to pale grey-brown, rarely dark



brown, thin, K-, C-, KC-, P-, UV-. Squamules 0.5-2(-3) mm broad, flattened, contiguous to scattered, finely incised to crenate, ascending at least at margin, the edges down-turned (section). Lower surface dark brown to black, pale only at margin, attached by a central, thick, to 400 μm long tuft of dark rhizohyphae. Upper cortex thin, composed by 1-2 layers of cells. Lower cortex absent. Perithecia frequent, laminal, 1-10 per squamule, immersed, 0.2-0.3 mm diam., pyriform to globose, the wall initially colourless, then brown-black throughout. Hymenium colourless. Paraphyses absent, substituted by periphyses of 20-30 x 2-3 μm . Asci elongate-clavate, thin-walled, I-, apically slightly thickened, with a small ocular chamber. Spores 2-celled, sometimes constricted at septum, hyaline, ellipsoid to slightly clavate, thin-walled, not ornamented, 8 per ascus, 15-21 x 5.5-7.5 μm . Photobiont chlorococcoid. Without lichen substances. Note: a mainly mild-temperate species of calciferous soil and calcicolous mosses; largely overlooked in Italy, where it seems to be most common in the submediterranean belt.

- 79 Thallus attached only by rhizohyphae, central holdfast absent 80
 80 Perithecia with involucrellum (section!)

77 - *Placidiopsis tenella* (Nyl.) Zahlbr.



Thallus squamulose, whitish to greenish grey, sometimes pale brownish, not pruinose, K-, C-, KC-, P-, UV-. Squamules 1-2 mm broad, irregularly rounded to crenate-lobulate, flattened to convex, smooth, contiguous, non imbricate. Lower surface pale, attached by colourless rhizohyphae which are 2.5-4 μm thick. Upper cortex 10-25 μm thick, covered by a 10-15 μm thick epinecral layer. Lower cortex absent. Perithecia frequent, laminal, immersed in the squamules, globose, with colourless wall and a dark apical involucrellum, 0.2-0.3 mm diam., the involucrellum small, flat, appearing as a blackish rim around the ostiole. Paraphyses absent, substituted by periphyses of 20-30 x 2.5-3 μm . Hymenium I+reddish. Asci clavate, thin-walled, I-, apically slightly thickened, with a small ocular chamber. Spores 2-celled, hyaline, narrowly ellipsoid, thin-walled, 8 per ascus, 14-18 x 6-7 μm . Photobiont chlorococcoid. Without lichen substances. Note: a mediterranean lichen known from Algeria and Calabria, found on calciferous soil in clearings of garrigue vegetation; probably overlooked, and more widespread in the south, but certainly extremely rare.

- 80 Perithecia without involucrellum 81
 81 Rhizohyphae brown (best observed under the microscope) 82
 81 Rhizohyphae hyaline 84
 82 Spores >21 μm long

78 - *Placidiopsis cinereoides* Breuss

Thallus squamulose, greenish grey-brown, not pruinose, more or less orbicular, K-, C-, KC-, P-, UV-. Squamules crenate to finely incised, flattened, smooth, contiguous and adpressed to the substratum, the marginal squamules somehow elongate to form rosettes, 0.5-2 mm



diam. Lower surface dark, attached by dark rhizohyphae of ca. 4 μm diam. Upper cortex thin, lower cortex absent or poorly developed. Perithecia frequent, laminal, globose, 0.2-0.4 mm diam., the wall colourless to brownish, without involucrellum. Paraphyses absent, substituted by periphyses, the terminal cells somehow inflated. Hymenium I+ reddish. Asci clavate, thin-walled, I-, apically slightly thickened, with a small ocular chamber. Spores (1-)2-celled, often slightly constricted at septum, hyaline, narrowly ellipsoid, thin-walled, 8 per ascus, (20-)22-28(-30) \times (6.5-)7-8(-8.5) μm . Photobiont chlorococcoid. Without lichen substances. Note: known only from the mountains of the Iberian Peninsula, not reported from Italy but perhaps occurring in the Alps or in the mediterranean mountains.

82 Spores $<21 \mu\text{m}$ long

83

83 Thallus grey to brownish grey, often faintly pruinose. Squamules scattered or aggregated in small groups, rounded to lobed. Spores ellipsoid, 7.5-9 μm broad

79 - *Placidiopsis pseudocinerea* Breuss



Thallus squamulose, grey to brownish grey, often faintly pruinose, K-, C-, KC-, P-, UV-. Squamules rounded, flattened, smooth, adpressed to the substratum, non imbricate, 1.5-5 mm diam., isolated or in small groups, rounded to somehow lobulate. Lower surface dark, attached by dark rhizohyphae which are 4-5 μm thick. Upper cortex 10-30(-40) μm thick, covered by an irregular epinecral layer. Lower cortex present, paraplectenchymatous. Perithecia frequent, laminal, pyriform to globose, semi-immersed in the squamules, the wall initially pale, then becoming dark throughout starting from the ostiole, without involucrellum, 0.2-0.35 mm diam. Paraphyses absent, substituted by periphyses. Hymenium I+ reddish. Asci clavate, thin-walled, I-, apically slightly thickened, with a small ocular chamber. Spores 2-celled, hyaline, ellipsoid, thin-walled, 8 per ascus, (14-)15-19(-21) \times (6.5-)7.5-9(-10) μm , some spores ovoid to clavate, sometimes curved, restricted at septum. Photobiont chlorococcoid. Without lichen substances. Note: an arctic-alpine, circumpolar lichen, found on soil and on muribund bryophytes on siliceous, base-rich or slightly calciferous soil (e.g. on calcareous schist); the species can be easily confused with *Catapyrenium cinereum* and is certainly much more widespread through the Italian Alps, mostly near or above treeline.

83 Thallus brownish, non pruinose. Squamules densely aggregated, incised. Spores broadly ellipsoid, 9-11 μm broad

80 - *Placidiopsis tirolensis* Breuss

Thallus squamulose, brownish, non pruinose, K-, C-, KC-, P-, UV-. Squamules 0.7-3 mm broad, flattened, smooth, contiguous and densely aggregated, incised. Lower surface dark, attached by dark rhizohyphae which are 4-5 μm thick. Upper cortex 10-20 μm thick, with a thin to absent epinecral layer. Lower cortex poorly developed, more or less paraplectenchymatous. Perithecia frequent, laminal,



globose, to 0.3 mm diam., the wall colourless only in very young perithecia, then dark throughout, without involucrellum. Paraphyses absent, substituted by periphyses. Hymenium I+ reddish. Asci clavate, thin-walled, I-, apically slightly thickened, with a small ocular chamber. Spores 2-celled, not constricted at septum, hyaline, broadly ellipsoid, thin-walled, 8 per ascus, 13-17 x 9-11 μ m. Photobiont chlorococcoid. Without lichen substances. Note: on calciferous, mostly organic soil. Recently-described, and known only from Austria, with a station which is very close to the Italian border (Volaja Lake, Carnic Alps); to be looked for in the Italian Alps, above treeline.

84 Squamules with a distinct brown paraplectenchymatous lower cortex (section!)

81 - *Placidiopsis oreades* Breuss

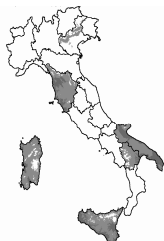


Thallus squamulose, pale brown to grey-brown, matt, K-, C-, KC-, P-, UV-. Squamules 1.5-3.5 mm broad, scattered to contiguous, not imbricate, adpressed to the substratum, crenulate-lobulate. Upper cortex 25-50 μ m thick, without or with a very thin epinecral layer. Lower surface with a distinct, brown paraplectenchymatous lower cortex and colourless rhizohyphae which are ca. 4 μ m thick. Perithecia frequent, laminal, pyriform, to 0.3 mm diam., the wall initially colourless, then brown throughout, without involucrellum. Paraphyses absent, substituted by periphyses. Perithecial wall dark throughout. Hymenium I+ reddish. Asci clavate, thin-walled, I-, apically slightly thickened, with a small ocular chamber. Spores 2-celled, hyaline, ellipsoid, thin-walled, 8 per ascus, 14-20 x (6.5-)7-9 μ m. Photobiont chlorococcoid. Without lichen substances. Note: on clay soil in the mountains. A recently-described species, known from the Alps, the Carpathians and the mountains of Asia. Never reported from Italy, but known from the Alps above treeline, and to be looked for further there.

84 Squamules without a brown paraplectenchymatous lower cortex 85

85 Perithecial wall pale throughout. Rhizohyphae 3-4 μ m thick

82 - *Placidiopsis cinerascens* (Nyl.) Breuss



Thallus squamulose, greenish grey to brownish grey, sometimes pruinose, matt, K-, C-, KC-, P-, UV-. Squamules rounded to lobulate, 1-3 mm broad, 0.15-0.35 mm thick, flattened to weakly convex, smooth, scattered to contiguous, sometimes weakly overlapping at margins, adpressed to the substratum. Lower surface pale, attached by hyaline rhizohyphae which are 3-4 μ m thick. Upper cortex 15-25 μ m thick, covered by a 10-30 μ m thick epinecral layer. Lower cortex absent or poorly developed. Perithecia frequent, laminal, immersed, slightly pyriform to globose, up to 0.3 mm broad, the wall initially colourless, then brownish, darker only around the ostiole, without involucrellum. Paraphyses absent, substituted by periphyses, the terminal cells somewhat enlarged. Hymenium I+ reddish. Asci narrowly clavate, thin-walled, I-, apically slightly thickened, with a small ocular chamber. Spores 2-celled, often slightly constricted at septum, hyaline, broadly ellipsoid

to subclavate, thin-walled, 8 per ascus, (13-)15-19(-21) x (5.5-)6-7.5(-8) μm . Photobiont chlorococcoid. Without lichen substances. Note: on more or less calciferous ground in dry-warm sites. In Italy this species seems to behave as a vicariant of the submediterranean *P. cartilaginea* in the mediterranean belt; certainly much more widespread and largely overlooked.

85 Perithecial wall dark throughout. Rhizohyphae 4.5-5.5 μm thick

83 - *Placidiopsis dermatocarpoides* Anzi



Thallus squamulose, brown, matt, K-, C-, KC-, P-, UV-. Squamules 1-3 mm broad, more or less convex, indistinctly lobulate with down-turned margin, contiguous, not overlapping. Lower surface pale, attached by hyaline rhizohyphae which are 4.5-5.5 μm thick. Upper cortex 25-30 μm thick, covered by a thick epinecral layer. Lower cortex absent. Perithecia frequent, laminal, pyriform, 0.25-0.3 μm in diam., the wall dark throughout, without involucrellum. Paraphyses absent, substituted by periphyses. Hymenium I+ reddish. Asci clavate, thin-walled, I-, apically slightly thickened, with a small ocular chamber. Spores 2-celled, hyaline, ellipsoid, thin-walled, 8 per ascus, 15-17 x 7-8 μm . Photobiont chlorococcoid. Without lichen substances. Note: known only from the type collection (Lombardy, 1550 m, see Nimis 1993), on soil in fissures of serpentine, this species needs further study.

86 Rhizohyphae dark (make a section of the squamule, and carefully observe the rhizohyphae under the microscope) 87

86 Rhizohyphae pale 89

87 Perithecia developing on the dark hypothallus between the squamules, with involucrellum (section!)

84 - *Involucropyrenium waltheri* (Kremp.) Breuss



Thallus squamulose to subcrustose, brownish, sometimes with a grey tinge, dull, thin, K-, C-, KC-, P-, UV-. Squamules >1.5 mm broad and long, usually contiguous, forming a crust, flattened to slightly convex, smooth, irregular in shape, the margins entire to usually crenate-lobulate, not up-turned, surrounded by a dark hypothallus. Marginal squamules often somehow elongate. Lower surface dark, attached by 4-5 μm thick, dark rhizohyphae. Upper and lower cortex paraplectenchymatous. Perithecia frequent, developing on the dark hypothallus between the squamules, globose, protruding, not flattened, with an involucrellum extending all around the perithecium, 0.2-0.35 mm broad. Perithecial wall black and carbonaceous throughout. Paraphyses absent, substituted by periphyses. Asci clavate, the wall I-. Spores 1-celled, hyaline, narrowly ovoid to club-shaped, thin-walled, 8 per ascus, (15-)17-21(-23) x (7.5-)8-10(-11) μm . Photobiont chlorococcoid. Without lichen substances. Note: on calciferous ground in alpine grasslands; probably more widespread in the Alps.

87 Perithecia immersed in the squamules, without involucrellum 88

- 88 Lower cortex present, paraplectenchymatous (section!). Squamules brownish darker toward the margin. Old perithecia with a dark wall. Asci 65-70 μm long

85 - *Catapyrenium cinereum* (Pers.) Körb.



Thallus squamulose to subcrustose, brownish grey, often faintly grey-pruinose especially toward the centre, and darker toward the margin, thin, K-, C-, KC-, P-, UV-. Squamules (0.5-)1-3 mm broad, finely divided-lobulate, adpressed to the substratum, contiguous, very rarely somewhat overlapping, forming a subcrustose thallus developing on a dark prothallus. Edge of squamules darker than the surface. Lower surface dark, attached by (3.5-)4-4.5(-5) μm thick, dark rhizohyphae. Upper and especially lower cortex paraplectenchymatous, the latter of polygonal cells in 2-3 layers. Perithecia frequent, numerous, laminal, globose, half immersed, not flattened, 0.2-0.3 mm in diam. Paraphyses absent, substituted by periphyses. Perithecial wall initially pale, then darkening throughout. Asci unitunicate, clavate, thin-walled, not or only slightly thickened at the apex, without ocular chamber, the wall I-, 65-70 x 16-22 μm . Spores 1-celled, hyaline, clavate, thin-walled, 8 per ascus, (15-)17-23(-25) x (6-)6.5-8.5(-9.5) μm . Photobiont chlorococcoid. Without lichen substances. Note: a boreal-montane to arctic-alpine, circumpolar species, common in the Alps near or above treeline, occurring also in more southern mountains on siliceous, base-rich soil with mica, or amongst terricolous bryophytes; often confused with *Placidopsis cinereoides*.

- 88 Lower cortex absent. Squamules usually not darker at margin. Most perithecia with a colourless wall. Asci 75-85 μm long

86 - *Catapyrenium daedaleum* (Kremp.) Stein



Thallus squamulose to subcrustose, brownish to brownish-greenish grey, often faintly pruinose, never darker at margin, thin, K-, C-, KC-, P-, UV-. Squamules 1-4 mm broad, flattened, smooth, contiguous, non imbricate, usually forming a rosette-like thallus reaching 9 cm diam., developing on a black hypothallus. Marginal squamules often elongated, rounded, often somewhat concave at tips, always without pruina. Edge of squamules crenulate, concolorous with upper surfaces. Lower surface dark, attached by dark rhizohyphae. Upper cortex paraplectenchymatous, lower cortex absent, the medulla becoming darker below. Rhizohyphae dark, 3-4(-4.5) μm in diam. Perithecia frequent, laminal, pyriform, half immersed, not flattened, 0.2-0.3 mm broad. Paraphyses absent, substituted by periphyses. Perithecial wall colourless to brown, esp. near the ostiole. Asci unitunicate, clavate, thin-walled, not or only slightly thickened at the apex, without ocular chamber, the wall I-, 75-85 μm long, 17-20 μm broad. Spores 1-celled, hyaline, clavate, thin-walled, 8 per ascus, (15-)17-22(-24) x (5-)6-8(-9) μm . Photobiont chlorococcoid. Without lichen substances. Note: a boreal-montane to arctic-alpine, circumpolar species found on plant debris, mosses and bare, humus rich soil on calciferous ground. Common in the Alps near or above treeline, perhaps less common

than *C. cinereum* in the mountains of the south, but extending to the mountains of Sicilia.

- 89 Perithecia with involucrellum, developing on the dark hypothallus between the squamules 90
- 89 Perithecia without involucrellum, developing on the squamules 91
- 90 Involucrellum all around the perithecium. Perithecia pyriform. A very rare, mediterranean species

87 - *Involucropyrenium sbarbaronis* (Servit) Breuss



Thallus squamulose to subcrustose, beige to pale brown, not pruinose, thin, closely adpressed to the substratum, K-, C-, KC-, P-, UV-. Squamules 0.4-1 mm broad, rounded to crenate, flattened to slightly convex, smooth, contiguous, mostly forming a subcrustose thallus. Prothallus often present, pale. Lower surface attached by ca. 4 µm thick, pale rhizohyphae. Upper cortex paraplectenchymatous, lower cortex absent. Perithecia frequent, developing from the hypothallus among the squamules, first globose, then pyriform, protruding, with an involucrellum extending all around the perithecium, 0.3-0.35 mm broad. Paraphyses absent, substituted by periphyses. Perithecial wall dark throughout. Asci narrowly clavate, the wall I-. Spores 1-celled, hyaline, narrowly ellipsoid, thin-walled, 8 per ascus, 15-20(-22) x 6-8 µm. Photobiont chlorococcoid. Without lichen substances. Note: only known from the type collection, this species, which may be confused with a *Verrucaria*, deserves further study.

- 90 Involucrellum apical. Perithecia globose. More common, mediterranean to submediterranean

88 - *Involucropyrenium tremniacense* (A.Massal.) Breuss

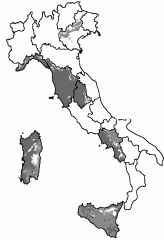


Thallus squamulose to subcrustose, beige to pale brown, dull, not pruinose, thin, closely adpressed to the substratum, K-, C-, KC-, P-, UV-. Squamules 0.3-1.5(-2) mm broad, rounded to crenate, flattened to slightly convex, smooth, contiguous, developing on a pale hypothallus. Lower surface pale, attached by ca. 4 µm thick, pale rhizohyphae. Upper cortex paraplectenchymatous, lower cortex absent. Perithecia frequent, developing from the hypothallus among the squamules, globose, protruding, with an apical involucrellum reaching up the half of the perithecium, to 0.35 mm broad. Paraphyses absent, substituted by periphyses. Perithecial wall dark throughout. Asci clavate, the wall I-. Spores 1-celled, hyaline, ellipsoid, thin-walled, 8 per ascus, 13-17(-18) x 6-7(-8) µm. Photobiont chlorococcoid. Without lichen substances. Note: a widespread species of open grasslands on calcareous substrata, most common below treeline; probably more widespread in Italy, to be looked for throughout the country.

- 91 Squamules small, densely imbricate, forming cushions

89 - *Heteropladidium imbricatum* (Nyl.) Breuss

Thallus squamulose, pale greyish brown to brownish, dull, rarely



faintly pruinose at margin, K-, C-, KC-, P-, UV-. Squamules 1-2 mm broad, rounded to crenulate, concave to convex, usually flattened, smooth, contiguous, densely imbricate to form cushions of 2-4 cm in diam. Lower surface whitish to yellowish white or very pale brown, attached by 4-5 μm thick pale rhizohyphae which are usually present only at the base of squamules. Upper cortex paraplectenchymatous, lower cortex absent. Perithecia rather rare, laminal, globose to pyriform, half immersed, to 0.35 mm broad. Perithecial wall initially pale, then brown, finally dark brown to black. Paraphyses absent, substituted by periphyses. Asci clavate, the wall I-. Spores 1-celled, hyaline, narrowly ellipsoid, thin-walled, 8 per ascus, 12-16 x 5-7 μm . Pycnidia dark. Conidia cylindrical, 3-4 x 1 μm . Photobiont chlorococcoid. Without lichen substances. Note: in fissures of hard calcareous rocks and amongst mosses, esp. limestone, in sheltered situations, mostly below the montane belt. Certainly overlooked, and much more widespread in Italy.

- 91 Squamules small to large, not densely imbricate, never forming cushions 92
- 92 Rhizines present (do not confuse true rhizines, which are formed by bundles of hyphae, with rhizohyphae, which consist of individual hyphae - if you are not certain, observe a section under the microscope!) 93
- 92 Rhizines absent 96
- 93 Perithecial wall dark throughout 94
- 93 Perithecial wall pale throughout 95
- 94 Perithecial wall black, friable, carbonaceous

90 - *Anthracocarpon virescens* (Zahlbr.) Breuss



Thallus squamulose, brown, K-, C-, KC-, P-, UV-. Squamules 2-4 mm broad, rounded to lobulate, flattened to slightly convex, smooth, scattered to contiguous on a dark hypothallus. Lower surface pale at first, but often blackening with age, attached by a mat of dark rhizohyphae and by 0.5-1.5 mm long, mostly simple, sparse, dark rhizines. Upper cortex paraplectenchymatous, lower cortex absent. Perithecia frequent, laminal, pyriform, half immersed, to 0.5 mm broad, with a 30-50 μm thick, carbonaceous, entire exciple. Paraphyses absent, substituted by periphyses. Asci narrowly clavate, the wall I-. Spores 1-celled, hyaline, thin-walled, very variable in shape and size, from elliptical to club-shaped, 8 per ascus, (13-)15-20(-23) x (6-)7-9 μm . Pycnidia laminal, to 200 μm in diam. Conidia cylindrical, (5-)6-8(-9) x 1.5 μm . Photobiont chlorococcoid. Without lichen substances. Note: a mainly mediterranean species of dry grasslands on calcareous substrata; known only from Calabria in Italy; overlooked or confused with related species in the past, probably more widespread, esp. in the south.

- 94 Perithecial wall blackish brown, not carbonaceous

91 - *Clavascidium umbrinum* (Breuss) Breuss

Thallus squamulose, medium to dark brown, dull, epruinose, K-, C-, KC-, P-, UV-. Squamules 2-4 mm broad, rounded or slightly lobed, flattened, smooth, dispersed or loosely aggregated, usually not overlapping, rather thin and fragile. Lower surface pale to usually dark, attached by simple dark rhizines and by 4-5.5 μm thick, brown rhizohyphae. Upper cortex paraplectenchymatous, 20-50 μm thick. Lower cortex absent. Perithecia frequent, laminal, broadly pyriform, half immersed, without involucrellum, up to 0.4 mm broad, with black-brown walls. Hymenium I+ red, K/I+ blue. Paraphyses absent, substituted by periphyses. Perithecial wall dark throughout. Asci clavate, thin-walled, the wall I-. Spores 1-celled, hyaline, thin-walled, 8 per ascus. Pycnidia laminal, or absent. Conidia oblong-ellipsoid, 3-4.5 x ca. 1.5 μm . Photobiont chlorococcoid. Without lichen substances. Note: only known from Piemonte, but with a wide distribution, this species should be looked for in other parts of Italy.



- 95 Squamules flattened to weakly convex, not pruinose. Pycnidia laminal. Spores ellipsoid, 12-15(-17) x (5.5-)6-7(-7.5) μm

92 - *Placidium lacinulatum* (Ach.) Breuss

Thallus squamulose, brown, dull, non pruinose or very slightly pruinose, K-, C-, KC-, P-, UV-. Squamules 3-8 mm broad, 0.3-0.5 mm thick, rounded at first, then crenulate, flattened to weakly convex, smooth, with undulate-crested edge, scattered to contiguous, rarely overlapping. Lower surface pale brown, sometimes darkening, attached by numerous to scarce dichotomously branched, robust, 100-300 μm thick, several mm long, pale to brown rhizines, and by colourless, 4-5 μm thick rhizohyphae. Upper and lower cortex paraplectenchymatous, the lower cortex poorly developed, the cells not arranged in vertical rows. Perithecia frequent, laminal, half immersed, globose to broadly pyriform, to 0.65 mm in diam., the wall colourless to pale brown throughout. Hymenium K/I+ blue. Paraphyses absent, substituted by periphyses. Asci cylindrical, thin-walled, I-, without a tholus. Spores 1-celled, hyaline, ellipsoid, thin-walled, 8 per ascus, uniseriate, 12-15(-17) x (5.5-)6-7(-7.5) μm . Pycnidia laminal, immersed, black, to 0.5 mm in diam. Conidia oblong-ellipsoid, 3-4(-5) x 1.3-2 μm . Photobiont chlorococcoid (*Myrmecia*). Without lichen substances. Note: a mainly mediterranean to mild-temperate species of loess and calciferous ground, most frequent in dry grasslands. Confused with related species in the past, probably much more widespread in Italy.



- 95 Squamules mostly subconcave, with up-turned margins, at least in part grey-pruinose. Pycnidia marginal. Spores broadly ellipsoid, (12-)14-18(-19) x (7-)7.5-9(-10) μm

93 - *Placidium semaforonense* Breuss

Thallus squamulose, brown, often grey-pruinose at margins, dull, K-, C-, KC-, P-, UV-. Squamules 3-7 mm broad, rounded to lobulate, flattened, smooth, with an undulate, mostly up-turned margin, scattered to contiguous, not imbricate. Lower surface pale, but often



becoming dark with age, attached by dichotomously branched, (50-)100-250 μm long, robust rhizines. Upper cortex paraplectenchymatous, lower cortex poorly differentiated, with cells not arranged in vertical rows. Rhizohyphae colourless, thin (3.5-5.5 μm thick). Perithecia frequent, laminal, half immersed, globose to pyriform, to 0.5 mm in diam. Perithecial wall pale throughout. Hymenium K/I+ blue. Paraphyses absent, substituted by periphyses. Asci subcylindrical, thin-walled, I-, without a tholus. Spores 1-celled, hyaline, broadly ellipsoid, thin-walled, 8 per ascus, uniseriate, (12-)14-18(-19) x (7-)7.5-9(-10) μm . Pycnidia black, marginal, semi-immersed. Conidia ellipsoid, 3-4.5 x 1.5-2 μm . Photobiont chlorococcoid (*Myrmecia*). Without lichen substances. Note: a macaronesian-mediterranean to irano-turanic lichen, also known from on fine-sandy soils in open, dry mediterranean grasslands and garrigues; to be looked for further in dry areas of the south.

96 Perithecial wall <25 μm thick (section!)

94 - *Placidium michelii* A.Massal.



Thallus squamulose, pale to dark chestnut brown, dull, not pruinose, thin, closely adpressed to the substratum, K-, C-, KC-, P-, UV-. Squamules 1-5 mm broad, rather thin (to 0.25 μm thick) rounded to undulate, flattened, smooth, scattered to contiguous. Lower surface black, attached by a dense mat of 4-6 μm thick, colourless rhizohyphae. Upper cortex paraplectenchymatous, 20-40 μm thick, without or with a very thin epinecral layer. Lower cortex thin, poorly differentiated, consisting of 1-3 layers of cells, the lower ones pigmented. Perithecia frequent, laminal, pyriform, half immersed, to 0.35 mm in diam., the wall rather thin (to 25 μm), initially colourless, but soon darkening throughout, starting from the ostiole. Paraphyses absent, substituted by periphyses. Hymenium K/I+ blue. Asci cylindrical, thin-walled, I-, without a tholus. Spores 1-celled, hyaline, ellipsoid, thin-walled, 8 per ascus, uniseriate, 11-15 x 5-6 μm . Pycnidia rare, laminal, immersed, black. Conidia oblong-ellipsoid, 2.5-3.5 x ca. 1.5 μm . Photobiont chlorococcoid (*Myrmecia*). Without lichen substances. Note: a mainly temperate lichen, found on mineral, esp. sandy soil in open grasslands. Confused with related species in the past, and probably more widespread, also in the south

- 96 Perithecial wall >25 μm thick 97
- 97 Pycnidia laminal, fully immersed in the squamules, or absent (observe carefully several squamules!) 98
- 97 Pycnidia marginal, prominent 99
- 98 Squamules 2-7 mm broad. Rhizohyphae 4.5-6.5 μm thick

95 - *Placidium squamulosum* (Ach.) Breuss

Thallus squamulose, brown, dull to somewhat shiny, closely adpressed to the substratum, K-, C-, KC-, P-, UV-. Squamules 2-5(-7) mm broad, 0.2-0.4 mm thick, rounded to crenulate, flattened, smooth, scattered to contiguous, the margins only rarely up-turned.



Lower surface pale, but often blackening esp. in the centre, attached by a dense mat of 4.5-6.5 μm thick, colourless rhizohyphae. Upper cortex paraplectenchymatous 30-60 μm thick, lower cortex poorly developed. Perithecia frequent, laminal, broadly pyriform, half immersed, to 0.7 mm in diam., the wall pale throughout, 25-30 μm thick. Paraphyses absent, substituted by periphyses. Hymenium K/I+ blue. Asci cylindrical, thin-walled, 1-, without a tholus. Spores 1-celled, hyaline, ellipsoid, thin-walled, 8 per ascus, uniseriate, 12-16 x (5-)5.5-7.5(-8) μm . Pycnidia laminal, immersed, black, 0.2-0.5(-0.7) mm in diam. Conidia oblong-ellipsoid, (2.5-)3-4 μm long, 1.3-2 μm broad. Photobiont chlorococcoid (*Myrmecia*). Without lichen substances. Note: a widespread holarctic lichen, found on calciferous soil, often amongst bryophytes, in open dry grasslands, mostly but not always below treeline; probably the most common species of the genus in Italy.

98 Squamules 0.7-2(-3) mm broad. Rhizohyphae 3.5-5 μm thick

96 - *Placidium tenellum* (Breuss) Breuss



Thallus squamulose, brown, dull, not pruinose, K-, C-, KC-, P-, UV-. Squamules 0.7-2(-3) mm broad, mostly rounded at least when young, flattened, smooth, scattered to contiguous. Lower surface pale, but often darkening esp. in the centre, attached by 3.5-4.5 μm thick, colourless rhizohyphae. Upper and lower cortex paraplectenchymatous. Perithecia frequent, laminal, pyriform, to 500 μm in diam., half immersed, the wall pale throughout. Paraphyses absent, substituted by periphyses. Hymenium K/I+ blue. Asci subcylindrical, thin-walled, 1-, without a tholus. Spores 1-celled, hyaline, ellipsoid, thin-walled, 8 per ascus, uniseriate, 12-14 x 5-7 μm . Pycnidia laminal. Conidia ellipsoid to subcylindrical, 3-4 x 1.5 μm . Photobiont chlorococcoid (*Myrmecia*). Without lichen substances. Note: a widespread, but apparently rare species of dry, very open grasslands on calcareous substrata, extending eastward to Mongolia. To be looked for in other dry-warm areas of the south.

99 Cells of lower cortex arranged in vertical rows (section!). Conidia 5-7 μm long 100

99 Cells of lower cortex not arranged in vertical rows, Conidia 3-5 μm long 101

100 Below treeline. Most squamules >6 mm broad, with a thin margin

97 - *Placidium adami-borosi* Szatala



Thallus squamulose, reddish brown, dull to slightly shiny, usually loosely attached, K-, C-, KC-, P-, UV-. Squamules more or less rounded, smooth, (3-)6-12 mm broad, flat to concave, scattered to contiguous, the often up-turned margins not markedly swollen. Lower surface black, attached by pale rhizohyphae. Upper cortex paraplectenchymatous. Cells of lower cortex arranged in vertical rows. Perithecia frequent, laminal, half immersed, globose to pyriform, to 550 μm in diam., the wall pale throughout. Paraphyses absent, substituted by periphyses. Hymenium K/I+ blue. Asci

subcylindrical, thin-walled, I-, without a tholus. Spores 1-celled, hyaline, ellipsoid, thin-walled, 8 per ascus, uniseriate, 14-17 x 6-7.5 μm . Pycnidia marginal, prominent, to 250 μm in diam. Conidia bacilliform, (4.5-)5-6(-6.5) x 1-1.5 μm . Photobiont chlorococcoid (*Myrmecia*). Without lichen substances. Note: a mainly mediterranean (-montane) lichen, found on soils derived from metamorphic base-rich rocks in dry grasslands. Locally common in the siliceous mountains of Sardegna and Calabria.

- 100 Above or near treeline. Most squamules <6 mm broad, with a distinctly thickened margin

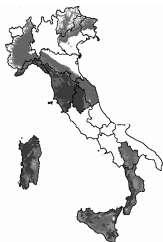
98 - *Placidium lachneum* (Ach.) de Lesd.



Thallus squamulose, reddish brown to brown, dull, K-, C-, KC-, P-, UV-. Squamules 2-7(-10) mm broad, rounded to crenate, flattened to mostly concave, smooth, with a thick, up-turned, often darker margin. Lower surface black, attached by (5.5-)6-7.5(-8) μm thick, pale rhizohyphae. Upper cortex paraplectenchymatous, 40-60 μm thick, with a very thin or without an epinecral layer. Cells of lower cortex arranged in vertical rows, the lowermost ones clearly black. Perithecia frequent, laminal, pyriform, half immersed, the wall pale throughout. Paraphyses absent, substituted by periphyses. Hymenium K/I+ blue. Asci cylindrical, thin-walled, I-, without a tholus. Spores 1-celled, hyaline, ellipsoid, thin-walled, 8 per ascus, uniseriate, (13-)14-17(-19) x 6-8(-9) μm . Pycnidia marginal, prominent and knotty, black, 200-400(-600) μm in diam. Conidia bacilliform, 5-7 μm long. Photobiont chlorococcoid (*Myrmecia*). Without lichen substances. Note: a mainly boreal-montane to arctic-alpine, circumpolar lichen, found on terricolous bryophytes and on more or less organic calciferous soil; occurring throughout the Alps, and in the highest mountains of the Apennines.

- 101 Squamules with very thin hairs, at least at the periphery (this character is difficult to observe: carefully examine several squamules under the binocular!)

99 - *Placidium pilosellum* (Breuss) Breuss



Thallus squamulose, yellowish brown, tan or more rarely dark brown, thin, K-, C-, KC-, P-, UV-. Squamules 2-6 mm broad, rather thin (0.25-0.4 mm thick), more or less rounded, flattened to weakly convex, smooth, with a more or less up-turned, undulate edge, and with very thin hairs, at least near the margins (binocular!). Lower surface usually pale. Upper cortex paraplectenchymatous, 40-60 μm thick, lower cortex indistinct, with cells not arranged in vertical rows. Rhizohyphae pale, 4-6 μm thick. Perithecia frequent, laminal, broadly pyriform, half immersed, to 0.5 mm in diam. Perithecial wall colourless to pale yellowish brown throughout. Paraphyses absent, substituted by periphyses. Hymenium K/I+ blue. Asci cylindrical, thin-walled, I-, without a tholus. Spores 1-celled, hyaline, ellipsoid, thin-walled, 8 per ascus, uniseriate, (10-)12-17(-19) x (5-)5.5-7(-7.5) μm . Pycnidia generally scarce, marginal, prominent and knotty, black, 200-300 μm in diam. Conidia 3-4 (4-5) μm long, 1.3-1.8 μm broad, oblong-ellipsoid. Photobiont chlorococcoid (*Myrmecia*).

Without lichen substances. Note: a mediterranean to mild-temperate lichen, found on calciferous soil rich in humus, often growing amongst bryophytes. A recently-described species (no old records), certainly much more widespread throughout the country.

101 Squamules without hairs

102

102 Squamules more or less rounded, 2-5 mm long, brownish. A very rare species, probably restricted to the Alps

100 - *Placidium imbecillum* (Breuss) Breuss

Thallus squamulose, brownish, dull to somewhat shiny, K-, C-, KC-, P-, UV-. Squamules 2-5 mm broad, rounded to mostly undulate, concave to flattened, smooth, with an up-turned edge. Lower surface black, brown at the periphery, attached by colourless, 5-6 µm thick rhizohyphae. Upper cortex paraplectenchymatous, lower cortex poorly developed, the cells not arranged in vertical rows. Perithecia frequent, laminal, pyriform, half immersed, to 400 µm in diam. Perithecial wall pale throughout. Paraphyses absent, substituted by periphyses. Hymenium K/I+ blue. Asci cylindrical, thin-walled, I-, without a tholus. Spores 1-celled, hyaline, ellipsoid, thin-walled, 8 per ascus, uniseriate, (12-)14-18(-20) x 6-8 µm. Pycnidia marginal, poorly evident. Conidia bacilliform, 3-5 x 1-1.5 µm. Photobiont chlorococcoid (*Myrmecia*). Without lichen substances. Note: known from the Austrian Alps, and from several isolated stations in southern Europe; to be looked for in the Italian Alps.



102 Squamules clearly elongated, >5 mm long, reddish brown. A rather common species throughout Italy

101 - *Placidium rufescens* (Ach.) A.Massal.

Thallus squamulose to subfoliose, reddish brown, dull to somewhat shiny, thick, K-, C-, KC-, P-, UV-. Squamules 6-10 mm long, 3-5 mm broad, to 0.6 mm thick, rounded at tips, with a mostly up-turned, undulate margin, pale to dark brown below, often blackening in the centre. Upper cortex paraplectenchymatous, 40-80 µm thick, with epinecral layer of variable thickness. Medulla prosoplectenchymatous. Lower cortex well-developed, paraplectenchymatous, the cells not arranged in vertical rows. Rhizohyphae colourless, (5.5-)6-7.5(-8) µm thick, mostly absent near the margins of squamules. Perithecia frequent, laminal, broadly pyriform, half immersed, to 0.5 mm in diam. Perithecial wall pale throughout. Paraphyses absent, substituted by periphyses. Hymenium K/I+ blue. Asci cylindrical, thin-walled, I-, without a tholus. Spores 1-celled, hyaline, ellipsoid, thin-walled, 8 per ascus, uniseriate, 15-20(-22) x (7-)7.5-9(-10) µm. Pycnidia marginal, usually abundant, prominent and knob-like, black. Conidia oblong-ellipsoid to subcylindrical, 3-5 x 1.3-2(-2.3) µm. Photobiont chlorococcoid (*Myrmecia*). Without lichen substances. Note: a mediterranean to mild-temperate, probably holarctic lichen, found on seepages of calcareous rocks, almost always with colonies of cyanobacteria, rarely on plant debris, calciferous soil, terricolous or epilithic bryophytes, from the lowlands to the subalpine belt. Widespread throughout the country, except the Po-plain.



Key 4 - Crustose lichens

- 1 With cyanobacteria (photobiont layer bluish-green in section) 2
 1 Without cyanobacteria (photobiont layer bright green to orange-green in section) 7
 2 Apothecia non lecanorine, without a thalline margin containing algal cells (if with perithecioid apothecia see Key 3, opt. 15: *Gloehoeppia turgida*)

1 - *Heppia lutosa* (Ach.) Nyl.



Thallus squamulose to subcrustose, brown to brown-black, thick, K-, C-, KC-, P-. Squamules (1-)3-5 mm broad, to 200 µm thick, concave at least when young, often granulose, mostly contiguous, appressed to the substratum, attached by a dense mat of rhizohyphae. Upper and lower cortex absent. Apothecia frequent, without a thalline margin, semi-immersed, up to 2 mm diam. Disc dark reddish brown, urceolate, concave. Margin indistinct. Epithecium brownish, K-. Hymenium I+ blue, 110-150 µm thick. Hypothecium colourless. Paraphyses simple, distinctly thickened above, free. Asci prototunicate, thin-walled, cylindrical to ovoid. Spores 1-celled, hyaline, ellipsoid, thin-walled, 8 per ascus, 15-24 x 7-10 µm. Pycnidia dark. Conidia bacilliform. Photobiont cyanobacterial (*Scytonema*-like). Without lichen substances. Note: on more or less calciferous soil in dry grasslands; probably more widespread, but certainly not common, also in the south.

- 2 Apothecia lecanorine, with a thalline margin containing algal cells 3
 3 Spores 1-celled

2 - *Moelleropsis nebulosa* (Hoffm.) Gyeln.



Thallus crustose, pale blue-grey to dark blue-black, granulose-subleprose, the granules 0.03-0.1 mm diam., forming a thick, compact to cracked crust, K-, C-, KC-, P-, UV-. Apothecia frequent, lecanorine, semi-immersed in the thallus, to 1.5 mm diam. Disc brown, margin granulose. Epithecium brownish. Hymenium colourless, K/I+ blue-green turning reddish brown. Hypothecium brownish, of intricately interwoven hyphae. Paraphyses simple, scarcely swollen at tips, conglutinate. Asci narrowly cylindrical, thin-walled, apically thickened, the apex with a I+ blue apical dome. Spores 1-celled, hyaline, ellipsoid, 8 per ascus, uni- to biserial in the asci, (11-)13-17(-20) x 6-8 µm, sometimes attenuated at one end, with a single oil droplet. Pycnidia unknown. Photobiont cyanobacterial (*Nostoc*), in short chains. Without lichen substances. Note: a mild-temperate early coloniser of clay-sandy soil, esp. earth banks along unpaved roads, in humid areas with siliceous substrata; most frequent in Tyrrhenian Italy, from the lowlands (but only in very humid areas) to the mountains, with optimum in the montane belt of Tyrrhenian Italy.

- 3 Spores many-celled, submuriform 4
- 4 Spores 4 per ascus. Most apothecia >1 mm diam

3 - *Collema limosum* (Ach.) Ach.



Thallus foliose to subcrustose, gelatinous when wet, dark olive-brown to bluish-blackish, thin and film-like, up to 5 cm diam., K-, C-, KC-, P-, UV-. Lobes flattened, contiguous, adpressed to the substratum, poorly evident to absent, smooth to rugose, the margins somehow swollen. Upper and lower cortex absent. Apothecia frequent, rounded, lecanorine, innate to adpressed, 1-3(-4) mm diam. Disc brown to blackish brown, slightly concave to convex; margin thick to thin in old apothecia, smooth to (rarely) lobulate, with an euthylectenchymatous excipulum. Epithymenium brownish. Hymenium colourless, I+ blue, 90-120 µm tall. Hypothecium colourless. Paraphyses simple or sparingly branched, with clavate to subglobose tips. Asci narrowly clavate, the apex thick, with a I+ blue apical dome and a I+ blue annulus projecting downwardly. Spores many-celled, hyaline, oblong to subovoid, submuriform, (2-)4 per ascus, 20-40 x 7-16 µm. Pycnidia very rare. Conidia straight, 4.5-6 x 1-1.8 µm. Photobiont cyanobacterial (*Nostoc*) in long chains. Without lichen substances. Note: a holarctic, temperate to boreal-montane, short-lived species of mineral, clay soil in disturbed habitats; certainly overlooked, but never common in Italy.

- 4 Spores 8 per ascus. Most apothecia <1 mm diam. 5
- 5 Photobiont *Scytonema*-like (cells 6-12 x 3-10 µm, isolated or in small groups)

4 - *Epiphloea terrena* (Nyl.) Trevis.



Thallus crustose to subsquamulose, pale brownish to yellowish grey, sometimes thin and inconspicuous, K-, C-, KC-, P-, UV-. Areolae 1-4 mm broad, 0.1-0.2 mm thick, digitate and radiating all around the apothecia, paraplectenchymatous in section. Apothecia frequent, without a thalline margin, but sometimes containing algal cells at the base of the proper margin, sessile, 0.5-1 mm diam. Disc brown to black, flat, smooth. Margin thin, smooth, persistent. Epithecium reddish brown. Hymenium and hypothecium colourless (the hypothecium sometimes pale brown). Spores hyaline, narrowly ellipsoid, submuriform, 8 per ascus, 18-38 x (5-)9-14 µm, with 4-7 horizontal septa and a few vertical septa. Photobiont *Scytonema*-like, in more or less rounded colonies. Without lichen substances. Note: on bare siliceous soil in mediterranean grasslands and garrigues; much overlooked in Italy, being known only from Liguria, to be looked for further in the south, but certainly not common.

- 5 Photobiont *Nostoc* (cells spherical, 3-6 µm in diam., mostly in short chains) 6
- 6 Thallus crustose-granulose, apothecia mostly flat, semi-immersed, with a thin margin. Most spores with 1 transversal septum, 16-28 x 7-15 µm

5 - *Leptogium byssinum* (Hoffm.) Nyl.

Thallus crustose, brownish to bluish green, gelatinous when wet, thin, areolate-granulose, K-, C-, KC-, P-, UV-. Areolae up to 3 mm broad, densely granulose, contiguous, paraplectenchymatous throughout, often with one layer of cortical cells. Apothecia frequent, lecanorine, rounded, semi-immersed or adnate, 0.4-0.8 mm. Disc brown, first concave, then flat, margin thin. Epithecium very pale brownish. Hymenium and hypothecium colourless. Paraphyses conglutinate, mostly simple, the apices swollen. Asci narrowly clavate, the wall K/I+ blue, apical dome pale blue with a dark blue axial tube. Spores ellipsoid, submuriform, (6-)8 per ascus, 14-33 x 7-15 µm. Photobiont *Nostoc*, in short chains. Without lichen substances. Note: an inconspicuous, largely overlooked, ephemeral lichen of calciferous-clayey soil, certainly more widespread in Italy.



- 6 Thallus small-subsquamulose, apothecia concave, sessile, with a rather thick margin. Most spores with 2 transversal septa, 24-32 x 13-16 µm

6 - *Leptogium biatorinum* (Nyl.) Leight.

Thallus crustose to small-subsquamulose, brownish black, thin, granulose-areolate, K-, C-, KC-, P-, UV-. Areolae granulose, crenate, flattened, contiguous, sometimes almost subsquamulose to lobulate. Apothecia frequent, lecanorine, rounded, sessile, slightly constricted, 0.4-0.8 mm diam. Disc brown, concave, margin thick. Epithecium very pale brownish. Hymenium and hypothecium colourless. Paraphyses conglutinate, mostly simple, the apices swollen. Asci narrowly clavate, the wall K/I+ blue, apical dome pale blue with a dark blue axial tube. Spores ellipsoid, submuriform, 8 per ascus, 24-32 x 13-16 µm. Photobiont *Nostoc*. Without lichen substances. Note: a temperate ephemeral lichen of disturbed habitats, most frequent on concrete walls, but also found on calciferous soil; certainly more widespread, esp. in urban areas below the montane belt, but overlooked, or confused with other species



- 7 Thallus dark, from black to very dark brown 8
- 7 Thallus not dark 15
- 8 With perithecia. With *Trentepohlia* (photobiont layer orange-green in section)

7 - *Porina mammillosa* (Th.Fr.) Vain.

Thallus crustose, green-grey to dark grey, often tinged brown-purple, rather thick, more or less continuous, K-, C-, KC-, P-, UV-. Perithecia frequent, up to 0.5 mm diam., black, globose, half immersed, with an apical, thick involucrellum, partly covered at the base by a thalline layer. Perithecial wall (in section) black outside, purple-red to orange in the inner part, somehow paler below. Paraphyses simple, not apically thickened, free; periphyses absent. Asci cylindrical, thin-walled, not or only slightly thickened at tip, without tholus, I-. Spores 4-celled, hyaline, fusiform, 8 per ascus, 25-40 x 4-6 µm. Photobiont trentepohlioid. Without lichen



substances. Note: an arctic-alpine, probably circumpolar species, found on bryophytes and plant debris on siliceous substrata. Known only from Piemonte, certainly much more widespread throughout the Alps.

- 8 With apothecia. With chlorococcoid algae (photobiont layer bright green in section) 9
- 9 With soredia

8 - *Trapeliopsis gelatinosa* (Flörke) Coppins & P.James



Thallus crustose, dark green-brown to dark green-grey, with or without pale green, farinose soredia, thin, continuous to granulose, K-, C-, KC-, P-, UV-. Soralia initially rounded, then confluent, much paler than thallus, K-, C-, KC-, P-. Apothecia frequent, rounded, without a thalline margin, sessile, slightly constricted, 0.3-1.5 mm diam. Disc dark green-grey to grey-black, flat, margin thin. Epithecium green, K+ brownish. Paraphyses slender, anastomosing, ramified, not apically thickened, conglutinate. Asci clavate-cylindrical, thin-walled, I+ pale blue, with a small I+ blue cap inside the thickened apex. Spores 1-celled, hyaline, ellipsoid, thick-walled, 8 per ascus, 8-14 x 4.5-6 µm. Pycnidia dark, immersed. Conidia cylindrical. Photobiont chlorococcoid. Without lichen substances. Note: a boreal-montane to cool-temperate early coloniser of mineral soil, sometimes overgrowing bryophytes and plant debris. Widespread throughout the Alps, most common near or above treeline.

- 9 Without soredia 10
- 10 Thallus KC+ red, with gyrophoric acid

9 - *Placynthiella icmalea* (Ach.) Coppins & P.James



Thallus crustose-granulose, pale to dark brown, more or less shining, K-, C+ red, KC+ red, P- (reactions best seen in squash preparations). Granules simple to (mostly) minutely coralloid, 25-150(-200) µm diam., not becoming yellowish green when wet, the thallus resembling a brown, subsidiate crust. Apothecia rare, without a thalline margin, up to 0.6 mm diam (usually less). Disc blackish brown to black, pinkish brown in shade-forms, flat to slightly convex. Margin thin, persistent, generally paler than disc. Epithecium K-, C+ red, KC+ red. Paraphyses ramified, swollen at apices. Asci cylindrical-clavate, thin-walled, the apical dome mostly I-, rarely weakly I+ blue. Spores 1-celled, hyaline, ellipsoid, 8 per ascus, 8-12 x 4-5 µm. Pycnidia unknown. Photobiont chlorococcoid. With gyrophoric acid and variable amounts of 5-O-methylhiascinic acid. Note: a widespread, mainly northern holarctic lichen found on disturbed soil, turf, decomposed lignum (common on stumps), much more rarely on acid bark, and then mostly on basal parts of trunks; most frequent in the Alps, but extending south to Calabria through the Apennines, in *Castanea*-stands.

- 10 Thallus KC-, without gyrophoric acid 11
- 11 Spores many-celled, muriform

10 - *Lopadium pezizoideum* (Ach.) Körb.



Thallus crustose, dark brown to dark green-brown, granulose, K-, C-, KC-, P-, UV-. Apothecia frequent, rounded, without a thalline margin, strongly constricted to almost substipitate, 0.7-1.2 mm diam. Disc black, strongly concave to finally flat. Margin thick, prominent, black, but brownish in outer part, somehow shiny, pseudoparenchymatous in section. Epithecium K-, C-. Hymenium colourless, I+ blue. Hypothecium dark brown to black. Paraphyses simple to ramified, relatively thick (ca. 2.5 µm) with dark, swollen, conical caps. Asci subcylindrical, thick-walled, the wall I+ blue, with a narrow, cap-like I+ blue tholus and a broad ocular chamber. Spores ellipsoid, hyaline to very pale brown at maturity, strongly muriform, 1 per ascus, 70-115 x 23-45 µm. Photobiont chlorococcoid. Without lichen substances, or with traces of atranorin. Note: a circumboreal-montane lichen found on bryophytes and plant debris over siliceous rocks; probably restricted to the Alps, near or above treeline.

11 Spores 1-celled

12

12 Thallus thick, composed by lobulate areolae at least 0.5 mm broad

11 - *Lecidoma demissum* (Rutstr.) Gotth.Schneid. & Hertel



Thallus crustose to subsquamulose, dark brown to grey-brown in shade, thick, K-, C-, KC-, P-, UV-. Areolae 1-2(-4) mm broad, flat to convex, contiguous, forming a compact crust to 8 cm in diam. Lower surface brown-black. Medulla I-. Apothecia frequent, without a thalline margin, sessile to adnate, 0.5-1.5 mm diam., often coalescing. Disc dull brown-black, paler when wet, flat to weakly convex. Margin thin, indistinct in old apothecia. Epithecium reddish brown. Hymenium colourless, to 70 µm tall, I+ blue. Hypothecium colourless. Paraphyses simple, distinctly thickened above, with dark cap, conglutinate. Asci thin-walled, clavate, with a I+ pale blue apical dome and a darker blue tubular structure. Spores 1-celled, hyaline, ellipsoid, thin-walled, 8 per ascus, (11-)12-16(-17) x 5.5-7 µm. Photobiont chlorococcoid. Without lichen substances. Note: a circumpolar, arctic-alpine lichen, found on clay soil, rarely on siliceous rocks, in clearings of Alpine grasslands with a long snow-lie. Widespread and rather common throughout the Alps, mostly above treeline.

12 Thallus thin, smooth to minutely granulose, the granules <0.3 mm in diam.

13

13 Thallus smooth. Spores subglobose, >16 µm long

12 - *Japewia tornoënsis* (Nyl.) Tønsberg

Thallus crustose, brown, thin, continuous, smooth, K-, C-, KC-, P-, UV-. Apothecia rounded, without a thalline margin, sessile, up to 0.8 mm diam. (usually less). Disc dark reddish brown, strongly convex. Margin mostly indistinct. Epithecium brownish, K-, C-, P-, N-, KC-. Hymenium 50-80 µm tall, colourless. Hypothecium colourless. Paraphyses anastomosing, ramified, distinctly thickened above, to



3.5 μm thick. Asci broadly clavate, the apex thicker, with an apical beak. Spores 1-celled, hyaline, subglobose, very thick-walled (2-5-3 μm thick), 8 per ascus, 16-22(-24) x (8-)10-15 μm . Photobiont chlorococcoid. Without lichen substances. Note: a circumboreal-montane species, found on twigs of shrubs, on terricolous mosses and plant debris; largely overlooked or misunderstood in the past; certainly widespread, and locally not rare, throughout the Alps, esp. near or above treeline.

- 13 Thallus granulose. Spores ellipsoid, <16 μm long. Epithecium brown (if epithecium green see 8: *Trapeliopsis gelatinosa*) 14

- 14 Granules wart-like (100-300 μm), becoming yellowish green when wet

13 - *Placynthiella oligotropa* (J.R.Laundon) Coppins & P.James



Thallus crustose, dark reddish-yellowish brown, granulose-verrucose, K-, C-, KC-, P-. Granules very coarse, wart-like (100-300 μm), becoming yellowish green when wet. Apothecia frequent, without a thalline margin, up to 0.6 mm diam. Disc brownish black, first flat and marginate, then often convex, with an indistinct margin. Epithecium hypothecium and excipulum reddish brown, K-, C-, KC-. Paraphyses ramified, with swollen tips. Asci cylindrical-clavate, thin-walled, the apical dome I- or weakly I+ blue. Spores 1-celled, hyaline, ellipsoid, 8 per ascus, 10-14 x 4.5-6 μm . Photobiont chlorococcoid. Without lichen substances. Note: a cool-temperate to boreal-montane, probably circumpolar lichen, found on soil and turf, mostly in clearings of woodlands; ranging throughout the Alps.

- 14 Granules small, less than 100 μm , not becoming yellowish green when wet

14 - *Placynthiella uliginosa* (Schrad.) Coppins & P.James



Thallus crustose, dark green to dark brown, granulose, K-, C-, KC-, P-, UV-. Granules not very coarse (20-100 μm), not becoming yellowish green, but often slightly subgelatinous when wet, often minutely rugose when dry. Apothecia frequent, without a thalline margin, up to 0.4 mm diam. (usually less), often coalescing. Disc pale pinkish brown to (rarely) black-brown, flat at first, rapidly becoming convex. Margin indistinct in old apothecia. Epithecium reddish brown, K-, C-, KC-. Paraphyses ramified, slightly thickened above. Asci cylindrical-clavate, thin-walled, the apical dome I- or weakly I+ blue. Spores 1-celled, hyaline, ellipsoid, 8 per ascus, 9-14(-16.5) x (4-)5-6(-7) μm . Photobiont chlorococcoid. Without lichen substances. Note: a cool-temperate to boreal-montane, probably circumpolar lichen of acid soil or strongly decomposed lignum; most frequent in the Alps, much rarer in the Apennines and in the mountains of Sicilia and Sardegna, where it is mostly found on lignum, in old *Castanea* stands.

- 15 Thallus bright (greenish-) yellow to orange 16
 15 Thallus not bright yellow to orange 44

- 16 With soredia 17
 16 Without soredia 19
 17 Thallus K-, without anthraquinones. Apothecia black

15 - *Arthrorhaphis citrinella* (Ach.) Poelt



Thallus crustose, areolate, bright yellow-green, thin, K-, C-, KC-, P-, UV+orange. Areolae 0.5-1(-2) mm broad, rounded, flat to mostly convex, contiguous, fragile. Soredia diffuse, granular. Apothecia rare, rounded, without a thalline margin, sessile, to 1.5 mm diam., usually less. Disc black, flat to finally convex, smooth. Margin thin, smooth, black. Epithecium dark grey-green, K-. Hymenium colourless, interspersed with oil droplets, I-. Paraphyses slender, anastomosing, ramified, not apically thickened, free. Margin (section) dark grey green. Asci bitunicate, clavate, I-, scarcely thickened at apex, with an ocular chamber. Spores 8-16-celled, hyaline, acicular, thin-walled, 8 per ascus, (40-)50-95(-110) x 2.5-3.5(-4) μ m. Pycnidia unknown. Photobiont chlorococcoid. With rhizocarpic acid, epanorin, and traces of atranorin. Note: an arctic-alpine, circumpolar species, found on mosses and soil rich in humus in sheltered situations; older thalli are lichenised, younger ones are lichenicolous. Restricted to above or near treeline in the Alps.

- 17 Thallus K+ red, with anthraquinones. Apothecia orange 18
 18 Coastal-mediterranean

16 - *Caloplaca limonia* Nimis & Poelt



Thallus crustose, yellow to yellowish green, areolate, granulose, K+ red, C-, KC-, P-. Areolae flattened, contiguous, densely covered by diffuse, 40-80 μ m diam., granular soredia (blastidia). Upper cortex paraplectenchymatous, evident only in young squamules. Apothecia rather rare, lecanorine, sessile. Disc yellow, K+ red. Margin thick, sorediate, yellow, K+ red. Epithecium yellowish, K+ red. Hypothecium colourless. Asci clavate, bitunicate, thickened at apex with a broad internal beak, I+ blue in the outer part of the apex. Spores 2-celled, hyaline, ellipsoid, polar-diblastic, 8 per ascus, 8-16 x 4-8 μ m. Photobiont chlorococcoid. With anthraquinones (thallus and apothecia). Note: a rare mediterranean lichen, found on calciferous rocks, soil, bryophytes, in open, more or less coastal habitats, often in sites visited by birds.

- 18 Subalpine to alpine

17 - *Caloplaca bryochryson* Poelt



Thallus crustose, initially subsquamulose, but often transformed into a more or less uniform sorediate crust, pale orange yellow, continuous, K+ red, C-, KC-, P-. Soredia diffuse, pale orange yellow, K+ red. Apothecia extremely rare, sessile to almost substipitate. Disc K+ red. Margin thick, sorediate, K+ red. Epithecium K+ red. Asci clavate, bitunicate, thickened at apex with a broad internal beak, I+ blue in the outer part of the apex. Spores 2-celled, hyaline, polar-diblastic, 8 per ascus. Photobiont

chlorococcoid. With anthraquinones (thallus and apothecia). Note: on mosses, soil and plant debris over calcareous substrata in sheltered, but well-lit situations above treeline in the Alps.

- | | | |
|----|--|----|
| 19 | Thallus with radiating marginal lobes | 20 |
| 19 | Thallus without radiating marginal lobes | 24 |
| 20 | Spores 2-celled | 21 |
| 20 | Spores 1-celled | 22 |
| 21 | Spores ellipsoid, 12-20 x 4-6 μm . Thallus non-pruinose | |

18 - *Caloplaca aurea* (Schaer.) Zahlbr.



Thallus crustose, areolate, ochraceous yellow to orange-yellow, non pruinose, thick, to more than 4 cm broad, anchored to thin layers of soil in rock fissures by bundles of rhizine-like hyphae, K+ red, C-, KC-, P-. Areolae 1-2(-3) mm broad, flattened to convex, smooth, contiguous, the marginal ones often elongate, to 2-3 mm long. Apothecia frequent, lecanorine, sessile, slightly constricted, 0.5-1.5(-2) mm diam. Disc orange-brown, flat to convex, rugose, K+ red, C-, P-. Margin thick, soon dividing into a thinner proper margin, and a thicker thalline margin. Epithecium orange, K+ red. Hymenium colourless, 80-100 μm thick. Hypothecium colourless. Paraphyses not anastomosing, simple. Asci clavate, bitunicate, thickened at apex with a broad internal beak, I+ blue in the outer part of the apex. Spores 2-celled with an open, short (<2 μm) septum, hyaline, narrowly ellipsoid to fusiform, 8 per ascus, 12-20 x 4-7 μm . Pycnidia orange-yellow, immersed. Conidia ellipsoidal, 1-celled. Photobiont chlorococcoid. With anthraquinones (thallus and apothecia). Note: a species of the southern mountains of Europe, found in fissures and cracks of calcareous rocks and dolomite, perhaps more widespread in the Alps.

- | | | |
|----|---|--|
| 21 | Spores fusiform, 18-27 x 5-8 μm . Thallus pruinose | |
|----|---|--|

19 - *Fulgensia pruinosa* (Körb.) Poelt



Thallus crustose, whitish yellow to orange-yellow, pruinose in the central part, 1-2 cm broad, K+ red, C-, KC-, P-, UV+ pale orange. Areolae 1-2(-3) mm broad, flattened, contiguous, the marginal ones often elongate, anchored to thin layers of soil in rock fissures by bundles of rhizinoids. Apothecia frequent, numerous, lecanorine, rounded, sessile, 0.5-1(-2) mm diam. Disc reddish orange to brownish orange, flat, rugose, K+ red. Margin thin, orange-yellow, K+ red. Epithecium K+ red. Hymenium colourless, 70-80 μm thick. Asci clavate, bitunicate, thickened at apex with a broad internal beak, I+ blue in the outer part of the apex. Spores 2-celled, hyaline, fusiform, thin-walled, 8 per ascus, 18-27(-30) x 5-8 μm . often slightly constricted in the centre. Pycnidia orange-yellow, immersed. Conidia bacilliform. Photobiont chlorococcoid. With anthraquinones (thallus and apothecia). Note: on steeply inclined to underhanging faces of calcareous rocks, mostly in fissures, sometimes on epilithic bryophytes. Known from the Alps, where it is certainly more widespread, the highest mountains of the C Apennines.

- 22 With schizidia (central parts of thallus covered by numerous flattened to convex, scale-like areoles), often without apothecia

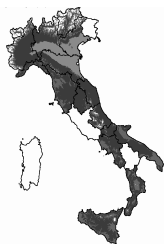
20 - *Fulgensia subbracteata* (Nyl.) Poelt



Thallus crustose, pale yellow to orange-yellow, sometimes yellowish-white-pruinose, orbicular, with radiating marginal lobes, the centre verrucose-areolate, to 3-4 cm diam., K+ red, C-, KC-, P-, UV+ pale orange. Lobes 0.5-1 mm broad and to 3 mm long, flattened, contiguous, radiating from the central part of thallus, which is densely covered by flattened, often elongate and lobe-like schizidia. Apothecia rare, lecanorine, sessile, 0.5-1.2 mm diam. Disc orange to brownish-orange, flat, smooth, K+ red. Margin thin, orange-yellow, K+ red, at maturity separating into a darker and thinner proper margin and a paler thalline margin. Epithecium K+ red. Hymenium colourless, 60-70 µm thick. Asci clavate, bitunicate, thickened at apex with a broad internal beak, I+ blue in the outer part of the apex. Spores 1-celled, hyaline, ovoid to slightly pyriform, thin-walled, 8 per ascus, 9-12 x 3.5-5 µm. Pycnidia orange-yellow, immersed. Conidia bacilliform. Photobiont chlorococcoid. With anthraquinones (thallus and apothecia). Note: common on calciferous ground, in clearings of grasslands and shrublands; a critical taxon needing revision, characterised by the abundant schizidia, which, however, are also present in other, related species, rather common below the montane belt, throughout the country.

- 22 Without schizidia, most often with apothecia 23
- 23 Thallus monophyllous (lobes almost fused together, esp. at the centre). Spores from ovoid to slightly pyriform, 7-16 x 3.5-5 µm

21 - *Fulgensia fulgens* (Sw.) Elenkin

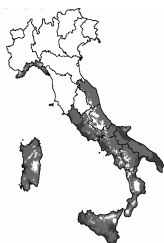


Thallus crustose, pale yellow to orange-yellow, sometimes yellowish-white-pruinose, orbicular, with radiating marginal lobes, the centre verrucose-areolate, to 3-4 cm diam., K+ red, C-, KC-, P-, UV+ pale orange. Lobes 1-2(-3) mm broad, flattened, contiguous, radiating from a verrucose centre, separate at margin, but fused together towards the centre. Apothecia frequent, lecanorine, rounded, sessile, 0.5-2(-5) mm diam. Disc orange to brownish orange, concave to flat, smooth, K+ red. Margin thin, orange-yellow, K+ red. Epithecium K+ red. Asci clavate, bitunicate, thickened at apex with a broad internal beak, I+ blue in the outer part of the apex. Spores 1-celled, rarely 2-celled, hyaline, thin-walled, of different forms within the same apothecium, from ovoid to slightly pyriform, 8 per ascus, 7-16 x 3.5-5 µm. Pycnidia orange-yellow, immersed. Conidia bacilliform. Photobiont chlorococcoid. With anthraquinones (thallus and apothecia). Note: a mild-temperate to xeric subtropical lichen, found on calcareous rocks, often in rock fissures, and on soil in open situations (grasslands, more rarely open woodlands). Certainly ranging throughout the country, below treeline, with optimum in the submediterranean belt. The distinction with *F. subbracteata* is not always easy.

- 23 Thallus non monophyllous (lobes contiguous, but separated).

Spores digitiform, with one end much larger than the other, 12-20 x 5-6 μm

22 - *Fulgensia fulgida* (Nyl.) Szatala



Thallus crustose, pale yellow to orange-yellow, sometimes yellowish-white-pruinose, orbicular, with radiating marginal lobes, the centre verrucose-areolate, to 3-4 cm diam., K+ red, C-, KC-, P-, UV+ pale orange. Lobes 1-2 mm broad, flattened, contiguous, well-separated also in the internal parts of the thallus. Apothecia frequent, lecanorine, rounded, sessile, 0.5-2 mm diam. Disc orange to brownish-orange, convex to flat, smooth, K+ red. Margin thin, orange-yellow, K+ red. Epithecium K+ red. Asci clavate, bitunicate, thickened at apex with a broad internal beak, I+ blue in the outer part of the apex. Spores 1-celled, rarely 2-celled, hyaline, clavate (one end of thicker than the other), thin-walled, 8 per ascus, 12-20 x 5-6 μm . Pycnidia orange-yellow. Conidia bacilliform. Photobiont chlorococcoid. With anthraquinones (thallus and apothecia). Note: a mainly mediterranean lichen, found on soil, sometimes on rock, esp. in fissures, in dry grasslands; to be looked for in dry-warm areas of the north, and in Toscana.

- 24 Thallus composed by very small (<0.4 mm diam.), rounded, scattered, bright yellow-green granules. Apothecia perithecioid to urceolate, small (<0.5 mm diam.), immersed in the granules 25
- 24 Thallus and apothecia different 30
- 25 Spores 12-16 per ascus. Restricted to the mediterranean belt

23 - *Thelocarpon macchiaie* Nimis, Poelt & Puntillo



Thallus crustose, bright yellow-pruinose, mostly reduced to a small wart containing an apothecium, K-, C-, KC-, P-. Apothecia frequent, perithecioid, rounded, up to 0.2 mm diam. Disc concave. Paraphyses simple, not apically thickened. Asci cylindrical, thin-walled. Spores 1-celled, hyaline, ellipsoid-cylindrical, thin-walled, 12-16 per ascus, 9.5-12(-16) x 5-6.5 μm . Pycnidia, rare, immersed in the warts, with a colourless wall. Conidia oblong-obtuse, simple. Photobiont chlorococcoid, present only at the base of the thalline warts. With pulvinic acid derivatives. Note: a recently-described species, easy to overlook; recently described from the island of Marettimo (Sicilia); perhaps more widespread in humid Mediterranean Italy, on more or less mineral soil in openings of garrigue vegetation.

- 25 Spores more than 50 per ascus. Occurring also outside the mediterranean belt 26
- 26 Disc of the apothecia not exposed (apothecia perithecioid, the warts opening through a narrow pore) 27
- 26 Disc of the apothecia at least partly exposed 28
- 27 Spores oblong-obtuse, 3-4(-5) x 1-1.5 μm . Paraphyses absent, substituted by periphyses.

24 - *Thelocarpon intermediellum* Nyl.

Thallus crustose, bright yellow-pruinose, mostly reduced to small (0.15-0.3 mm in diam.), scattered warts containing an apothecium, K-, C-, KC-, P-. Apothecia frequent, perithecioid, rounded, without a thalline margin, semi-immersed in the warts, 0.15-0.25(-0.3) mm diam. Disc concave, not exposed (the warts opening through a small pore). Margin 30-45 µm thick above, 15-25 µm below, colourless in section. Paraphyses absent, substituted by richly branched, easily detached periphyses around the ostiole and on the sides. Asci flask-shaped, persistent, thin-walled, the wall I+ pale blue, the base I+ brownish red. Spores 1-celled, hyaline, oblong-obtuse, slightly constricted in the middle, thin-walled, many per ascus, 3-4(-5) x 1-1.5 µm. Pycnidia, rare, immersed in the warts, with a colourless wall. Conidia oblong-obtuse, simple. Photobiont chlorococcoid, rarely present only at the base of the thalline warts. With pulvinic acid derivatives. Note: a rarely-collected, but apparently widespread ephemeral species of siliceous rocks, and, occasionally, rotten wood and organic soil. Italian distribution very poorly known: perhaps more widespread in the Alps



- 27 Spores subglobose to broadly ellipsoid, 1.5-4(-6) x 1.5-2 µm. Paraphyses present.

25 - *Thelocarpon laureri* (Flot.) Nyl.

Thallus crustose, greenish-yellow, mostly reduced to small (0.15-0.4 mm in diam.) bright yellow-pruinose, scattered warts containing an apothecium, K-, C-, KC-, P-. Apothecia frequent, perithecioid, immersed in the warts, 0.15-0.3(-0.4) mm diam. Disc concave, not exposed, the ostiole sometimes darker. Algal sheath present inside the warts, reaching the apex. Paraphyses present, ramified, not apically thickened, as long as the asci. Periphyses present. Asci flask-shaped, thin-walled, persistent, the wall I+ pale blue, I+ yellow-red at the base. Spores 1-celled, hyaline, subglobose to broadly ellipsoid, thin-walled, many (50-100) per ascus, 2-4(-6) x 1.2-2 µm. Pycnidia, rare, immersed in the warts, with a colourless wall. Conidia oblong-obtuse, simple. Photobiont chlorococcoid, present only at the base of the thalline warts, which are surrounded by an algal sheath. With pulvinic acid derivatives. Note: an ephemeral early coloniser of different substrata, incl. roofing tiles, rotten wood, soil. Italian distribution very poorly known: perhaps more widespread in the mountains, throughout the country.



- 28 Periphyses absent. Paraphyses branched (carefully observe many paraphyses under the microscope!). Asci I+ pale blue, on *Baeomyces*

26 - *Thelocarpon lichenicola* (Fuckel) Poelt & Hafellner

Thallus crustose, bright yellow-pruinose, mostly reduced to small, globose to lens-shaped warts containing an apothecium, K-, C-, KC-, P-. Apothecia frequent, perithecioid, rounded, without a thalline margin, semi-immersed, up to 0.35 mm diam. Disc concave, partly exposed at maturity, margin raised. Hymenial jelly I-. Periphyses absent, paraphyses slender, poorly branched, not apically thickened,



ca. 1 μm thick. Asci cylindrical-clavate, thin-walled, I+ pale blue. Spores 1-celled, hyaline, broadly ellipsoid, thin-walled, many (50-100) per ascus, 4-6(-7) x 1.5-2 μm . Pycnidia, rare, immersed in the warts, with a colourless wall. Conidia oblong-obtuse, simple. Probably not-lichenised. With pulvinic acid derivatives. Note: on clay soil in disturbed sites, often in *Calluna*-heaths, mostly on *Baeomyces rufus*. Italian distribution very poorly known: to be searched for further in the Alps.

28 Periphyses present. Paraphyses not branched. On bare soil, or, if on *Baeomyces*, asci I- 29

29 Asci I+ blue. Spores 4-5 x 1-2 μm

27 - *Thelocarpon citrum* (Wallr.) Rossman



Thallus crustose, bright yellow-pruinose, mostly reduced to scattered, globose to conical warts containing an apothecium, K-, C-, KC-, P-. Apothecia frequent, perithecioid, rounded, without a thalline margin, but immersed in the warts, 0.1-0.15 mm diam. Disc concave, partly exposed. Margin 20-25 μm thick above, 15-18 μm thick below, colourless in section. Paraphyses slender, simple, not apically thickened, as long as the asci. Asci globose to flask-shaped, persistent, I+ dark blue. Hymenial jelly I-. Spores 1-celled, hyaline, oblong-obtuse, thin-walled, many per ascus, 4-5 x 1-2 μm . Pycnidia, rare, immersed in the warts, with a colourless wall. Conidia oblong-obtuse, simple. Photobiont chlorococcoid, present only at the base of the thalline warts. With pulvinic acid derivatives. Note: an ephemeral species of disturbed habitats. Italian distribution very poorly known.

29 Asci I-. Spores 4-7(-12) x 1.7-2.5(-3) μm

28 - *Thelocarpon epibolum* Nyl.



Thallus crustose, bright yellow-pruinose, mostly reduced to small (0.1-0.16 mm in diam.) scattered, conical to globose warts containing an apothecium, K-, C-, KC-, P-. Apothecia frequent, perithecioid, rounded, without a thalline margin, but immersed in the warts, up to 0.12 mm diam. Disc concave, partly exposed. Margin 15-30 μm thick, colourless in section. Paraphyses simple, slender, not apically thickened, as long as asci. Asci globose to flask-shaped, persistent, I-. Hymenial gelatine I+ reddish, K/I+ blue. Spores 1-celled, hyaline, oblong-obtuse, thin-walled, many per ascus, 4-7 x 1.7-2.5 μm . Pycnidia, rare, immersed in the warts, with a colourless wall. Conidia oblong-obtuse, simple. Photobiont often absent, or chlorococcoid, present only at the base of the thalline warts. With pulvinic acid derivatives. Note: an ephemeral species, found on foliose lichens, rotting wood, decaying bryophytes, peat. Italian distribution very poorly known: overlooked, certainly more widespread in the Alps.

30 Apothecia non lecanorine, without a thalline margin 31

30 Apothecia lecanorine, with a thalline margin containing algal cells 33

31 Thallus P+ orange-yellow, parasitic on *Baeomyces*

29 - *Epilichen scabrosus* (Ach.) Clem.



Thallus crustose to almost subsquamulose, yellow to yellow-green, thin, areolate, K-, C-, KC-, P+ orange-yellow, UV+ orange. Areolae flattened to convex, contiguous. Apothecia frequent, without a thalline margin, sessile, usually crowded and sometimes confluent, 0.2-0.8 mm diam. Disc black, first flat, later convex, and then margin indistinct. Epithecium olive-brown to brown, K-. Hymenium 70-100 μm tall. Hypothecium dark brown. Paraphyses (paraphysoids) densely ramified, not apically thickened, anastomosing. Asci elongate-clavate, with a I+ weakly blue tholus, the outer gelatinous coat I+ blue. Spores 2-celled, pigmented, broadly ellipsoid, not ornamented, slightly constricted at septum, 8 per ascus, (9-)10-17(-18) x 6-10 μm . Photobiont chlorococcoid. With pulvinic acid derivatives. Note: restricted to cold-humid situations in upland areas; at first a parasite of *Baeomyces* species, becoming autotrophic when old. Hitherto known only from the Alps in Italy.

31 Thallus P-, parasitic or not

32

32 Most spores longer than 23 μm , 8-12-celled, (20-)25-45(-60) x 3-4.5 μm

30 - *Arthrorhaphis alpina* (Schaer.) R.Sant.



Thallus crustose, areolate, bright yellow-green, matt, thick, K-, C-, KC-, P-, UV+ orange. Areolae 0.5-1(-2) mm broad, convex to almost bullate, scattered to mostly contiguous, forming a compact crust to 2 cm in diam., with a farinose epinecral upper layer and a rough surface. Apothecia rather rare, without a thalline margin, located among the squamules and sometimes arranged in rows, rounded, sessile, to 1.7 mm diam. Disc black, first concave then flat, smooth. Margin thin, smooth, black, dark grey-green in section. Epithecium and hypothecium dark grey green, K-. Hymenium colourless, interspersed with oil droplets, I-. Paraphyses slender, anastomosing, ramified, not apically thickened, free. Asci bitunicate, clavate, I-, scarcely thickened at apex, with an ocular chamber. Spores 8-16-celled, hyaline, acicular, thin-walled, 8 per ascus, (20-)25-45(-60) x 3-4.5(-5) μm . Pycnidia unknown. Photobiont chlorococcoid. With rhizocarpic acid, epanorin and sometimes traces of atranorin. Note: an arctic-alpine, circumpolar species, found on weakly calciferous soil rich in humus; first parasymbiotic on *Baeomyces*, later an autonomous lichen. Restricted to the Alps in Italy, near or above treeline.

32 Most spores shorter than 23 μm , 4-5-celled, 16-23 x 3 μm

31 - *Arthrorhaphis vacillans* Th.Fr.

Thallus crustose, areolate, first greenish yellow, then bright yellow-green, thick, K-, C-, KC-, P-, UV+ orange. Areolae 1-2 mm broad, flat to weakly convex, contiguous. Apothecia without a thalline margin, sessile, to 1.5 mm diam. Disc black, concave when young, then soon flat, smooth. Margin thin, smooth, black. Epithecium and



hypothecium dark grey green, K-, N+ emerald green. Hymenium interspersed with oil droplets, I-. Paraphyses slender, anastomosing, ramified, not apically thickened, free, ca. 1.5 μm thick. Excipulum brown-black in outer part, blue-green inside. Asci bitunicate, clavate, I-, scarcely thickened at apex, with an ocular chamber. Spores 4-5-celled, hyaline, acicular, thin-walled, 8 per ascus, (14-)16-22(-25) x 3-3.5(-4) μm . Pycnidia unknown. Photobiont chlorococcoid. With rhizocarpic acid, epanorin, and traces of atranorin. Note: an arctic-alpine, circumpolar species found in humid soil in subalpine-alpine situations; it starts the life-cycle as a parasite of *Baeomyces placophyllus*, later becoming autotrophic. Italian distribution very poorly known: probably restricted to the Alps, near or above treeline.

- 33 Thallus K-, or K+ orange 34
 33 Thallus K+ deep red 37
 34 Apothecial disc brown. Spores 100-200 per ascus, subglobose, <4 μm long

32 - *Acarospora schleicheri* (Ach.) A.Massal.



Thallus crustose, greenish yellow to greenish white, thick, areolate, K-, C-, KC-, P-, UV+ orange. Areolae 1-2(-3) mm broad, angular, flattened, contiguous, forming a compact crust, the marginal ones sometimes weakly elongate. Medulla white, K-, C-, KC-, P-. Apothecia frequent, rounded to irregular in shape, lecanorine, semi-immersed, 0.5-1 mm diam. Disc brown, smooth to rugose, flat to convex. Margin thin, greenish yellow to greenish white. Hymenium I+ blue, >100 μm tall. Hypothecium colourless. Paraphyses numerous, simple to sparsely ramified above. Asci clavate, with a clear apical dome, I-. Spores 1-celled, hyaline, subglobose, 100-200 per ascus, 3-4 x 2-3 μm . Parasitic on *Diploschistes muscorum*. Photobiont chlorococcoid. With rhizocarpic acid (cortex). Note: a xeric subtropical species, found on subneutral clay soil, decalcified ground over calcareous substrata, and weathered gypsum in open dry grasslands; common only in dry-continental areas; known from Sicily, to be looked for in dry-warm Alpine valleys.

- 34 Apothecial disc yellow to orange. Spores 8 to 16 per ascus, not subglobose, >9 μm long 35
 35 On calciferous substrata. Spores 8 per ascus, >15 μm long

33 - *Candelariella unilocularis* (Elenkin) Nimis



Thallus crustose, yellow to yellow-orange, thin to indistinct, K-, C+ weakly orange, KC-, P-. Apothecia lecanorine, sessile, up to 2.5 mm diam. Disc yellow, mostly flat, margin thin, concolorous with disc. Epithecium yellow, granular, K-. Hymenium I+ blue. Hypothecium colourless. Margin (section) yellow. Paraphyses simple or poorly branched, the tips not or only slightly swollen. Asci clavate, with an apical dome which is I+ blue only in the internal, lower part, interrupted in the centre by a paler blue strip. Spores 1(-2)-celled, hyaline, oblong-obtuse, 8 per ascus, 16-26 x 7-8 μm . Photobiont chlorococcoid. With calycin and pulvinic acid derivatives. Note:

probably a species of the mountains of the southern holarctic zone, found on epilithic or more rarely terricolous mosses on limestone and dolomite; a characteristic element of calcareous mountains, well-distinct from *C. aurella*. Probably ranging throughout the Alps, also known from the highest mountains of the central Apennines.

- 35 On siliceous substrata. Spores 12-32 per ascus, <15 µm long 36
 36 Mostly on wood, very rarely on soil. Thallus of closely packed, granular elements. Apothecia rare

34 - *Candelariella kuusamoënsis* Räsänen



Thallus crustose, orange-yellow, thick, formed by closely packed, granular elements (up to 0.3 mm diam.), continuous to cracked-areolate, K-, C+ orange, KC-, P-. Apothecia rare, lecanorine, sessile, up to 1.5 mm diam. Disc orange-yellow, flat. Margin thin, concolorous with disc, K-. Epitecium yellow, K-. Hymenium I+ blue. Hypothecium colourless. Margin (section) yellow. Asci clavate, with an apical dome which is I+ blue only in the internal lower part, interrupted in the centre by a paler blue strip. Spores 1(-2)-celled, hyaline, oblong-obtuse, 12-16 per ascus, 9-14 x 4.5-5.5 µm. Photobiont chlorococcoid. With calycin and pulvinic acid derivatives. Note: a boreal-montane, poorly understood lichen, found on the top of poles and wooden fences, on plant debris and soil, more rarely on rocks; certainly widespread, but not common, in the Alps.

- 36 Mostly on siliceous rocks, but sometimes found on mosses and mineral soil over siliceous substrata. Thallus from granulose to small-lobulate, with flat lobules, not forming convex pillows of densely packed coralloid elements. Apothecia frequent

35 - *Candelariella vitellina* (Hoffm.) Müll.Arg.



Thallus crustose, from granulose to small-lobulate, with flat to weakly convex lobules (0.3-2 mm broad), orange-yellow, K- or K+ weakly orange-reddish, C- or C+ orange, KC-, P-. Apothecia frequent, lecanorine, sessile, up to 1.5(-2) mm diam., rounded to irregular-lobate in shape. Disc orange-yellow, sometimes darkening, flat, K-. Margin thin, smooth to crenulate, concolorous with disc, K-. Epitecium yellow, granular, K-. Hymenium I+ blue. Hypothecium colourless. Margin (section) yellow. Asci clavate, with an apical dome which is I+ blue only in the internal, lower part, interrupted in the centre by a paler blue strip. Spores 1(-2)-celled, hyaline, oblong-obtuse, (12-)16-32 per ascus, 9-15 x (3-)4-5(-6.5) µm. Pycnidia frequent, semi-immersed, the wall colourless. Conidia bacilliform, 2.5-3 x 1-1.5 µm. Photobiont chlorococcoid. With calycin and pulvinic acid derivatives. Note: a holarctic, variable, almost cosmopolitan lichen with a broad ecological range, found on a wide variety of siliceous rocks, on roofing tiles, brick, and sometimes on bryophytes, lignum and acid bark, from the mediterranean belt (where it is very rare) to above treeline in the Alps. The species, being extremely polymorphic and wide-ranging, is a good candidate for molecular studies.

- 37 Spores 1-celled 38
 37 Spores 2-celled 41
 38 With schizidia (flattened to convex, exfoliating, scale-like areolae) 39
 38 Without schizidia 40
 39 Restricted to upland areas. Areolae convex. Spores ellipsoid, not restricted in the centre, 9-13 x 4-7 μm

36 - *Fulgensia bracteata* (Hoffm.) Räsänen subsp. *deformis* (Erichsen) Poelt



Thallus crustose, orange-yellow to golden yellow, composed of more or less dispersed groups of small, convex, almost granulose areolae, without radiating marginal lobes, 1-2 cm broad, K+ red, C-, KC-, P-, UV+ pale orange. Areolae rounded, strongly convex, scattered to mostly contiguous, with round to lobulate schizidia, 0.2-0.4 mm broad. Apothecia very rare, lecanorine, sessile, 1-2 mm broad. Disc orange-brown, convex to flat, smooth, K+ red. Margin thin, orange-yellow, K+ red, at maturity separating into a darker and thinner proper margin and a paler thalline margin. Epithecium K+ red. Asci clavate, bitunicate, thickened at apex with a broad internal beak, I+ blue in the outer part of the apex. Spores 1-celled, hyaline, broadly ellipsoid, thin-walled, 8 per ascus, 9-13 x 4-7 μm . Pycnidia orange-yellow, immersed. Conidia bacilliform, 4-5 x 1-1.5 μm . Photobiont chlorococcoid. With anthraquinones (thallus and apothecia). Note: *Fulgensia bracteata* s.lat. is a critical taxon, well-worthy of molecular studies. This subspecies (?), found on base-rich soil in open situations, is restricted to the Alps in Italy, mostly above treeline.

- 39 Restricted to eu-mediterranean stands. Areolae flat. Spores cylindrical, restricted in the centre, 12-16 x 3-5 μm

37 - *Fulgensia poeltii* Llimona



Thallus crustose, orange-yellow, more or less orbicular, K+ red, C-, KC-, P-, UV+ pale orange. Areolae flattened, granulose, contiguous, forming a more or less compact crust, the marginal ones sometimes elongate, but never forming a placodioid thallus. Apothecia frequent, lecanorine, sessile. Disc orange, concave to mostly flat, smooth, K+ red. Margin thin, orange-yellow, K+ red. Epithecium K+ red. Asci clavate, bitunicate, thickened at apex with a broad internal beak, I+ blue in the outer part of the apex. Spores 1-celled, hyaline, cylindrical, restricted in the centre, thin-walled, 8 per ascus, 12-16 x 3-5 μm . Photobiont chlorococcoid. With anthraquinones (thallus and apothecia). Note: a mediterranean lichen found on calciferous soil in dry, open situations; easily confused with *F. subbracteata* when sterile; hitherto known only from a single station in Calabria, probably more widespread in S Italy, esp. in areas with a warm-dry climate, but certainly not common.

- 40 Areolae convex, thick, little dissected at margin, more or less

pruinose. Apothecial margin thick

38 - *Fulgensia bracteata* (Hoffm.) Räsänen subsp. *bracteata*

Thallus crustose, orange-yellow to golden yellow, composed of more or less dispersed groups of areolae, without radiating marginal lobes, 1-2 cm broad, K+ red, C-, KC-, P-, UV+ pale orange. Areolae thick, rounded, flat to mostly convex, scattered to (mostly) contiguous on a rather thick whitish hypothallus, not or only slightly dissected at margin, more or less pruinose, the marginal ones sometimes elongate, to 1-2 mm long. Apothecia frequent, lecanorine, sessile, 1-2 mm in diam. Disc orange-brown, weakly concave to flat, smooth to rugose, K+ red. Margin thick, orange-yellow, K+ red, at maturity separating into a darker and thinner proper margin and a paler thalline margin. Epithecium K+ red. Hymenium colourless, 60-70 μm thick. Asci clavate, bitunicate, thickened at apex with a broad internal beak, I+ blue in the outer part of the apex. Spores 1-celled, hyaline, ellipsoid, not restricted in the centre, thin-walled, 8 per ascus, 9-13 x 4-7 μm . Pycnidia orange-yellow, immersed. Conidia bacilliform. Photobiont chlorococcoid. With anthraquinones (thallus and apothecia). Note: *Fulgensia bracteata* s.lat. is a critical taxon, well-worthy of molecular studies. This subspecies (?) is found on base-rich soil in open situations, and is less restricted to upland areas than the var. *alpina*.



- 40 Areolae flat thin, dissected at margin, not or only faintly pruinose.
Apothecial margin thin

**39 - *Fulgensia bracteata* (Hoffm.) Räsänen var. *alpina*
(Th.Fr.) Räsänen**

Thallus crustose, orange-yellow to golden yellow, composed of more or less dispersed groups of areolae, without radiating marginal lobes, K+ red, C-, KC-, P-, UV+ pale orange. Areolae thin, dissected at margin, flattened, scattered to (mostly) contiguous, not or only faintly pruinose. Apothecia frequent, lecanorine, sessile, 1-2 mm in diam. Disc orange-brown, weakly concave to flat, smooth to rugose, K+ red. Margin thin, crenulate-undulate, orange-yellow, K+ red, at maturity separating into a darker and thinner proper margin and a paler thalline margin. Epithecium K+ red. Hymenium colourless, 60-70 μm thick. Asci clavate, bitunicate, thickened at apex with a broad internal beak, I+ blue in the outer part of the apex. Spores 1-celled, hyaline, ellipsoid, not restricted in the centre, thin-walled, 8 per ascus, 9-13 x 4-7 μm . Pycnidia orange-yellow, immersed. Conidia bacilliform. Photobiont chlorococcoid. With anthraquinones (thallus and apothecia). Note: *Fulgensia bracteata* s.lat. is a critical taxon, well-worthy of molecular studies. This taxon, found on base-rich soil in open situations, is restricted to above treeline in the Alps.



- 41 Spores pyriform, with one end much larger than the other
(extremely rare, known from a single locality in the Gennargentu
Massif, Sardegna)

40 - *Caloplaca canariensis* (Follmann & Poelt) Breuss

Thallus crustose, orange-yellow, areolate, smooth, K+ red, C-, KC-,



P-. Areolae angular, convex, contiguous. Apothecia frequent, lecanorine, sessile, up to 1.5 mm diam. Disc dark orange-yellow to brownish orange, flat, smooth, K+ red. Margin thin, orange-yellow. Epithecium K+ red. Paraphyses slightly thickened above. Asci clavate, bitunicate, thickened at apex with a broad internal beak, I+ blue in the outer part of the apex. Spores 2-celled, hyaline, pyriform, 8 per ascus, 12-17 x 5-7.5 μm . Pycnidia orange-yellow, immersed. Conidia cylindrical. Photobiont chlorococcoid. With anthraquinones (thallus and apothecia). Note: a xeric subtropical lichen found on base-rich clay soil in clearings of grasslands and shrublands; common in Macaronesia and also known from N Africa; in Italy only known from a single station in Central Sardegnia (Desulo, Gennargentu Massif).

- 41 Spores ellipsoid 42
 42 Spores not constricted at septum. Restricted to above treeline
see 18 - Caloplaca aurea (Schaer.) Zahlbr.
 42 Spores constricted at septum. From the lowlands to above treeline 43
 43 On mineral soil, mostly in lowland areas. Spores 11-17 x 5-8 μm

41 - Fulgensia desertorum (Tomin) Poelt

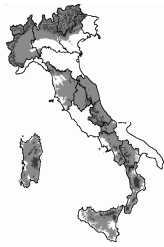


Thallus crustose, verrucose-areolate, sulphur- to orange-yellow, more or less pruinose, 1-2 cm broad, K+ red, C-, KC-, P-, UV+ pale orange. Areolae flat to mostly convex, contiguous, often sitting on a rather thick hypothallus, the marginal ones sometimes elongate, to 1-2 mm long, the central ones strongly convex, almost verrucose, 0.3-0.5-1 mm tall. Apothecia frequent, lecanorine, sessile. Disc orange to brownish orange, flat, rugose, K+ red. Margin thin, at maturity separating into a darker and thinner proper margin and a paler thallic margin. Epithecium K+ red. Asci clavate, bitunicate, thickened at apex with a broad internal beak, I+ blue in the outer part of the apex. Spores 2-celled, hyaline, ovoid-ellipsoid, often slightly constricted at septum, thin-walled, 8 per ascus, 11-17 x 5-8 μm . Pycnidia orange-yellow, immersed. Conidia bacilliform. Photobiont chlorococcoid. With anthraquinones (thallus and apothecia). Note: an often misunderstood species, hence Italian distribution very poorly known. Locally common only in areas with gypsum, in open grasslands, below the montane belt; to be looked for in dry-continental Alpine valleys.

- 43 On epilithic mosses, esp. *Schistidium*, mostly in upland areas.
 Spores 15-23 x 5-8 μm

42 - Fulgensia schistidii (Anzi) Poelt

Thallus crustose to subsquamulose, orange-yellow, not pruinose, 0.5-1(-1.5) cm broad, K+ red, C-, KC-, P-, UV+ pale orange. Areolae/lobules 0.5-1 mm broad and long, flattened, smooth, often slightly ascending, reduced to a few near the apothecia. Apothecia frequent, usually numerous, lecanorine, sessile, 1-1.5 mm diam. Disc orange to brownish orange, flat, somehow rugose, K+ red. Margin thin, orange-yellow, K+ red. Epithecium K+ red. Hymenium



colourless, 70-80 μm thick. Asci clavate, bitunicate, thickened at apex with a broad internal beak, I+ blue in the outer part of the apex. Spores 2-celled, hyaline, more or less bacilliform, with rounded ends, often slightly constricted at septum, thin-walled, 8 per ascus, 15-23 x 5-8 μm . Pycnidia orange-yellow, immersed. Photobiont chlorococcoid. With anthraquinones (thallus and apothecia). Note: on pulvinate epilithic mosses (esp. *Grimmia* spp. and *Schistidium apocarpum*) over calciferous substrata throughout the country, mostly above the submediterranean belt.

- 44 Photobiont trentepohlioid 45
- 44 Photobiont chlorococcoid 55
- 45 With perithecia 46
- 45 With apothecia 50
- 46 Spores 2-celled

43 - *Thelopsis isciaca* Stizenb.



Thallus crustose, grey to pinkish-grey, often whitish-pruinose, thin, more or less continuous to indistinctly areolate, K-, C-, KC-, P-, UV-. Perithecia frequent, immersed in thalline warts, subglobose and protruding, somehow flattened above, up to 1 mm diam., yellowish to pale pinkish grey, the wall pale-coloured in section, ca. 30 μm wide. Hymenium colourless, I+ blue-green, rapidly turning red-brown. Paraphyses not anastomosing, simple, slender, not apically thickened, free. Asci narrowly cylindrical, thin-walled throughout, without apical thickening or apparatus, the walls closely glued with the neighbouring paraphyses, I-. Spores 2-celled, hyaline, ellipsoid, halonate, >100 per ascus, 12-15(-20) x 5-8 μm . Pycnidia immersed. Conidia thread-like. Photobiont trentepohlioid. Without lichen substances. Note: a mediterranean-macaronesian species, also known from coastal Western N America, found on base-rich rocks, soil, mosses, tree bark; mostly Tyrrhenian, locally abundant in coastal situations (e.g. in some islands of the south and in the Tyrrhenian parts of Liguria).

- 46 Spores not 2-celled 47
- 47 Perithecia dark-coloured, mostly black 48
- 47 Perithecia not dark-coloured 49
- 48 Spores 8 per ascus, fusiform, >20 μm long. Thallus continuous

see 7 - *Porina mammillosa* (Th.Fr.) Vain.

- 48 Spores much more than 8 per ascus, oblong-obtuse, <20 μm long. Thallus granulose

44 - *Thelopsis melathelia* Nyl.

Thallus crustose, orange-red to reddish-brown, becoming grey in the herbarium, granulose, K-, C-, KC-, P-. Perithecia frequent, 0.5-0.8 mm diam., black, with a striate surface. Hymenium colourless, I+



blue, becoming red-brown. Paraphyses simple, slender, thread-like, free. Asci cylindrical to narrowly oblong, thin-walled throughout, without apical apparatus. Spores mostly 4-celled, hyaline, oblong-obtuse, with a thick perispore, many per ascus, 11-20 x 4-7 μm . Photobiont trentepohlioid. Without lichen substances. Note: an arctic-alpine, circumpolar species, found on moribund bryophytes, humic soil and plant remains over calciferous substrata; known only from the Alps, to be looked for in the highest mountains of C Italy, mostly above treeline.

49 Mainly coastal-mediterranean. Spores muriform

45 - *Topelia rosea* (Servít) M.Iørg. & Vězda



Thallus crustose, thin, continuous, granulose-farinose, white to pale pinkish grey rapidly fading in the herbarium, K-, C-, KC-, P-, UV-. Perithecia frequent, globose, pale pinkish, immersed in thalline warts, not flattened but with a punctiform, depressed, darker pore, 0.4-0.5(-0.7) mm diam. Hymenium I+ blue-green, rapidly turning to reddish-brown. Paraphyses not anastomosing, simple, flexuose, not apically thickened, free. Periphyses short-celled, stiff, more abundant near the pore. Asci unitunicate, narrowly cylindrical, tapering apically, without apical thickening or apparatus. Spores hyaline, thin-walled, broadly ellipsoid, muriform, 8 per ascus, arranged in a row, 20-28 x 11-16 μm . Photobiont trentepohlioid. Without lichen substances. Note: a mainly mediterranean-atlantic lichen, found on calcareous rocks, over soil and moribund bryophytes in shaded-humid situations. Very rare in humid parts of Mediterranean Italy, especially in the small islands (e.g. Marettimo).

49 Subalpine to alpine. Spores not muriform

46 - *Belonia russula* Nyl.



Thallus crustose, pale reddish grey to reddish brown, the pink-reddish colour most evident in the wet state, becoming yellowish in the herbarium, thin to inconspicuous, mostly granulose, K-, C-, KC-, P-, UV-. Apothecia perithecioid (opening by a broad pore), frequent, 0.4-0.7 mm diam., dull reddish brown to yellowish brown, greyish around the ostiole, covered by the thallus below. Margin (section!) colourless in outer part, yellowish brown inside. Epithecium colourless. Hymenium colourless, K-, C-, I+ blue. Paraphyses not anastomosing, simple, not apically thickened, free. Asci narrowly cylindrical, thin-walled throughout. Spores many-celled (with up to 23 septa), hyaline, acicular, 8 per ascus, (50-)75-100(-125) x 3-4(-5) μm . Photobiont trentepohlioid. Without lichen substances. Note: a mainly arctic-alpine, probably circumpolar species, found on base-rich, weakly calciferous soil, sometimes on bryophytes, and (mostly) on steeply inclined or underhanging basic siliceous rocks; perhaps more widespread in the Alps.

50 Apothecial margin densely white-pruinose. Apothecial disc red to bright reddish brown. Apothecia not perithecioid, >0.5 mm diam.

47 - *Gyalecta ulmi* (Sw.) Zahlbr.

Thallus crustose, whitish to pale grey, thin, continuous, K-, C-, KC-, P-. Apothecia frequent, without a thalline margin (but often covered



at the base by a thin thalline layer when young), strongly constricted, up to 2(-2.5) mm diam. Disc red to reddish-brown, concave at first, then often flat, often white-pruinose, K-, C-, KC-, P-. Margin thick, smooth to (mostly) crenate or verruculose, densely white-pruinose, K-, C-, KC-, P-. Epithecium brownish. Hymenium I+ blue. Paraphyses simple to poorly branched thickened above. Asci cylindrical to elongate-subclavate, thin-walled, without tholus, the wall and the contents I+ blue. Spores 4-celled, hyaline, broadly ellipsoid, 8 per ascus, (12-)14-21(-25) x 5-8 μm . Photobiont trentepohlioid. Without lichen substances. Note: a temperate lichen, found on mature trees (esp. near the base of *Ulmus*), but also on calcicolous mosses on steeply inclined faces; probably more frequent in the past; there are no recent records from the north.

- 50 Apothecial margin not white-pruinose. Apothecial disc not red to reddish-brown, or, if so, apothecia perithecioid, <0.5 mm diam. 51

- 51 Apothecia perithecioid, <0.5 mm diam.

see 46 - Belonia russula Nyl.

- 51 Apothecia not perithecioid, with an evident disc, >0.5 mm diam. 52

- 52 Apothecia more or less immersed in the thallus, not constricted at the base 53

- 52 Apothecia sessile 54

- 53 All septa of the spores parallel. Spores 10-16(-20) x 5-6(-7) μm . Apothecia up to 1(-2) mm diam.

48 - *Gyalecta foveolaris* (Ach.) Schaer.



Thallus crustose, whitish, more or less continuous to granulate K-, C-, KC-, P-. Apothecia frequent, without a thalline margin (but often covered at the base by a thin thalline layer when young), semi-immersed, not constricted, up to 1(-2) mm diam. Disc concave, K-, C-, KC-, P-. Margin thick, smooth to crenulate, whitish to more or less pink-coloured, K-, C-, KC-, P-. Epithecium colourless to very pale brown. Hymenium I+ blue. Hypothecium colourless. Paraphyses simple to poorly branched thickened above. Asci cylindrical to elongate-subclavate, thin-walled, without tholus, the wall and the contents I+ blue. Spores mostly 4-celled, with three parallel septa, hyaline, ellipsoid, 8 per ascus, 10-16(-20) x 4-6 μm . Photobiont trentepohlioid. Without lichen substances. Note: a circumpolar, arctic-alpine lichen, found on calciferous soil, occasionally on rocks in humid and shaded situations; to be looked for throughout the calcareous Alps, near or above treeline.

- 53 Some septa of the spores not parallel with each other. Spores 9-14(-16) x 4-7 μm . Apothecia up to 0.6 mm diam.

49 - *Gyalecta geoica* (Ach.) Ach.

Thallus crustose, whitish, thin, more or less continuous, K-, C-, KC-, P-. Apothecia frequent, without a thalline margin (but often covered at the base by a thin thalline layer when young), semi-immersed, not



constricted, up to 0.6(-0.8) mm diam. Disc yellowish to orange-brown when old, flat to concave, K-, C-, KC-, P-. Margin thick, more or less pink-coloured, paler than disc, K-, C-, KC-, P-. Epithecium colourless to pale yellowish brown. Hymenium I+ blue. Paraphyses simple to poorly branched, thickened above. Asci cylindrical to elongate-subclavate, thin-walled, without tholus, the wall and the contents I+ blue. Spores 4-celled, with at least a septum not parallel with the others, hyaline, ellipsoid, 8 per ascus, 9-14(-16) x 4-7 µm. Photobiont trentepohlioid. Without lichen substances. Note: a cool-temperate to arctic-alpine, circumpolar species found on soil, bryophytes and plant debris over calcareous or basic siliceous substrata, often in rock fissures in sheltered situations. Probably ranging throughout the Italian Alps.

- 54 Apothecial disc flat, orange-yellowish. Margin orange-yellowish. Apothecia up to 5 mm diam.

50 - *Gyalecta friesii* Körb.



Thallus crustose, whitish, thin, more or less continuous, K-, C-, KC-, P-. Apothecia frequent, without a thalline margin, sessile, strongly constricted at the base, 1-5 mm diam. Disc orange-yellowish, mostly flat, K-, C-, KC-, P-. Margin thick, smooth, somewhat paler than disc, K-, C-, KC-, P-. Epithecium colourless to yellowish. Hymenium I+ blue. Paraphyses simple to poorly branched thickened above. Asci cylindrical to elongate-subclavate, thin-walled, without tholus, the wall and the contents I+ blue. Spores 4-celled, hyaline, ellipsoid, 8 per ascus, 14-20 x 3-5 µm. Photobiont trentepohlioid. Without lichen substances. Note: a circumboreal-montane species growing on bryophytes and plant debris, more rarely on bark of conifers and on siliceous rocks. Extremely rare in Italy.

- 54 Apothecial disc deeply concave, orange-reddish. Margin white to grey. Apothecia up to 3 mm diam.

51 - *Gyalecta peziza* (Mont.) Anzi



Thallus crustose, whitish, thin, K-, C-, KC-, P-. Apothecia frequent, without a thalline margin (but often covered at the base by a thin thalline layer when young), sessile, strongly constricted, up to 3 mm diam. Disc reddish-orange, strongly concave, K-, C-, KC-, P-. Margin thick, whitish, paler than disc, K-, C-, KC-, P-. Epithecium colourless to pale reddish brown. Hymenium I+ blue. Paraphyses simple to poorly branched thickened above. Asci cylindrical to elongate-subclavate, thin-walled, without tholus, the wall and the contents I+ blue. Spores 4-celled, hyaline, ellipsoid, 8 per ascus, 15-18 x 5-6 µm, all septa of the spores parallel. Photobiont trentepohlioid. Without lichen substances. Note: a mainly arctic-alpine, circumpolar species, found on slightly calciferous soil rich in humus, and on terricolous bryophytes, mostly above treeline. Certainly ranging throughout the Alps, but only locally common.

- 55 With soredia or isidia 56
55 Without soredia or isidia 66

- 56 Thallus with isidia 57
 56 Thallus with soredia 58
 57 Isidia cylindrical, diffuse. Thallus K+ yellow changing to reddish brown, P+ yellow, then orange-red, with fumarprotocetraric acid and without gyrophoric acid

52 - *Pertusaria oculata* (Dicks.) Th.Fr.



Thallus crustose, whitish grey, often obscured by the isidia, thin, K+ yellow changing to reddish brown, C- or C+ pale red, KC- or KC+ yellow-red, P+ yellow, then orange-red, UV- or UV+ blue white. Isidia initially wart-like, then cylindrical, dense and diffuse, darker than thallus, 1-3 mm long, to 0.4 mm broad, often K+ red at the tips, tending to fall easily. Apothecia rare, lecanorine, semi-immersed, 1-2 mm diam. Disc black, flat to slightly concave, rough. Margin distinct, at least in young apothecia. Epitecium K+ violet. Paraphyses thin, densely ramified, free. Asci cylindrical, with a clear tholus and a thick ocular chamber the outer gel weakly I+ blue. Spores 1-celled, hyaline, ellipsoid, thick-walled, (6-)8 per ascus, (15-)23-28(-31) x (8-)10-14(-16) µm. Pycnidia dark, immersed at the top of isidia. Conidia bacilliform, 3.5 x 0.5 µm. Photobiont chlorococcoid. With fumarprotocetraric acid and variable amounts of protocetraric and gyrophoric acids. Note: a circumpolar, arctic-alpine lichen, found on soil and plant remains, mostly above treeline; restricted to the Alps and the N Apennines in Italy.

- 57 Isidia spathulate, clustered in round patches. Thallus K-, P-, with gyrophoric acid and without fumarprotocetraric acid

53 - *Trapeliopsis wallrothii* (Spreng.) Hertel & Gotth.Schneid.



Thallus squamulose to subcrustose, whitish to pale grey, thick, K-, C+ red, KC+ red, P-. Squamules angular, flattened to somewhat convex, contiguous, areolate-subcrustose in the centre, elongated at the periphery to form a subrosulate thallus, the marginal lobes 0.5-1 mm wide. Isidia laminal, simple, coarsely granular to spathulate, clustered in rounded patches which are evident also when the isidia have fallen. Apothecia rare, without a thalline margin, sessile, up to 1.5 mm diam. Disc pink-brown to dull grey-green or almost black often faintly pruinose, flat to convex. Margin distinct, thin, often paler than disc. Epitecium and hypothecium brownish. Paraphyses slender, anastomosing, ramified, not apically thickened, conglutinate. Asci clavate-cylindrical, thin-walled, I+ pale blue, with a small I+ blue cap inside the thickened apex. Spores 1-celled, hyaline, ellipsoid, thick-walled, 8 per ascus, 8-14 x 4-5 µm. Photobiont chlorococcoid. With gyrophoric acid. Note: on base-rich, non- or weakly calciferous soil, sometimes overgrowing mosses, mostly in open situations. More frequent in the south and in Tyrrhenian Italy (e.g. in Sardegna), very rare elsewhere.

- 58 Thallus K+ yellow 59

58 Thallus K-

62

59 Thallus KC+ yellow, with stictic acid

54 - *Baeomyces rufus* (Huds.) Rebert.



Primary thallus crustose, grey-green to dull greenish white, thick, areolate, K+ yellow, C-, KC+ yellow, P+ orange-yellow, UV-. Areolae convex, contiguous, to 1 mm broad, with a warty to smooth cortex, often powdery soresiate, the soresia greenish grey. Schizidia present occasionally, <0.2 mm diam., disc-like. Medulla UV-. Apothecia frequent, without a thalline margin, terminal, brought on erect, subfruticose, smooth, flattened to subcylindrical, often longitudinally fissured stipes 2-4(-6) mm tall. Disc red brown, flat to convex, the margins often inrolled, most often fissured, to 2.5 mm diam., single or coalescing. Paraphyses simple to poorly branched above, slender, 1-1.8 μ m thick. Asci unitunicate, cylindrical, thin-walled, the apex truncate, I-. Spores 1-(2-)celled, hyaline, fusiform, 8 per ascus, 8-13 x 2.5-4.5 μ m. Pycnidia rare. Conidia bacilliform. Photobiont chlorococcoid. With stictic acid, and variable amounts of norstictic and constictic acids. Note: a holarctic early coloniser of acid soils with high clay content and of weathered siliceous rocks, often found in disturbed sites; mostly sterile in upland areas. Throughout Italy, mostly in the mountains.

59 Thallus KC- or KC+ red, without stictic acid

60

60 Thallus KC-

55 - *Lecanora bryopsora* (Doppelb. & Poelt) Hafellner & Türk



Thallus crustose, whitish to pale grey, continuous to warty, thin to rather thick, K+ yellow, C-, KC-, P+ yellowish. Soredia granular, whitish to very pale yellowish white, developing in initially discrete, then often confluent soralia. Apothecia rare, lecanorine, sessile, strongly constricted, up to 1.5 mm diam. Disc brown, flat, C-, P-. Margin thick, smooth to crenulate, whitish to pale grey, K+ yellow, C-, KC-, P-. Epithemium brownish. Hymenium and hypothecium colourless. Asci *Lecanora*-type, broadly clavate, with a I+ blue tholus, a broad ocular chamber, and a broadly cylindrical axial mass. Spores 1-celled, hyaline, ellipsoid, 8 per ascus, 10-16 x 5-8 μ m. Photobiont chlorococcoid. With atranorin and variable amounts of zeorin. Note: closely related to *Lecanora epibryon*; certainly more widespread in the Alps, but difficult to recognise, being often sterile.

60 Thallus KC+ red

61

61 Thallus P-, with gyrophoric acid, without alectorialic and barbatolic acids. Spores 8 per ascus

56 - *Ochrolechia inaequatula* (Nyl.) Zahlbr.

Thallus crustose, whitish to whitish grey, K+ yellow, C+ red, KC+ red, P-, UV+ blue-white. Areolae convex, verrucose, contiguous. Soredia diffuse, whitish tending to very pale ochraceous, C+ red, KC+ red, P+ orange, UV+ blue-white. Apothecia frequent,



lecanorine, sessile, strongly constricted, 2-4 mm diam. Disc pale reddish brown, flat, smooth. Margin thick, whitish to whitish grey, sorediate. Paraphyses anastomosing, ramified, conglutinate. Epihymenium brownish. Hymenium colourless, I+ blue. Hypothecium colourless. Asci narrowly clavate, uniformly thick-walled, the outer gel strongly I+ blue. Spores 1-celled, hyaline, ellipsoid, thick-walled, 8 per ascus, 25-55 x 10-25 μm . Photobiont chlorococcoid. With gyrophoric acid and an unidentified substance in the medulla. Note: an arctic-alpine lichen, found on mosses, plant debris and soil, mostly near or above treeline; certainly widespread in the Alps, but very much overlooked and undercollected in the past.

- 61 Thallus P+ yellow-orange, with alectorialic and barbatolic acids, without gyrophoric acid. Spores 2 per ascus

57 - *Pertusaria geminipara* (Th.Fr.) Brodo



Thallus crustose, whitish grey to yellowish white, often becoming pinkish in the herbarium, verrucose-granulose, K+ yellow, C+ red, KC+ yellow-red, P+ yellow-orange, UV- or UV+ orange. Areolae convex, contiguous, to 0.3 mm broad, some of which tend to become sorediate starting from the top, forming sub-tuberculate soralia. Soredia granular, whitish tending to very pale ochraceous, P+ orange. Apothecia extremely rare in Italian material, lecanorine, rounded, sessile, up to 2.5 mm diam. Disc reddish brown to almost black, flat, more or less smooth. Margin thick, undulate to crenulate. Paraphyses thin, anastomosing, densely ramified. Asci bitunicate, cylindrical, thick-walled, with a clear tholus and a thick ocular chamber, the outer wall weakly I+ blue. Spores 1-celled, hyaline, ellipsoid, thick-walled, 2 per ascus, 22-40 x 15-20 μm . Pycnidia dark, immersed. Conidia bacilliform. Photobiont chlorococcoid. With alectorialic and barbatolic acids, and variable amounts of xanthonones. Note: an arctic-alpine, circumpolar lichen, found on mosses, plant debris and soil over acid substrata; certainly more widespread in the Alps above treeline, but overlooked, confused with other species, and undercollected in the past.

- 62 Thallus greenish, entirely leprose-sorediate, KC-, with pulvinic acid derivatives

58 - *Chaenotheca furfuracea* (L.) Tibell



Thallus crustose to subleprose, yellowish green, consisting of a thick mat of soredia-like granules, K-, C-, KC-, P-. Apothecia rather frequent, on long stalks, pin-like, 1.6-3 mm tall. Capitulum, maezedium and stalk covered by a dense yellowish green pruina. Asci disintegrating early, often producing a mass of spores (maezedium) which accumulates on the surface of the apothecia. Spores 1-celled, pigmented, globose, with a minute verrucose ornamentation, many per ascus, 2.3-3 μm in diam. Photobiont chlorococcoid, with elongated cells (*Stichococcus*). With vulpinic and pulvinic acids. Note: a widespread holarctic lichen, found beneath overhanging faces protected from rain, esp. in forests, often on exposed roots, but rather indifferent to the substrata (also found on siliceous rocks and lignum); in the Mediterranean belt it is

restricted to very humid forests.

- 62 Thallus not greenish, not entirely leprose-sorediate, KC+ red to orange, without pulvinic acid derivatives 63
- 63 Thallus with lecanoric acid. Spores 1 per ascus, 2-celled

59 - *Varicellaria rhodocarpa* (Körb.) Th.Fr.

Thallus crustose, yellowish grey to whitish, granulose, irregularly spreading or forming well-delimited patches to 1 dm in diam., often indistinctly areolate in young parts, later more or less continuous-granulose, K-, C+ red, KC+ red, P-, UV+ yellowish, esp. in sun-exposed parts, rarely UV+ bluish white. Soredia grey to cream-coloured, initially in discrete soralia, then becoming confluent forming an almost leprose thallus. Apothecia frequent, lecanorine, immersed 1-3 in thalline warts, the latter granulose, fissured at the margin. Disc yellow to reddish, heavily white-pruinose, flat, rugose. Margin thin, smooth, mostly indistinct. Spores 2-celled, hyaline, oblong-obtuse, thick-walled, 1 per ascus, 200-400 x 70-140 µm. Photobiont chlorococcoid. With lecanoric acid and variable quantities of lichexanthone. Note: a mainly arctic-alpine species, found on acid soil, and plant remains, more rarely on lignum or on rocks, in tundra-like environments; restricted to the Alps in Italy.



- 63 Thallus with gyrophoric acid. Spores 8 per ascus, 1-celled 64
- 64 Thallus with orange-red, K+ red patches (anthraquinones)

60 - *Trapeliopsis pseudogranulosa* Coppins & P.James

Thallus crustose, grey to greenish-white with dirty orange patches, first composed by convex areolae but soon becoming continuous, granulose-sorediate, forming large crusts, K- (the orange-coloured parts K+ red), C+ red, KC+ red, P-. Soredia granular to farinose 18-25 µm diam., greenish white, in part orange-pigmented. Medulla and soralia K+ red and UV+ deep orange-red in the pigmented parts, UV+ bluish grey in the unpigmented parts. Apothecia rare, rounded, without a thalline margin, sessile, up to 1.5 mm diam. Disc greenish grey to grey-black, mostly flat. Margin thin, undulate. Epithecium green to greenish brown. Hymenium colourless, I-. Hypothecium pale yellowish brown. Paraphyses anastomosing, ramified, not apically thickened, conglutinate, 1-2 µm thick. Asci *Trapelia*-type, clavate-cylindrical, thin-walled, I+ pale blue, with a small I+ blue cap inside the thickened apex. Spores 1-celled, hyaline, ellipsoid, thick-walled, 8 per ascus, 9-13(-14) x 4-6 µm. Pycnidia unknown. Photobiont chlorococcoid, the cells 7-10 µm in diam. With gyrophoric acid and anthraquinones. Note: in humid *Castanea* woodlands, on mosses on basal parts of trunks, decaying lignum and acid organic soil in areas with siliceous substrata; certainly more widespread, especially in Tyrrhenian Italy.



- 64 Thallus without orange-red, K+ red patches (no anthraquinones) 65
- 65 Thallus C+, KC+ orange-red. Soredia grouped into maculiform soralia. Apothecia lecanorine, >2 mm diam. Spores >30 µm long

61 - *Ochrolechia androgyna* (Hoffm.) Arnold



Thallus crustose, whitish, often delimited by a pale prothallus, thick to thin, continuous to coarsely verrucose, K-, C+ red to orange, KC+ red to orange, P-, UV+ bluish white. Soredia granular, yellowish-green to grey-green, K-, C+ red, KC+ red, P-. Soralia maculiform, prominent, at first discrete, then becoming confluent. Apothecia rare, lecanorine, rounded, sessile, 2-4 mm diam. Disc concave to flat, pinkish to orange-brown. Margin thick, whitish, paler than disc. Epihymenium brownish. Hymenium colourless, I+ blue. Hypothecium colourless. Asci narrowly clavate, uniformly thick-walled, the outer gel strongly I+ blue. Spores 1-celled, hyaline, ellipsoid, 8 per ascus, 30-45 x 13-22. Photobiont chlorococcoid. With gyrophoric acid (constant), sometimes with variolaric or murolic acids. Note: on bark and on steeply inclined rock faces in humid montane forests, sometimes also on soil and bryophytes; a polymorphic species, closely related to *O. tartarea*.

- 65 Thallus C+, KC+ red. Soredia diffuse. Apothecia non-lecanorine, <2 mm diam. Spores <15 µm long

62 - *Trapeliopsis granulosa* (Hoffm.) Lumbsch



Thallus crustose, whitish to pale grey to rarely pale pinkish, thick, areolate, granulose, K-, C+ red, KC+ red, P-, UV+ bluish white. Areolae convex, contiguous, granular to verrucose, to 0.5 mm in diam., often somewhat elongate at the margins. Soredia diffuse, granular, whitish to brownish yellow, sometimes absent, K-, C+ red, KC+ red, P-. Apothecia frequent, non-lecanorine without a thalline margin, sessile, up to 1.5 mm diam. Disc extremely variable in colour, pale pink to reddish brown or dark grey-green to almost black, initially flat, then rapidly convex. Margin thin. Epithecium pale to greenish brown. Hymenium colourless, 70-80 µm tall. Paraphyses slender, anastomosing, ramified, not apically thickened, conglutinate. Asci clavate-cylindrical, thin-walled, I+ pale blue, with a small I+ blue cap inside the thickened apex. Spores 1-celled, hyaline, ellipsoid, thick-walled, 8 per ascus, 9-14 x 4-6 µm. Pycnidia dark, immersed. Conidia cylindrical. Photobiont chlorococcoid. With gyrophoric acid. Note: an arctic-alpine to cool-temperate, circumpolar lichen, found on soil rich in humus, bryophytes, peat, rotting wood, sometimes also on rocks, mostly in clearings of grasslands and shrublands; most common in the Alps, rarer in the Apennines.

- 66 Thallus with radiating marginal lobes 67
66 Thallus without marginal lobes 72
67 Apothecia lecanorine, with a thalline margin containing algal cells 68
67 Apothecia non lecanorine, without a thalline margin 69
68 Apothecial disc dark. Thallus KC-. Spores 50-100 per ascus

63 - *Acarospora placodiiformis* H.Magn.

Thallus crustose, whitish with a greenish-yellowish tinge, usually



densely covered by a thick layer of white, granular pruina, thick, orbicular, areolate, with radiating marginal lobes, K-, C-, KC-, P-. Areolae convex, contiguous, the marginal lobes evident, ca. 2 mm broad. Medulla white, K-, C-, KC-, P-. Apothecia frequent, lecanorine, rounded, semi-immersed, not constricted, 1-5 mm diam. Disc reddish brown to almost black, somehow shiny, flat, smooth. Margin thick. Epithecium brown. Hymenium I+ blue. Hypothecium colourless. Paraphyses numerous, simple to sparsely ramified above. Asci clavate, with a distinct apical dome, I-. Spores 1-celled, hyaline, subglobose, 50-100 per ascus, 4-6 x 4 µm. Parasitic on *Diploschistes* spp., esp. *Diploschistes gypsaceus*. Photobiont chlorococcoid. With rhizocarpic acid and an unknown terpenoid. Note: a xeric subtropical species, found on weathered gypsum in very open stands; known only from Emilia-Romagna, it should be looked for in other gypsum outcrops of the south (e.g. in Sicilia).

- 68 Apothecial disc reddish brown. Thallus KC+ yellow. Spores 8 per ascus

64 - *Squamarina lentigera* (Weber) Poelt



Thallus squamulose to subcrustose, white-pruinose to brownish green, thick, orbicular, to 7 cm in diam., K-, C-, KC+ yellowish, P-. Squamules 1-3 mm broad, contiguous and more or less isodiametric in the centre, elongate at the margin, forming regular rosettes, flattened, smooth, appressed to the substratum, the edges crenate, most often up-turned, white. Upper cortex paraplectenchymatous, well delimited against the thick medulla. Underside pale brown. Medulla P-. Apothecia frequent, lecanorine, rounded, sessile, strongly constricted, up to 4 mm diam. Disc pale to reddish brown, smooth, plane to finally convex. Margin smooth, often disappearing in old apothecia. Paraphyses slightly thickened above. Epithecium brownish, hymenium and hypothecium colourless. Asci clavate, with a I+ blue apical dome. Spores 1-celled, hyaline, ellipsoid, thin-walled, 8 per ascus, (9-)10-13 x 4-5 µm. Pycnidia dark, immersed. Conidia thread-like. Photobiont chlorococcoid. With usnic acid. Note: a species of dry-continental areas, with a broad altitudinal range; only locally common, esp. on gypsaceous or clayey soil in dry grasslands; also present in dry-warm Alpine valleys.

- 69 Lobes short, contiguous >2 mm broad. Thallus KC+ orange, with stictic acid. Apothecia pale-coloured, stipitate. Spores hyaline

65 - *Baeomyces placophyllus* Ach.



Primary thallus crustose, glaucous grey-green, thick, forming rosettes, the centre squamulose, with radiating marginal lobes, often covered by peltate, pale-coloured, fragile, mostly marginal schizidia to 0.2 mm diam., K+ yellow, C-, KC+ orange, P+ orange. Marginal lobes to 6 mm broad, flattened, contiguous, raised at the tips. Medulla P+ orange, UV+ orange. Apothecia frequent, without a thalline margin, terminal, brought on short, smooth, subfruticose stipes, to 6 mm tall and 2 mm thick. Disc ochraceous to reddish brown, flat, the margin often reflexed, to 4-5 mm broad. Epithymenium yellowish brown. Hymenium colourless, I-. Paraphyses slender, simple or sparingly branched towards the tips,

not anastomosing. Asci cylindrical, unitunicate, thin-walled, the apex truncate, I-. Spores 1(-2)-celled, hyaline, fusiform, 8 per ascus, 8-14 x 2-4 μm . Photobiont chlorococcoid. With stictic acid. Note: an arctic-alpine to boreal-montane, probably circumpolar lichen, found on sandy-clay soil in open stands (e.g. montane-subalpine grasslands), often in moderately disturbed habitats, sometimes reaching the Alpine belt. Probably restricted to the Alps in Italy, but to be looked for also in the highest siliceous mountains of the Apennines.

- 69 Lobes elongate, strongly pruinose, <1 mm broad. Thallus KC-, without stictic acid. Apothecia black, sessile. Spores pigmented 70
70 Spores 4 per ascus

66 - *Buellia asterella* Poelt & Sulzer



Thallus crustose, white, orbicular, with radiating marginal lobes, K+ yellowish red to very rarely K-, C-, KC-, P+ orange or P-. Lobes 0.2-0.5 mm broad, elongate, flattened to weakly convex, strongly white farinose-pruinose. Apothecia frequent, without a thalline margin, sessile, 0.4-0.8(-1) mm diam. Disc black, flat to weakly convex, sometimes pruinose when young. Margin thin, smooth, not evident in old apothecia. Epithecium yellowish brown. Hypothecium brownish. Paraphyses distinctly thickened above, with dark cap. Asci *Bacidia*-type, distinctly thickened at the apex, with a I+ blue tholus, the outer gelatinous coat I+ pale blue. Spores 2-celled, pigmented, ellipsoid, constricted at septa, thin-walled, 4 per ascus, (10-)11-16(-19) x (4.5-)5-8(-8.5) μm . Pycnidia dark, immersed. Conidia bacilliform, 5-8 x 1-2 μm . Photobiont chlorococcoid. With atranorin and variable amounts of norstictic acid. Note: on calciferous soil in dry grasslands, very rare.

- 70 Spores 8 per ascus 71
71 In dry alpine valleys. Spores with rugulate ornamentation, (12-)13-20(-23) x (5.5-)6-10(-10.5) μm

67 - *Buellia elegans* Poelt



Thallus crustose, densely white-pruinose, orbicular, with radiating marginal lobes, K+ yellow to yellowish red, C-, KC-, P+ orange. Lobes 0.5-1 mm broad, elongate, flattened, often darker at the tip. Apothecia frequent, rounded, without a thalline margin, sessile, up to 1.2 mm diam. Disc black, rarely faintly pruinose, flat to convex. Margin thin, smooth. Epithecium yellowish brown. Hypothecium brownish. Paraphyses distinctly thickened above, with dark cap. Asci *Bacidia*-type, distinctly thickened at the apex, with a I+ blue tholus, the outer gelatinous coat I+ pale blue. Spores 2-celled, pigmented, ellipsoid, constricted at septa, thin-walled, 8 per ascus, with rugulate ornamentation, (12-)13-20(-23) x (5.5-)6-10(-10.5) μm . Pycnidia dark, immersed. Conidia bacilliform, 4.5-8 x 1-1.5 μm . Photobiont chlorococcoid. Chemically variable: with atranorin and variable amounts of norstictic acid, with or without stictic and divaricatic acids. Note: a widespread steppe-species found on soil deriving from calciferous schists in open grasslands; restricted to

dry-warm valleys in the Alps. To be looked for in Val d'Aosta and South Tyrol.

- 71 Strictly mediterranean. Spores with microfoveate ornamentation, 10-17 x 5.5-8.5 μm

68 - *Buellia zoharyi* Galun



Thallus crustose, densely white-pruinose, orbicular, with radiating marginal lobes, K+ yellow then reddish, C-, KC-, P+ orange. Lobes 0.5-1 mm broad, elongate, flattened. Apothecia frequent, without a thalline margin, sessile, up to 1 mm diam. Disc black, rarely faintly pruinose, flat. Margin thin, smooth. Epithecium yellowish brown. Hypothecium brownish. Paraphyses distinctly thickened above, with dark cap. Asci *Bacidia*-type, distinctly thickened at the apex, with a I+ blue tholus, the outer gelatinous coat I+ pale blue. Spores 2-celled, pigmented, ellipsoid, constricted at septa, thin-walled, 8 per ascus, with microfoveate ornamentation, 10-17 x 5.5-8.5 μm . Pycnidia dark, immersed, frequent. Conidia bacilliform, 4-6.5 x 1-1.5 μm . Photobiont chlorococcoid. With atranorin, and norstictic and stictic acid in variable concentrations. Note: on gypsum in mediterranean grasslands; never reported from Italy; to be looked for in dry areas of the south.

- 72 With perithecia 73
 72 With apothecia 96
 73 Thallus KC+ red

69 - *Protothelenella leucothelia* (Nyl.) H.Mayrhofer & Poelt



Thallus crustose, whitish, thin, composed of granules or warts, K-, C+ red, KC+ red, P-. Perithecia frequent, 0.3-0.5 mm diam., black-brown at the punctiform ostiole, paler below, mostly covered by a thalline layer, without involucrellum. Hymenium colourless, I+ blue. Paraphyses (paraphysoids) persistent, anastomosing, ramified, not apically thickened. Asci bitunicate, fissitunicate, cylindrical, thick-walled, the outer wall I+ blue, with a I+ blue apical apparatus. Spores hyaline, fusiform-elongate, often apiculate at the ends, muriform, thick-walled, the outer wall much thicker than the septa, 8 per ascus, 24-36 x 9-14 μm . Photobiont chlorococcoid, surrounded by a gelatinous coat (*Elliptochloris*). With an unidentified parapside of orcynol type. Note: on acid soil, moribund bryophytes, plant debris and lichens (*Cladonia*), sometimes on rotting wood; probably ranging throughout the Alps, but overlooked.

- 73 Thallus KC- 74
 74 Spores 2-celled 75
 74 Spores not 2-celled 76
 75 Spores 32 per ascus, with thread-like appendages at both ends, fusiform, <2.5 μm broad

70 - *Epigloea grummannii*



Thallus crustose, inconspicuous, thin, continuous, subgelatinous when wet, more or less greenish, K-, C-, KC-, P-. Perithecia frequent, globose to elliptical, not flattened, 0.06-0.13 mm diam., pale brown, surrounded by a thin gelatinous layer; ostiole paler. Paraphyses thin, thread-like, simple, slightly thickened above. Asci clavate, the entire wall I+ blue. Spores 2-celled, hyaline, fusiform, thin-walled, not ornamented, 32(-50) per ascus, with 2-3 μm long, thread-like appendages at both ends, 13-16.5(-18) x 1.5-2(-2.5) μm . Pycnidia not known. Photobiont chlorococcoid (*Coccomyxa*-type). Without lichen substances. Note: on algal colonies developing on dying mats of *Grimmia* and *Hypnum*; certainly overlooked, and more widespread in the Alps.

- 75 Spores 8 per ascus, without appendages at the ends, ellipsoid, >3 μm broad

71 - *Epigloea soleiformis* Döbbeler



Thallus crustose, inconspicuous, subgelatinous when wet, more or less greenish, thin, continuous, K-, C-, KC-, P-. Perithecia frequent, globose, 0.07-0.15 mm diam., greenish or greyish-black with a thin gelatinous coat, and with a depression around the ostiole. Paraphyses thin, thread-like, simple, slightly thickened above. Asci clavate to cylindrical, the entire wall I+ blue. Spores 2-celled, club-shaped, with one cell larger, hyaline, slightly or not constricted at septum, thin-walled, not ornamented, 8 per ascus, (8.5-)9.5-12.5(-14) x 3.5-4.5(-5) μm . Pycnidia globose, black. Conidia bacilliform to narrowly ellipsoid. Photobiont chlorococcoid (*Coccomyxa*-type). Without lichen substances. Note: on algal colonies developing on moribund bryophytes, squamules of *Cladonia*, decaying wood and humus; certainly overlooked, and more widespread in the Alps.

- 76 Spores 4-celled 77
76 Spores not 4-celled 78
77 Thallus gelatinous when wet. Spores narrowly ellipsoid, with appendages at both ends, 3.5-5 μm broad. Top of perithecium with a circular swelling around the ostiole

72 - *Epigloea medioincrassata* (Grumann) Döbbeler



Thallus crustose, inconspicuous, subgelatinous when wet, more or less greenish, thin, continuous, K-, C-, KC-, P-. Perithecia frequent, globose, flattened, 0.1-0.22 mm diam., pale brown to rarely black, covered by a thin gelatinous layer, with a circular swelling around the ostiole. Paraphyses thin, simple, thread-like, slightly thickened above. Asci clavate to cylindrical, the entire wall I+ blue. Spores 4-celled, hyaline, narrowly ellipsoid, with 2-4(-8) μm long, thread-like appendages at both ends, thin-walled, not ornamented, 8 per ascus, excluding appendages (18-)24-33(-38) x 3.5-5 μm . Photobiont chlorococcoid (*Coccomyxa*-type). Without lichen substances. Note: on algal colonies on moribund bryophytes and, more rarely, on lignum; certainly overlooked, and more widespread in the Alps.

- 77 Thallus not gelatinous when wet. Spores ellipsoid, without appendages, 10-14 μm broad. Top of perithecium without circular swelling

73 - *Thelidium zwackii* (Hepp) A.Massal.



Thallus crustose, pale grey to pale brown, thin, continuous to more rarely cracked-areolate, K-, C-, KC-, P-. Perithecia frequent, black, globose, half-immersed in the thallus, the upper part protruding, 0.1-0.25 mm diam., without involucrellum. Hymenium I+ red, K/I+ blue. Paraphyses absent, substituted by periphyses. Perithecial wall (section) black above, pale-coloured below, without involucrellum. Asci clavate, bitunicate, thin-walled, the wall apically thickened, I-. Spores (2-)4-celled, hyaline, ellipsoid, 8 per ascus, (23-)26-36 x (9-)10-14(-15) μm . Photobiont chlorococcoid. Without lichen substances. Note: a mainly temperate species found on calcareous and basic siliceous rocks and thin layers of soil, e.g. on walls, pebbles, etc.; one of the few species of the genus which occur at low altitudes in Italy. Certainly overlooked, and to be searched for more intensively throughout the country.

- 78 Perithecia pale-coloured 79
 78 Perithecia dark-coloured 80
 79 Spores submuriform, ellipsoid <50 μm long

74 - *Leucocarpia biatorella* (Arnold) Vězda



Thallus crustose, greenish white to yellowish white, thin, smooth to mostly granulose-verrucose, K-, C-, KC-, P-. Perithecia frequent, globose, sometimes with a short neck near the ostiole, without involucrellum, at least half covered by a thalline layer, up to 0.8 mm diam., pale-coloured, with a darker, yellowish or yellowish-pinkish ostiole. Perithecial wall made up by tangentially arranged hyphae. Paraphyses absent, substituted by short-celled periphyses, 60-70 x ca. 1 μm . Asci thick-walled, clavate, with a thick tholus, I+ reddish. Spores hyaline, ellipsoid, initially 4-celled, then rapidly submuriform, 8 per ascus, (25-)28-38(-45) x 10-14 μm . Photobiont chlorococcoid (*Trebouxia*). Without lichen substances. Note: an inconspicuous lichen found on thin layers of calciferous, humus-rich ground, or over epilithic mosses; probably overlooked and more widespread, but never common, in the Alps.

- 79 Spores not muriform, acicular >100 μm long

75 - *Belonia incarnata* Th.Fr.



Thallus crustose, greyish white to greenish grey, subgelatinous when wet, thin and film-like, K-, C-, KC-, P-. Apothecia frequent, lecanorine and perithecioid, semi-immersed, 0.2-0.5 mm diam. Disc pinkish to yellowish grey, concave, opening through a broad pore. Thalline margin poorly evident, often limited to the basal part of the apothecium. True margin pale to reddish brown, thin. Epithecium colourless. Hymenium K-, C-, I+ blue. Paraphyses not anastomosing, simple, not apically thickened, free. Asci narrowly

cylindrical, thin-walled. Spores many-celled (with ca. 20 parallel septa), hyaline, acicular, 8 per ascus, (80-)100-170 x 3-4.5(-6) μm . Photobiont chlorococcoid (*Trebouxia*). Without lichen substances. Note: an arctic-alpine species, found on soil rich in humus, often in rather disturbed habitats, such as on mountain track sides, mostly above treeline; easy to overlook and probably more widespread throughout the Alps.

- | | | |
|----|---|----|
| 80 | Spores 1-celled | 81 |
| 80 | Spores more than 4-celled | 85 |
| 81 | Thallus thick, subsquamulose-sublobate | 82 |
| 81 | Thallus thin, inconspicuous | 83 |
| 82 | Lower cortex present, dark, paraplectenchymatous (section!). Thallus brownish grey, often faintly pruinose especially toward the centre, and darker toward the margin. Old perithecia with a dark wall. Asci 65-70 x 16-22 μm . Spores (15-)17-23(-25) x (6-)6.5-8.5(-9.5) μm | |

76 - *Catapyrenium cinereum* (Pers.) Körb.

Thallus squamulose to subcrustose, brownish grey, often faintly grey-pruinose especially toward the centre, and darker toward the margin, thin, K-, C-, KC-, P-, UV-. Squamules (0.5-)1-3 mm broad, finely divided-lobulate, appressed to the substratum, contiguous, very rarely somewhat overlapping, forming a subcrustose thallus developing on a dark prothallus. Edge of squamules darker than the surface. Lower surface dark, attached by dark rhizohyphae which are (3.5-)4-4.5(-5) μm broad. Upper and especially lower cortex paraplectenchymatous, the latter of polygonal cells in 2-3 layers. Perithecia frequent, numerous, laminal, globose, half immersed, not flattened, 0.2-0.3 mm in diam. Paraphyses absent, substituted by periphyses. Perithecial wall initially pale, then darkening throughout. Asci unitunicate, clavate, thin-walled, not or only slightly thickened at the apex, without ocular chamber, the wall 1-, 65-70 x 16-22 μm . Spores 1-celled, hyaline, clavate, thin-walled, 8 per ascus, (15-)17-23(-25) x (6-)6.5-8.5(-9.5) μm . Photobiont chlorococcoid. Without lichen substances. Note: a boreal-montane to arctic-alpine, circumpolar species occurring also in more southern mountains on siliceous, base-rich soil with mica, or amongst terricolous bryophytes; often confused with *Placidiopsis cinereoides*.



- | | | |
|----|---|--|
| 82 | Lower cortex absent. Thallus brownish grey, often faintly pruinose especially towards the centre, never darker at margin. Most perithecia with a pale to colourless wall. Asci 75-85 x 17-20 μm Spores (15-)17-22(-24) x (5-)6-8(-9) μm | |
|----|---|--|

77 - *Catapyrenium daedaleum* (Kremp.) Stein

Thallus squamulose to subcrustose, brownish to brownish-greenish grey, often faintly pruinose, never darker at margin, thin, K-, C-, KC-, P-, UV-. Squamules 1-4 mm broad, flattened, smooth,



contiguous, non imbricate, usually forming a rosette-like thallus reaching 9 cm diam., developing on a black hypothallus. Marginal squamules often elongated, rounded, often somewhat concave at tips, always without pruina. Edge of squamules crenulate, concolorous with upper surfaces. Lower surface dark, attached by dark rhizohyphae. Upper cortex paraplectenchymatous, lower cortex absent, the medulla becoming darker below. Rhizohyphae dark, 3-4(-4.5) μm in diam. Perithecia frequent, laminal, pyriform, half immersed, not flattened, 0.2-0.3 mm broad. Paraphyses absent, substituted by periphyses. Perithecial wall colourless to brown, esp. near the ostiole. Asci unitunicate, clavate, thin-walled, not or only slightly thickened at the apex, without ocular chamber, the wall I-, 75-85 μm long, 17-20 μm broad. Spores 1-celled, hyaline, clavate, thin-walled, 8 per ascus, (15-)17-22(-24) x (5-)6-8(-9) μm . Photobiont chlorococcoid. Without lichen substances. Note: a boreal-montane to arctic-alpine, circumpolar species found on plant debris, mosses and bare, humus rich soil on calciferous ground; perhaps less common than *C. cinereum* in the mountains of the south.

83 Spores >12 μm broad

78 - *Verrucaria geophila* Zahlbr.



Thallus crustose, greenish grey, green and subgelatinous when wet, thin, continuous to slightly cracked, K-, C-, KC-, P-. Perithecia frequent, black, half-immersed, globose, not flattened at the top, up to 1 mm diam. (usually less). Perithecial wall dark throughout. Asci broadly clavate, thin-walled, bitunicate, I-. Spores 1-celled, hyaline, ellipsoid, 8 per ascus, 20-36 x 12-16 μm . Photobiont chlorococcoid. Without lichen substances. Note: a rare, rather poorly known species of slightly calciferous soil in Mediterranean grasslands. Perhaps more widespread in the south.

83 Spores <12 μm broad

84

84 Paraphyses present. Perithecia covered by a thalline layer. Spores often clavate

79 - *Thrombium epigaeum* (Pers.) Wallr.



Thallus crustose, yellowish to greyish, indistinct, subgelatinous when wet, thin and often film-like, continuous, K-, C-, KC-, P-. Perithecia frequent, black, globose, not flattened at the top, up to 0.5 mm diam., without involucrellum, covered by the thallus up to the ostiole. Perithecial wall pale to dark brown throughout, 20-30 μm thick. Paraphyses persistent, simple, to 1 μm thick, not apically thickened, free. Periphyses absent. Asci subcylindrical but often clavate at apices, thin-walled, the apex slightly thickened, I+ blue with a narrow, cylindrical axial mass. Spores 1-celled, hyaline, narrowly ellipsoid to often clavate, thin-walled, 8 per ascus, (15-)18-25(-30) x 5-10(-12) μm . Photobiont chlorococcoid (*Leptosira?*). Without lichen substances. Note: an ephemeral, probably holarctic coloniser of calciferous, clayey soil in rather disturbed habitats, such as track sides; very easy to overlook, and probably undercollected in Italy.

- 84 Paraphyses absent, substituted by periphyses. Perithecia not covered by a thalline layer. Spores narrowly ellipsoid, never clavate

80 - *Verrucaria xyloxena* Norman



Thallus crustose, brown to blackish brown, thin, verrucose, sometimes surrounded by a brown prothallus, composed by goniocysts 15-35 μm diam., the cells of goniocysts isodiametric to oblong, thick-walled, K-, C-, KC-, P-. Perithecia frequent, brownish black to black, spherical to broadly ovoid, 0.14-0.25 mm diam., immersed, protruding, not flattened at the top, the wall dark-carbonaceous throughout, without involucrellum. Paraphyses absent, substituted by 25-35 μm long, branched periphyses. Hymenium colourless, I+ red. Asci broadly clavate, bitunicate-fissitunicate, thick-walled above when young, with a small ocular chamber. Spores 1-celled, hyaline, ellipsoid, 8 per ascus, (15-)16-23(-25) x 6-8(-9) μm . Pycnidia not known. Photobiont chlorococcoid. Without lichen substances. Note: on more or less calciferous soil, often associated with acrocarpous mosses; easily overlooked, and perhaps more widespread in the Alps.

- 85 Spores pigmented 86
 85 Spores hyaline 87
 86 In upland areas. Spores 2 per ascus, 70-150 x 30-60 μm

81 - *Polyblastia helvetica* Th.Fr.



Thallus crustose, pale to dark grey, subgelatinous when wet, thin and filmy, continuous to granular, K-, C-, KC-, P-, UV-. Perithecia black, frequent, semi-immersed in the thallus, globose or somehow flattened at the top, 0.3-0.5 mm diam., without involucrellum, the wall brown to black throughout or more rarely paler below. Paraphyses absent or ephemeral, substituted by periphyses. Asci sac-like, bitunicate, thin-walled. Spores pigmented at least when old, ellipsoid-cylindrical, strongly muriform, (1-)2 per ascus, 70-150 x 30-60 μm . Photobiont chlorococcoid. Without lichen substances. Note: alpine to subalpine. On calciferous soil, often amongst bryophytes. For Italy reported only from the Dolomites. Probably overlooked or confused with other species, and more widespread in the Alps.

- 86 In lowland areas, mainly mediterranean. Spores 8 per ascus, 40-55 x 20-25 μm

82 - *Polyblastia rouxiana* Vězda & Vivant

Thallus crustose, bluish-greenish grey, thin, continuous, film-like to verruculose, K-, C-, KC-, P-. Perithecia frequent, black, initially globose, then flask-shaped, immersed in the thallus and/or in the substratum and protruding only with the apical part, 0.5-0.7 mm diam., without involucrellum. Perithecial wall 30-40 μm thick, brownish-black throughout. Paraphyses absent, substituted by periphyses. Asci *Verrucaria*-type, sac-like, bitunicate, thin-walled,



100-120 x 40-50 μm . Spores pigmented, ellipsoid, slightly narrower and more pointed at one end, muriform, 8 per ascus, 40-55 x 20-25 μm . Photobiont chlorococcoid. Without lichen substances. Note: on bare soil in clearings of garrigue and maquis vegetation over calcareous substrata. For Italy it was reported only from Calabria and Sicilia. Mainly mediterranean, and probably more widespread in the south.

87 Spores submuriform

83 - *Protothelenella sphinctrinoidella* (Nyl.) H.Mayrhofer & Poelt



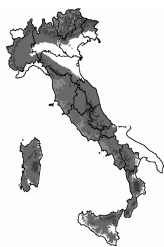
Thallus crustose, whitish to pale grey, greenish when wet, thin, continuous and often film-like and inconspicuous, K-, C-, KC-, P-. Perithecia black, more or less shiny, frequent, protruding to semi-immersed, globose to slightly pyriform, 0.1-0.3 mm diam. Perithecial wall 15-20 μm thick, dull greenish and K+ violaceous above, most often pale-coloured below. Hymenium colourless, I+ blue. Paraphyses (paraphysoids) anastomosing, strongly ramified, not apically thickened. Asci bitunicate, fissitunicate, cylindrical, thick-walled, the outer wall I+ blue, with a I+ blue apical apparatus. Spores hyaline, ellipsoid, submuriform, thick-walled, the outer wall distinctly thicker than the septa, 8 per ascus, 22-33 x 7-10 μm . Photobiont chlorococcoid, surrounded by a gelatinous coat (*Elliptochloris*). Without lichen substances. Note: on soil, moribund bryophytes and lichens, more rarely on decaying plants, often in rather disturbed habitats, e.g. on mountain track sides; certainly more widespread in the Alps.

88 Spores strongly muriform

88

88 Spores 2-4 per ascus

84 - *Chromatochlamys muscorum* (Fr.) H.Mayrhofer & Poelt var. *muscorum*



Thallus crustose, whitish to very pale brown, thin, more or less continuous and membrane-like, K-, C-, KC-, P-, UV-. Perithecia frequent, globose to broadly pyriform, half immersed, not flattened, 0.3-0.6 mm diam. Surface black to brown in upper part, covered by the pale thallus below, the wall 50-70 μm thick, dark above, paler below. Paraphyses (paraphysoids) persistent, thin, branched and anastomosing, not apically thickened, free. Periphyses (periphysoids) present near the ostiole, conglutinate. Asci bitunicate and fissitunicate, I-, thick-walled, the inner wall thinner than the outer one, the apex with an internal beak. Spores hyaline, becoming straw-coloured when old, elongate-ellipsoid to subcylindrical, muriform, 2-4 per ascus, 60-110 x 20-27 μm . Photobiont chlorococcoid. Without lichen substances. Note: a holarctic lichen, found on moribund pleurocarpous mosses on rocks and soil; when epiphytic, on basal parts of old trunks.

88 Spores more than 4 per ascus

89

89 Spores 6-8 per ascus

85 - *Chromatochlamys muscorum* (Fr.) H.Mayrhofer & Poelt var. *octospora* (Nyl.) H.Mayrhofer & Poelt



Thallus crustose, whitish to pale brown, thin, more or less continuous and membrane-like, K-, C-, KC-, P-. Perithecia frequent, globose to broadly pyriform, half immersed, not flattened, 0.3-0.6 mm diam. Surface black to brown in upper part, covered by the pale thallus below, the wall 50-70 μm thick, dark above, paler below. Paraphyses (paraphysoids) persistent, thin, branched and anastomosing, not apically thickened, free. Periphyses (periphysoids) present near the ostiole, conglutinate. Asci bitunicate and fissitunicate, I-, thick-walled, the inner wall thinner than the outer one, the apex with an internal beak. Spores hyaline, becoming straw-coloured when old, elongate-ellipsoid to subcylindrical, muriform, 6-8 per ascus, 40-60 x 15-20 μm . Photobiont chlorococcoid. Without lichen substances. Note: a mainly western lichen in Europe, found on moribund mosses on rocks and soil. Certainly very rare in Italy.

89 Spores 8 per ascus 90

90 Hymenial algae present (section!) 91

90 Hymenial algae absent 92

91 Spores 28-33 x 11-13 μm . Hymenial algae more or less globose. Thallus subgelatinous when wet

86 - *Staurothele geoica* Zschacke



Thallus crustose, grey to dark greenish grey, subgelatinous when wet, thin, continuous, K-, C-, KC-, P-. Perithecia black, half immersed, not flattened at the top, small, up to 0.3 mm diam. (usually less), without involucrellum, the wall uniformly black throughout. Paraphyses absent, substituted by periphyses. Hymenium I+ reddish. Hymenial algae more or less globose. Asci sac-like, verrucarioid, thin-walled, bitunicate, without a distinct ocular chamber. Spores hyaline, ellipsoid, (sub-)muriform, 8 per ascus, 28-33 x 11-13 μm . Photobiont chlorococcoid (*Stichococcus*). Without lichen substances. Note: a taxon which deserves further study. On soil amongst bryophytes and on plant debris.

91 Spores 36-43 x 13-17 μm , Hymenial algae globose to mostly rectangular in shape. Thallus not subgelatinous when wet

87 - *Staurothele terricola* (Bagl.) Poelt & Nimis



Thallus crustose, grey, greenish when wet, thin, continuous, K-, C-, KC-, P-. Perithecia half immersed, not flattened, black. Paraphyses absent, substituted by periphyses. Hymenium I+ reddish. Hymenial algae globose to mostly rectangular in shape. Asci sac-like, verrucarioid, thin-walled, bitunicate, without a distinct ocular chamber. Spores hyaline, ellipsoid, muriform, 8 per ascus, 36-43 x 13-17 μm . Photobiont chlorococcoid (*Stichococcus*). Without lichen substances. Note: known only from clearings of garrigues in

Sardegna, this taxon needs further study.

- 92 Thallus thick, evident 93
- 92 Thallus inconspicuous, reduced to a thin film 94
- 93 Spores <40 µm long. Thallus grey-white, sometimes tinged brown, composed of coarse, subsquamulose, cartilaginous granules becoming subgelatinous when wet

88 - *Polyblastia sendtneri* Kremp.



Thallus crustose, grey-white, sometimes tinged brown, composed of coarse, subsquamulose, rather thick cartilaginous areolae, K-, C-, KC-, P-. Perithecia frequent, black, globose, half immersed, with an involucrellum extending to the upper half, 0.1-0.2 mm diam. Paraphyses ephemeral to absent, soon substituted by periphyses. Asci sac-like, bitunicate, thin-walled. Spores hyaline, ellipsoid-cylindrical, muriform, 8 per ascus, 15-30 x 9-16 µm. Pycnidia dark, immersed. Conidia bacilliform. Photobiont chlorococcoid. Without lichen substances. Note: a circumpolar, arctic-alpine species, found on organic soil, mosses and plant debris; most common in the Alps, above treeline, but also known from the C Apennines (Gran Sasso Massif).

- 93 Spores >40 µm long. Thallus pale greenish grey to brownish, subsquamulose to coarsely granular, often cracked, not subgelatinous when wet

89 - *Polyblastia terrestris* Th.Fr.



Thallus crustose, pale greenish grey to brownish, subsquamulose to coarsely granular, often cracked, thick, K-, C-, KC-, P-. Perithecia frequent, globose, with an involucrellum extending at least to the upper half, 0.4- 0.8 mm diam., black, covered by thallus at the base. Paraphyses ephemeral to absent, soon substituted by periphyses. Perithecial wall dark throughout. Asci sac-like, bitunicate, thin-walled. Spores hyaline, ellipsoid-cylindrical, muriform, 8 per ascus, 45-90 x 18-50 µm. Photobiont chlorococcoid. Without lichen substances. Note: on calciferous soil in upland areas, both on bare ground and amongst bryophytes; a critical taxon, which needs revision, hitherto known only from the Alps in Italy.

- 94 Perithecial wall pale below. Perithecia >0.4 mm diam.

90 - *Protothelenella sphinctrinoides* (Nyl.) H.Mayrhofer & Poelt



Thallus crustose, whitish to pale greenish brown, somewhat gelatinous when wet, thin, granular-warty to film-like, K-, C-, KC-, P-. Perithecia frequent, black to brown-black, paler when wet, semi-immersed in the thallus, globose to slightly pyriform, 0.4-0.6 mm diam. Perithecial wall reddish brown above, paler to colourless below and inside, without involucrellum. Paraphyses (paraphysoids) persistent, anastomosing, strongly ramified, not apically thickened. Hymenium colourless, I+ blue. Asci bitunicate, fissitunicate, cylindrical, thick-walled, the outer wall I+ blue, with a I+ blue apical

apparatus. Spores hyaline to pale straw-coloured when old, broadly ellipsoid to narrowly ovate, muriform, thick-walled, the outer wall much thicker than the septa, 8 per ascus, uniseriate to somewhat overlapping, (38-)40-50 x 10-15 μm . Photobiont chlorococcoid, surrounded by a gelatinous coat (*Elliptochloris*). Without lichen substances. Note: an arctic-alpine to boreal-montane, circumpolar lichen, found on moribund bryophytes on soil and rock, more rarely on soil, in rather disturbed sites (e.g. on mountain track sides) with a long snow-lie, often in crevices or small depressions of the ground; much undercollected, probably ranging throughout the Alps.

94 Perithecial wall dark throughout. Perithecia <0.4 mm diam. 95

95 Spores <40 μm long. Perithecia fully immersed

91 - *Polyblastia epigaea* A. Massal.



Thallus crustose, brown, thin, continuous to verrucose, K-, C-, KC-, P-. Perithecia frequent, black, globose, immersed, with an involucrellum extending to the upper half, up to 0.2 mm diam., the wall colourless to brownish. Paraphyses absent or ephemeral, substituted by periphyses. Asci sac-like, bitunicate, thin-walled. Spores hyaline, sometimes very pale brown when very old, ellipsoid-cylindrical, muriform, 8 per ascus, 26-37 x 10-17 μm . Photobiont chlorococcoid. Without lichen substances. Note: on humous soil. Never reported from Italy, to be looked for in the Alps.

95 Spores >40 μm long. Perithecia protruding

92 - *Polyblastia evanescens* Arnold



Thallus crustose, grey, thin and film-like, continuous, K-, C-, KC-, P-. Perithecia frequent, black, globose, protruding, up to 0.2 mm diam. Paraphyses absent or ephemeral, substituted by periphyses. Perithecial wall dark throughout. Asci sac-like, bitunicate, thin-walled. Spores hyaline, sometimes very pale brown when old, ellipsoid-cylindrical, muriform, 8 per ascus, 45-60 x 18-25 μm . Photobiont chlorococcoid. Without lichen substances. Note: on bryophytes (e.g. *Rhacomitrium*, *Distichum*, *Encalypta*) in open vegetation above treeline; very rarely collected, but perhaps more widespread in the Alps.

96 Apothecia lecanorine, with a thalline margin containing algal cells 97

96 Apothecia non lecanorine, without a thalline margin 143

97 Spores strongly muriform 98

97 Spores not muriform (or at most with one longitudinal septum only) 100

98 Apothecia up to 7 mm diam. Thallus C-, KC-, with norstictic and conorstictic acids

93 - *Diploschistes ocellatus* (Vill.) Norman

Thallus crustose, pale grey to white, thick, verrucose-areolate, pruinose, often forming a compact crust easily detachable from the



substratum, K+ yellow changing to red, C-, KC-, P+ orange, UV-. Areolae 0.4-3 mm broad, to 4 mm thick, mostly convex, contiguous, forming a large crust. Apothecia frequent, lecanorine, rounded, sessile, up to 7 mm diam. Disc black to black-brown, mostly faintly white-pruinose, flat. Margin thick, smooth, pruinose, pseudoparenchymatous in section. Hymenium and hypothecium colourless, I-. Paraphyses mostly simple, not apically thickened, free. Asci subcylindrical, the wall I-, the content I+ orange-red, with a somewhat abrupt apical thickening, lacking any apical apparatus. Spores pigmented, broadly ellipsoid, muriform, 8 per ascus, 20-32 x 7-15 μm . Pycnidia dark, cerebriform, semi-immersed. Conidia bacilliform, 4-7 x 1-1.5 μm . Photobiont chlorococcoid (*Trebouxia*). With norstictic and connorstictic acids. Note: a mild-temperate lichen found on limestone, dolomite and calciferous sandstone, more rarely on soil, esp. common in the SW part of the Peninsula, below the montane belt.

98 Apothecia up to 3 mm diam. Thallus C+ and KC+ red, with lecanoric and diploschistesic acids

99

99 Spores (4-)8 per ascus, 20-38 x 9-17 μm . Non parasitic. Thallus pruinose

94 - *Diploschistes diacapsis* (Ach.) Lumbsch



Thallus crustose, grey to greyish white, continuous to verrucose-areolate, loosely attached, slightly pruinose, K+ yellow to red (the reaction sometimes indistinct), C+ red, KC+ red, P-, UV-. Areolae 0.5-2.5 mm diam., 1-3 mm thick, flat to subconvex, mostly irregularly angular at least when young. Apothecia frequent, lecanorine, rounded, semi-immersed and urceolate, 1-2.5 mm diam. Disc black, often faintly white-pruinose, concave. Margin distinct, thick, pseudoparenchymatous in section. Hymenium and hypothecium colourless, I-. Paraphyses simple, not apically thickened, 1-2 μm broad, free. Asci subclavate to cylindrical, the wall I-, the content I+ orange-red, with a somewhat abrupt apical thickening, lacking any apical apparatus. Spores pigmented, broadly ellipsoid, muriform, 4-8 per ascus, 20-38 x 9-17 μm . Pycnidia dark, cerebriform, half immersed. Conidia bacilliform, 4-6 x 1-1.5 μm . Photobiont chlorococcoid (*Trebouxia*). With lecanoric and diploschistesic acids, and with variable amounts of orsellinic acid. Note: a widespread species of arid grasslands, found on calciferous or base-rich soil in open, dry situations; certainly much more widespread throughout the country, especially in dry areas.

99 Spores always 4 per ascus, 18-32 x 6-15 μm . Starting the life-cycle on other lichens. Thallus non- or weakly pruinose

95 - *Diploschistes muscorum* (Scop.) R.Sant.

Thallus crustose, greenish to whitish grey, pruinose or not, continuous to verrucose-areolate, K+ yellowish to red, C+ red, KC+ red, P-, UV-. Areolae 0.2-0.6 mm diam., flat to subconvex, thin to thick, irregularly angular at least when young. Apothecia frequent, lecanorine, rounded, urceolate, semi-immersed and not constricted, to 1.8(-2) mm diam. Disc black, often faintly pruinose, concave.



Margin distinct, thick, pseudoparenchymatous in section. Hymenium and hypothecium colourless to pale brown, I-. Paraphyses mostly simple, not apically thickened, free. Asci subclavate to cylindrical, the wall I-, the content I+ orange-red, with a somewhat abrupt apical thickening, lacking any apical apparatus. Spores pigmented, broadly ellipsoid, muriform, 4 per ascus, 18-32 x 6-15 μm . Photobiont chlorococcoid (*Trebouxia*). With lecanoric and diploschistesic acids and variable amounts of orsellinic acid. Note: a holarctic lichen, often - but apparently not always - starting the life-cycle on the squamules of *Cladonia* (esp. *C. pocillum* and *C. symphycarpa*), generally found on mosses and plant debris in dry grasslands on limestone. Rather common throughout the country, with a wide altitudinal range.

- 100 Thallus K+ rapidly red, with norstictic acid 101
 100 Thallus K+ yellow or K-, without norstictic acid 104
 101 Thallus KC+ yellow-red, P+ yellow. Spores >50 μm broad

96 - *Pertusaria glomerata* (Ach.) Schaer.



Thallus crustose, whitish grey to yellowish white, smooth to mostly verrucose-tuberculate, K+ yellow, then rapidly red, C-, KC+ faintly yellow-red, P+ yellow, UV+ glaucous. Apothecia frequent, lecanorine, immersed in subglobose, strongly constricted, 1-1.5 mm broad thalline warts, 1(-3) per wart, the disc 0.1-0.2 mm diam., brown-black, yellow-brown when young, punctiform. Epithecium brown-black, K+ violet. Paraphyses thin, densely ramified, free. Asci cylindrical, with a clear tholus and a thick ocular chamber, the outer gel weakly I+ blue. Spores 1-celled, hyaline, ellipsoid, thick-walled, mostly 4 per ascus, (50-)70-125(-170) x 25-50(-60) μm . Pycnidia dark, immersed. Conidia bacilliform, 8-11 x 0.5 μm . Photobiont chlorococcoid. With norstictic acid and variable amounts of stictic acid. Note: an arctic-alpine lichen, found on soil rich in humus and plant debris in sites with a long snow-lie. Certainly ranging throughout the Italian Alps.

- 101 Thallus KC-, P- (rarely P+ orange). Spores <50 μm broad 102
 102 In lowland areas. Parasitic on *Diploschistes*. Thallus pruinose-farinose. Spores many more than 8 per ascus

97 - *Acarospora nodulosa* (Dufour) Hue var. *reagens* (Zahlbr.) Clauzade & Cl.Roux



Thallus crustose, white, thick, areolate, farinose, K+ red (mostly in the medulla), C-, KC-, P-. Areolae (2-)3-5(-6) mm broad, contiguous, mostly convex, the lower surface usually dark-coloured. Apothecia frequent, lecanorine, rounded, semi-immersed, 1-2(-4) mm diam. Disc brown to almost black, flat, smooth. Margin thick. Epithecium brown. Hymenium colourless, I+ blue. Hypothecium colourless. Paraphyses numerous, simple to sparsely ramified above. Asci clavate, with a distinct apical dome. Spores 1-celled, hyaline, globose, many per ascus, 4-6 x 4-6 μm . Pycnidia dark, immersed. Conidia broadly ellipsoidal, 1-celled. Photobiont chlorococcoid.

With norstictic acid. Note: parasitic on *Diploschistes scruposus* s.lat.
A xeric subtropical lichen found on gypsum in exposed situations, to be looked for in gypsum outcrops of southern Italy (e.g. in Sicilia).

102 In upland areas, with optimum above treeline. Not on *Diploschistes*. Thallus not pruinose-farinose. Spores 8 per ascus 103

103 Thallus thin, inconspicuous

98 - *Bryonora castanea* (Hepp) Poelt

Thallus crustose, greyish to brownish, thin, continuous to rarely granulose, often indistinct, K+ red, C-, KC-, P- or P+ orange. Medulla UV-. Apothecia frequent, lecanorine, sessile, 0.5-2(-3) mm diam. Disc dark reddish brown, first concave, then flat, sometimes faintly pruinose. Margin thick, crenulate-undulate. Paraphyses simple, distinctly thickened above, conglutinate. Epithecium reddish brown, hypothecium pale brown. Asci *Lecanora*-type broadly clavate, with a I+ blue tholus, a broad ocular chamber, and a broadly cylindrical axial mass. Spores 1-celled (rarely 2-3-celled), hyaline, ellipsoid-cylindrical, thick-walled, 8 per ascus, 14-20(-28) x 5-7 µm. Photobiont chlorococcoid. With norstictic acid. Note: a mainly arctic-alpine, circumpolar lichen, found on soil, mosses, plant remains and on other lichens in Alpine grasslands above treeline.



103 Thallus thick, granulose to subsquamulose, forming a distinct crust

99 - *Bryodina rhypariza* (Nyl.) Hafellner & Türk

Thallus crustose, grey to brownish grey, thick, granulose to subsquamulose, K+ red, C-, KC-, P-. Medulla UV-. Areolae/squamules 0.2-0.5 mm broad, sometimes larger, contiguous, often forming an up to 5 cm broad subrosulate crust. Upper surface finely rugose. Apothecia frequent, lecanorine, sessile, 0.5-2(-3.5) mm diam. Disc dark brown to blackish brown, mostly flat, not pruinose. Margin thick, crenulate, usually paler than disc. Epihymenium brownish. Hymenium colourless. Lower part of hypothecium made up by strongly interwoven hyphae which separate the hypothecium from the thalline cortex of the apothecia. Excipulum with numerous granules. Paraphyses simple, distinctly thickened above, conglutinate. Asci *Lecanora*-type broadly clavate, with a I+ blue tholus, a broad ocular chamber, and a broadly cylindrical axial mass. Spores 1-celled, hyaline, ellipsoid-cylindrical, thin-walled, 8 per ascus, 17-24 x 4-5.5 µm. Pycnidia dark, ovoid, immersed. Conidia bacilliform, 12-17 x 0.7 µm. Photobiont chlorococcoid. With norstictic acid. Note: a mainly arctic-alpine species, found on mosses (*Andreaea*, *Grimmia*), often associated with cyanobacteria (*Stigonema*); almost certainly restricted to the Alps in Italy, mostly above treeline.



104 Thallus K+ yellow 105

104 Thallus K- 108

105 Apothecia pale-coloured, yellowish to orange. Thallus C+ red and spores 8 per ascus

100 - *Anzina carneonivea* (Anzi) Scheid. var. *carneonivea*



Thallus crustose, whitish grey, thin, often hemiendosubstratic, more or less continuous, K+ yellowish, C-, KC-, P-. Apothecia very common, 0.12-0.3 mm diam., lecanorine, immersed in thalline warts, initially single, then becoming confluent, C+, KC+ red. Disc yellowish-brown to orange, flat. Margin thin, smooth, paler than disc, proper margin poorly developed. Epithecium yellowish brown, K-. Hymenium colourless, I-. Hypothecium colourless. Paraphyses (paraphysoids) ca. 1.5 μ m thick, anastomosing, ramified, not apically thickened. Asci subcylindrical, thick-walled, the outer wall weakly I+ blue, not very thickened at the top, with a I+ strongly blue apical ring, 70-80 x 15-20 μ m. Spores 2(-4)celled, hyaline, ellipsoid to narrowly ellipsoid, thin-walled, with a thin halo, 8 per ascus, (11-)13-15(-18) x 5-7 μ m. Pycnidia dark, semi-immersed to protruding, 90-160 μ m in diam. Conidia short, bacilliform, 3.5-4.5 x ca. 0.7 μ m. Photobiont chlorococcoid (*Asterochloris*). With gyrophoric acid (apothecia) and traces of lecanoric acid. Note: on bark, esp. of conifers, wood, plant debris, moribund bryophytes, restricted to the Alps.

- 105 Apothecia dark-coloured, brown to blackish. Thallus C-, or, if C+ red, then spores 1 per ascus 106
- 106 Thallus C+ and KC+ red, with gyrophoric acid. Spores 1 per ascus, >100 μ m long

101 - *Pertusaria bryontha* (Ach.) Nyl.



Thallus crustose, whitish to pale grey, smooth to wrinkled, continuous to verruculose, the warts sometimes elongated, simulating coarse isidia, K+ yellowish, C+ red, KC+ red, P+ yellow, then orange-red, UV+ bluish white or orange. Apothecia frequent, lecanorine, immersed in crowded, convex thalline warts, (0.2-)1(-2.5) mm diam. Disc brown-black, yellow-brown when young, flat to convex, rough. Margin persistent, smooth to warted, often undulate. Epithecium brown-black, K+ violet. Paraphyses thin, densely ramified, free. Asci cylindrical, bitunicate, thick-walled, with a clear tholus and a thick ocular chamber, the outer gel weakly I+ blue. Spores 1-celled, hyaline, ellipsoid, thick-walled (the wall mostly 12-20 μ m thick), 1 per ascus, (110-)150-210(-230) x (35-)60-90(-100) μ m. Photobiont chlorococcoid. With stictic and gyrophoric acids, and sometimes with xanthonones. Note: an arctic-alpine, circumpolar lichen, found on mosses and plant debris, mostly on calcareous substrata; probably widespread throughout the Alps.

- 106 Thallus KC-, without gyrophoric acid. Spores 8 per ascus, <35 μ m long 107
- 107 Spores 1-celled, hyaline

102 - *Lecanora epibryon* (Ach.) Ach.

Thallus crustose, whitish to pale grey, continuous to warted, K+ yellow, C-, KC-, P+ yellowish, UV-. Apothecia frequent, more or less rounded, lecanorine, sessile, strongly constricted to almost



substipitate, 0.5-2(-3) mm diam. Disc reddish brown, often somewhat shiny, mostly flat, C-, P-. Margin thick, smooth to crenulate-undulate, whitish to pale grey, K+ yellow, C-, KC-, P-, containing (section under polarised light!) small, irregular crystals in the cortex, to 100 µm thick in section. Epithecium brownish, hymenium and hypothecium colourless. Paraphyses slightly thickened above. Asci broadly clavate, with a I+ blue tholus, a broad ocular chamber, and a broadly cylindrical axial mass. Spores 1-celled, hyaline, ellipsoid, 8 per ascus, 15-19 x 7.5-9.5 µm. Photobiont chlorococcoid. With atranorin and variable amounts of zeorin. Note: a circumpolar, arctic-alpine species, found on mosses and plant debris in open calcareous grasslands and alpine tundras, often on ridges in *Carex firma* stands; common in the Alps, rarer in the Apennines.

107 Spores 2-celled, pigmented

103 - *Rinodina mniaraea* (Ach.) Körb. var. *mniaraeiza* (Nyl.) H.Magn.



Thallus crustose, whitish to pale brown to reddish brown, rather thick, areolate, K+ yellow, C-, KC-, P+ yellowish. Areolae more or less rounded, flattened to slightly convex, smooth, contiguous. Medulla filled by small crystals dissolving in K. Apothecia frequent, lecanorine, adnate to sessile, slightly constricted, 0.4-1.5 mm diam. Disc dark brown to blackish, flat to mostly convex. Margin thin, smooth. Epithecium brownish orange. Hymenium colourless. Hypothecium colourless to pale yellowish, with oil droplets. Paraphyses distinctly thickened above, the apical cell to 4 µm thick. Asci broadly clavate, with a I+ blue tholus, a broad ocular chamber, and a cylindrical to short-conical axial mass. Spores 2-celled, pigmented, ellipsoid, thick-walled, 8 per ascus, 20-34 x 10-15 µm. Photobiont chlorococcoid. With atranorin and variable amounts of variolaric acid. Note: on soil, mosses, plant debris, in tundra-like environments above treeline. Certainly more widespread in the Italian Alps.

108 Spores 4-celled

109

108 Spores not 4-celled

110

109 Spores pigmented. Apothecial margin thin, smooth

104 - *Rinodina conradii* Körb.



Thallus crustose, whitish grey to brown, thin, continuous, smooth to rugose, K-, C-, KC-, P-. Apothecia frequent, lecanorine, sessile, slightly constricted, 0.3-0.7(-1) mm diam. Disc dark brown to blackish, flat or mostly convex. Margin thin, smooth. Epithecium reddish brown. Hymenium colourless, up to 120 µm tall. Hypothecium colourless. Paraphyses distinctly thickened above. Asci broadly clavate, with a I+ blue tholus, a broad ocular chamber, and a cylindrical to short-conical axial mass. Spores 4-celled, pigmented, narrowly ellipsoid, thick-walled, 8 per ascus, 25-31 x 10-15 µm. Pycnidia dark, immersed. Conidia bacilliform, 3.5-4 x 1 µm. Photobiont chlorococcoid. Without lichen substances. Note: a short-

lived early coloniser of base-rich soil and terricolous bryophytes in open habitats, sometimes on mosses on basal parts of ancient trees.

109 Spores hyaline. Apothecial margin thick, crenulate

105 - *Bryonora curvescens* (Mudd) Poelt



Thallus crustose, grey to dark grey brown, thin, smooth to granulose, often indistinct, K- or rarely K+ red, C-, KC-, P-, UV-. Apothecia frequent, lecanorine, rounded, sessile, strongly constricted, 0.5-1(-5) mm diam. Disc dark brown to blackish brown, initially faintly grey-pruinose, concave at first, then flat, sometimes becoming convex. Margin thick, smooth, crenulate, grey to deep red-brown, often paler than disc. Paraphyses simple, distinctly thickened above, conglutinate. Asci *Lecanora*-type broadly clavate, with a I+ blue tholus, a broad ocular chamber, and a broadly cylindrical axial mass. Spores 1(-8)-celled (the septation unclear in squash preparations), hyaline, ellipsoid-cylindrical, thick-walled, straight to curved, 8 per ascus, (18-)24-35(-41) x 5-6.5(-8) μm . Photobiont chlorococcoid. With variable amounts of norstictic acid. Note: an arctic-alpine, circumpolar lichen, found on bryophytes (e.g. *Andreaea*, *Grimmia*) in sites with periodic seepage of water. Certainly widespread throughout the Alps above treeline, but not common.

110 Spores more than 4-celled 111

110 Spores 1- to 2-celled 112

111 Subalpine to alpine. Spores hyaline, not submuriform

*see 75 - **Belonia incarnata** Th.Fr.*

111 Mainly mediterranean. Spores pigmented, submuriform

106 - *Rinodina intermedia* Bagl.



Thallus crustose, whitish grey to cream-coloured or brownish, evanescent to rather evident, more or less continuous to sometimes faintly lobulate, thin, K-, C-, KC-, P-. Apothecia frequent, lecanorine, Subimmersed to adnate, 0.5-0.8(-1) mm diam. Disc dark brown to black, flat to rarely convex. Margin thin, smooth to finely rugose. Margin (section) to 20 μm thick, I-. Epithecium orange-brown. Hymenium 110-135(-150) μm tall. Hypothecium pale yellowish brown, up to 100 μm tall. Paraphyses richly branched and distinctly thickened above, the apical cells to 5 μm broad. Asci broadly clavate, with a I+ blue tholus, a broad ocular chamber, and a cylindrical to short-conical axial mass. Spores pigmented, narrowly ellipsoid, submuriform with up to 6 lumina, thick-walled, smooth, 8 per ascus, 24-36 x - 11-16 μm . Photobiont chlorococcoid. Without lichen substances. Note: a mediterranean-macaronesian species, found on soil and mosses over basic siliceous substrata, in open grasslands and garrigue vegetation.

112 Spores 1-celled 113

112 Spores 2-celled 120

113 Thallus C and KC+ red, with gyrophoric acid

107 - *Trapelia coarctata* (Sm.) M.Choisy



Thallus crustose, whitish, pale grey to pinkish-grey, thin, continuous to cracked, sometimes with a whitish prothallus, K-, C+ red, KC+ red, P-, UV+ bluish white. Apothecia frequent, lecanorine, rounded at least when young, sessile, up to 0.8 mm diam. (usually less); immature apothecia frequent, appearing as white dots on the thallus. Disc pinkish-grey to pale or dark reddish-brown. Proper margin concolourous with disc, surrounded by a thin, paler thalline margin in young apothecia. Paraphyses thin, anastomosing, densely ramified, not apically thickened. Asci clavate-cylindrical, thin-walled, I+ pale blue, with a small I+ blue cap inside the thickened apex. Spores 1-celled, hyaline, ellipsoid, 8 per ascus, 15-25 x 7-13 µm. Photobiont chlorococcoid. With gyrophoric acid. Note: a widespread holarctic lichen, an early coloniser of siliceous pebbles near the soil, sometimes on bare clayey soil, with a wide altitudinal and latitudinal range; rare, and mostly Tyrrhenian, in the eu-Mediterranean belt.

113 Thallus C and KC-, without gyrophoric acid

114

114 Spores many more than 8 per ascus

108 - *Acarospora nodulosa* (Dufour) Hue var. *nodulosa*



Thallus crustose, chalk-white pruinose, thick, areolate, K-, C-, KC-, P-. Medulla K-. Areolae (2-)3-4(-5) mm broad, contiguous, mostly convex, often crenulate-lobulate at margin. Apothecia frequent, mostly rounded, lecanorine, semi-immersed when young to sessile when old, 1-2(-4) mm diam. Disc brown to almost black, flat, smooth to rugose. Margin thick, white-pruinose. Epithecium brown. Hymenium I+ blue. Hypothecium colourless. Paraphyses numerous, simple to sparsely ramified above. Asci clavate, with a distinct apical dome, I-. Spores 1-celled, hyaline, subglobose, many per ascus, 4-7 x 3-6 µm. Pycnidia dark, immersed. Conidia broadly ellipsoidal, 1-celled. Photobiont chlorococcoid. Without lichen substances. Note: parasitic on *Diploschistes scruposus* s.lat. A xeric subtropical lichen found on gypsum in exposed situations, to be looked for in gypsum outcrops of southern Italy (especially in Sicily).

114 Spores 8 per ascus

115

115 Thallus yellowish green to greenish

109 - *Lecanora leptacina* Sommerf.



Thallus crustose, yellowish to yellowish green, areolate, K-, C-, KC-, P- or rarely P+ faintly yellow. Areolae flat to convex, sometimes subsquamulose, scattered to mostly contiguous, forming a compact crust, often slightly elongate at the margin, sometimes surrounded by a dark prothallus. Apothecia frequent, lecanorine, rounded, sessile, semi-immersed to slightly constricted, up to 1.5 mm diam (usually less). Disc olivaceous green, becoming blackish with age, often faintly white-blue pruinose. Margin persistent, mostly crenulate-undulate, smooth. Epithecium yellowish brown, K+ blue-green. Paraphyses sparsely anastomosing and ramified, slightly thickened above. Asci clavate, with a I+ blue tholus, a broad ocular

chamber, and a broadly cylindrical axial mass. Spores 1-celled, hyaline, ellipsoid, 8 per ascus, (9-)10-13(-15) x (4.5-)6-9 μm . Photobiont chlorococcoid. With atranorin, psoromic and 2'-O-demethylpsoromic acid. Note: a probably circumpolar, arctic-alpine lichen, found on mosses (*Andreaea*, *Grimmia*) and plant debris in sites with a long snow-lie; for Italy there is only an old record (see Nimis 1993: 355) from the Alps of Piemonte. Perhaps more widespread in the Alps.

- 115 Thallus not yellowish green to greenish 116
 116 Thallus grey-brown to brownish green 117
 116 Thallus whitish to pale whitish grey 118
 117 Thallus thin. Apothecial margin smooth. Spores $<8 \mu\text{m}$ broad. Apothecia K- (if apothecia K+ violet-red see 124: *Caloplaca nivalis*)

see 105 - Bryonora curvescens (Mudd) Poelt

- 117 Thallus thick. Apothecial margin rough, with warts or squamules. Spores $>8 \mu\text{m}$ broad

110 - *Psoroma hypnorum* (Vahl) Gray

Thallus crustose to subsquamulose, green-grey to yellowish brown in sun-forms, bright green when wet, thick, areolate-lobulate, K-, C-, KC-, P-, UV-. Areolae subgranular to mostly subsquamulose, contiguous to imbricate, 0.2-0.5 mm diam., with interspersed darker, more or less bluish, more granular squamules containing *Nostoc* (cephalodia). Upper and lower cortex paraplectenchymatous, 30-40 μm thick. Apothecia frequent, lecanorine, sessile, up to 5 mm diam. Disc brown, concave, smooth. Margin thick, verruculose, with numerous squamules and thin transparent hairs in the lower part. Epitecium brownish. Hymenium I+ dark blue. Paraphyses simple, not apically thickened, short-celled. Asci clavate to subcylindrical, with a I+ blue tholus and an internal, darker I+ blue ring-structure. Spores 1-celled, hyaline, ellipsoid, thick-walled, ornamented, 8 per ascus, 19-28 x 8-10 μm . Pycnidia pale, semi-immersed. Conidia bacilliform, 5-6 x 12 μm . Photobiont chlorococcoid. Without lichen substances. Note: an arctic-alpine to boreal-montane, circumpolar lichen, found on soil, often in and amongst bryophytes, in moist habitats; most frequent in the Alps, from the montane belt to above treeline. To be looked for in the siliceous mountains of Calabria.



- 118 Apothecial disc black (sometimes covered by a white pruina), and spores at least 20 μm broad

111 - *Megaspora verrucosa* (Ach.) Hafellner & V. Wirth var. *verrucosa*

Thallus crustose, whitish to pale or rarely dark grey, continuous to warty, more or less densely white-pruinose, K-, C-, KC-, P-, UV-. Apothecia frequent, lecanorine, immersed in thalline warts, up to 1.5 mm diam (usually less). Disc black, initially pore-like, then



expanded, concave to flat with age, rough, the black colour expanding to the margins, forming a dark halo. Margin thick, smooth, whitish to grey, darker in inner part, pruinose. Epithecium olivaceous green, K+ brownish, C-, P-, N+ green. Hymenium colourless, I+ blue. Hypothecium colourless. Paraphyses anastomosing, ramified, not apically thickened, conglutinate. Asci narrowly clavate to subcylindrical, thick-walled, the outer wall weakly I+ blue. Spores 1-celled, hyaline, broadly ellipsoid to subglobose, thick-walled, 8 per ascus, 30-60 x 22-40 μm . Pycnidia dark, immersed. Conidia filiform, up to 12 μm long. Photobiont chlorococcoid. Without lichen substances. Note: a circumpolar, arctic-alpine lichen found on mosses and plant debris over calciferous ground in open situations; most common above treeline, it descends to lower altitudes in dry-continental areas; rather common also in the Apennines, south to the calcareous mountains of Sicilia.

- 118 Apothecial disc not black, or, if black, spores $<7 \mu\text{m}$ broad 119
 119 Apothecia $<0.8 \text{ mm}$ diam., with a thin, pruinose, often crenulate margin. Spores small, 10-16 x 5-7 μm . Apothecial disc K- (if K+ violet-red see 124: *Caloplaca nivalis*)

112 - *Lecanora hagenii* (Ach.) Ach. var. *fallax* Hepp



Thallus crustose, whitish, thin, more or less continuous, K-, C-, KC-, P-, UV-. Apothecia frequent, lecanorine, sessile, strongly constricted, up to 0.5 mm diam. (usually less). Disc from brownish-black to olivaceous brown, but usually densely white-grey-pruinose, mostly flat. Margin thin, crenulate, whitish, densely pruinose. Epithecium brownish, granular. Hymenium and hypothecium colourless. Asci elongate-clavate, with a I+ blue tholus, a broad ocular chamber, and a broadly cylindrical axial mass. Spores 1-celled, hyaline, ellipsoid, 8 per ascus, 10-16 x 5-7 μm . Photobiont chlorococcoid. Without lichen substances. Note: a circumpolar, arctic-alpine lichen, common on plant debris and mosses over calciferous substrata from the oromediterranean belt to the Arctic zone. Very common throughout the Alps, also known from the C Apennines, to be looked for also in the highest calcareous mountains of the south. This is probably a well-distinct species, which needs further study.

- 119 Apothecia $>0.8 \text{ mm}$ diam., with a thick, smooth, non-crenulate margin. Spores large, (45-)50-75 x 25-40(-50) μm

113 - *Ochrolechia upsaliensis* (L.) A.Massal.



Thallus crustose, whitish, thin, continuous to granular-warted, K-, C- or C+ yellowish, KC-, P-. Apothecia frequent, lecanorine, sessile, strongly constricted, up to 3 mm diam. Disc pale yellowish to brownish, mostly flat and white-pruinose, K-, C- or C+ yellowish, KC-, P-. Margin thick, smooth, whitish, P-. Paraphyses anastomosing, ramified, conglutinate. Epithymenium brownish. Hymenium colourless, I+ blue. Hypothecium colourless. Asci narrowly clavate, uniformly thick-walled, the outer gel strongly I+ blue. Spores 1-celled, hyaline, ellipsoid, thick-walled, 8 per ascus,

(45-)50-75 x 25-40(-50) μm . Pycnidia dark, immersed. Conidia bacilliform. Photobiont chlorococcoid. With variable amounts of variolaric and murolic acids. Note: an arctic-alpine species of calciferous soil and plant debris; widespread but only locally common throughout the Alps, especially above treeline; also known from the Gran Sasso Massif in the C-Apennines.

120 Apothecia densely white-pruinose, <0.3 mm diam.

114 - *Lecania pusilla* Tretiach



Thallus crustose, pale green-grey to whitish, reduced to a few granules near the apothecia, K-, C-, KC-, P-. Apothecia lecanorine, sessile, 0.1-0.3 mm diam. Disc yellowish under a thick layer of white pruina, strongly convex. Margin indistinct. Epithecium pale brown, K-. Hypothecium colourless. Paraphyses slightly thickened above. Asci clavate, with a I+ blue tholus, a small ocular chamber, and a weakly I+ blue gelatinous coat. Spores 2-celled, hyaline, fusiform, with pointed ends, thin-walled, 8 per ascus, 15-19 x 2-5 μm . Photobiont chlorococcoid. Without lichen substances. Note: a very inconspicuous lichen of calcicolous bryophytes inside woods, hitherto known only from the Trieste Karst and the Friulian pre-Alps in Italy (shaded, deep dolines); to be looked for in other calcareous areas of submediterranean Italy.

- 120 Apothecia not densely white-pruinose and <0.3 mm diam at the same time 121
- 121 Apothecia dark-coloured 122
- 121 Apothecia not dark-coloured, mostly bright yellow to orange 130
- 122 Spores hyaline 123
- 122 Spores pigmented 125
- 123 Apothecia K+ red. Spores polar-diblastic

115 - *Caloplaca ammiospila* (Wahlenb.) H.Olivier



Thallus crustose, pale grey to whitish, thin, continuous to small-verrucose, K-, C-, KC-, P-. Apothecia frequent, lecanorine, sessile, constricted at the base, up to 0.7-1(-1.5) mm diam. Disc rusty red to brownish black in sun-forms, flat, with a roughened surface, K+ red. Margin rather thick, smooth, persistent, often undulate-crenulate with age, sometimes slightly paler than disc. Epithecium orange, K+ red. Hymenium and hypothecium colourless. Asci clavate, bitunicate, thickened at apex with a broad internal beak, I+ blue in the outer part of the apex. Spores 2-celled, hyaline, ellipsoid, polar-diblastic, 8 per ascus, (11-)13-16(-17) x (5-)6-8(-9) μm , the septa 3-4.5 μm thick. Pycnidia orange-yellow, immersed. Conidia ellipsoidal, 1-celled. Photobiont chlorococcoid. With anthraquinones (apothecia). Note: a mainly arctic-alpine to boreal-montane, circumpolar lichen, found on terricolous mosses and plant debris, more rarely on decaying, rather soft lignum, mostly above treeline. Not rare in suitable habitats, throughout the Alps.

123 Apothecia K -. Spores non polar-diblastic

124

124 Thallus not reduced to triangular units arranged all around the apothecium. Spores 8 per ascus, 16-23 x 6-8 μm

116 - *Halecania lecanorina* (Anzi) M.Mayrhofer & Poelt

Thallus crustose, grey to brownish grey, areolate to verrucose-granulose, K-, C-, KC-, P-, UV-. Areolae rather thick, flat to mostly convex, the marginal ones often slightly elongate. Apothecia lecanorine, sessile, 0.5-1(-2) mm diam. Disc dark brown to black, flat. Thalline margin ephemeral, proper margin thick, dark. Epithecium brownish. Hymenium colourless, I+ blue, 75-90 μm tall. Hypothecium colourless. Paraphyses simple, distinctly thickened above, with a dark cap. Asci clavate to subcylindrical, with a I+ blue outer gelatinous coat and a uniformly I+ blue apical dome. Spores 2-celled, hyaline, halonate, narrowly ellipsoid, 8 per ascus, 12-23 x (5-)6-8(-9) μm . Pycnidia immersed. Conidia bacilliform. Photobiont chlorococcoid. Note: on thin layers of soil, on mosses and plant debris over calcareous substrata, mostly near or above treeline; perhaps more widespread in the Alps, but certainly not common.



124 Thallus reduced to small triangular units arranged all around the apothecium. Spores many more than 8 per ascus, 7-17 x 2-4 μm

117 - *Solorinella asteriscus* Anzi

Thallus crustose, white-pruinose, reduced to a few triangular lobes all around the apothecia, more visible in the wet state, thin, K-, C-, KC-, P-, UV-. Apothecia frequent, immersed, up to 4 mm diam. Disc brownish black when dry, paler when wet, flat, smooth. Epiphymenium brownish. Hypothecium colourless, lying above a layer of algae. Margin composed by radially arranged hyphae. Paraphyses simple, not apically thickened, free. Asci narrowly clavate, the wall I-. Spores 2-celled, hyaline, narrowly ellipsoid, constricted at septa, curved, many per ascus, 7-17 x 2-4 μm . Photobiont chlorococcoid. Without lichen substances. Note: a typical lichen of steppe grasslands on loess, whose distribution extends widely into C Asia, found or on soil deriving from calcareous schists, restricted to strongly continental Alpine valleys in Italy, where it is extremely rare.



125 Thallus forming a thick, areolate crust

118 - *Phaeorrhiza nimbosa* (Fr.) H.Mayrhofer & Poelt

Thallus squamulose to subcrustose, from brownish to pale ochraceous yellowish in shade, sometimes faintly white-pruinose, thick, K-, C-, KC-, P-, UV-. Squamules more or less rounded, flattened, smooth, contiguous, usually non imbricate, forming a compact crust. Lower surface dark, with a dense mat of blackish, 4-5 μm thick rhizohyphae. Upper cortex paraplectenchymatous. Apothecia frequent, rounded, lecanorine, sessile to semi-immersed, to 1.2 mm diam. Disc black, sometimes faintly pruinose. Margin thin, smooth. Epithecium reddish brown. Hymenium colourless. Hypothecium colourless. Paraphyses distinctly thickened above,



with a brown cap. Asci *Lecanora*-type, broadly clavate, with a I+ blue tholus, a broad ocular chamber, and a cylindrical to short-conical axial mass. Spores 2-celled, pigmented, ellipsoid, rather thin-walled except at the ends, 8 per ascus, 18-22 x 8-10 μm . Pycnidia dark, immersed. Conidia bacilliform. Photobiont chlorococcoid. With variolaric acid, zeorin, and triterpenes. Note: common above treeline, mostly on calciferous substrata, especially in the Alps; occurring also in the Central Apennines (Gran Sasso and Majella Massives).

- 125 Thallus thin, film-like 126
 126 Apothecial margin (section!) with a well-developed cortex (section!) 127
 126 Apothecial margin without a well-developed cortex 128
 127 Apothecial cortex I- (section!). Apothecial disc brown to greyish brown, to 0.7 mm diam. Spores 16-24 x 7-10 μm

119 - *Rinodina olivaceobrunnea* C.W.Dodge & G.E.Baker

Thallus crustose, grey-brown, thin, more or less continuous, K-, C-, KC-, P-, UV-. Apothecia frequent, lecanorine, sessile, slightly constricted, 0.2-0.7 mm diam. Disc dark brown to greyish brown, flat to mostly convex. Margin thin, smooth, the cortex I- in section. Epithecium brownish. Hymenium and hypothecium colourless. Paraphyses distinctly thickened above. Asci broadly clavate, with a I+ blue tholus, a broad ocular chamber, and a cylindrical to short-conical axial mass. Spores 2-celled, pigmented, ellipsoid, thick-walled, 8 per ascus, 15-25 x 6-10.5 μm . Pycnidia dark, immersed. Conidia bacilliform. Photobiont chlorococcoid. With traces of zeorin and pannarin. Note: an arctic-alpine, circumpolar species, found on soil, bryophytes and plant debris in tundra-like environments; certainly widespread throughout the Alps, but not very common.



- 127 Apothecial cortex I+ blue. Apothecial disc black, to 1.7 mm diam. Spores 24-34 x 9-14 μm

120 - *Rinodina turfacea* (Wahlenb.) Körb.

Thallus crustose, grey-brown, thin, K-, C-, KC-, P-, UV-. Apothecia frequent, lecanorine, sessile, slightly constricted, 1-1.7 mm diam. Disc black, flat to mostly convex. Margin thin, smooth, the cortex I+ blue in section. Epithecium brownish. Hymenium and hypothecium colourless. Paraphyses distinctly thickened above. Asci broadly clavate, with a I+ blue tholus, a broad ocular chamber, and a cylindrical to short-conical axial mass. Spores 2-celled, pigmented, ellipsoid, thick-walled, 8 per ascus, 24-34 x 9-14 μm . Pycnidia dark, immersed. Conidia bacilliform. Photobiont chlorococcoid. With sphaerophorin and variable amounts of variolaric acid. Note: an arctic-alpine, circumpolar lichen, found on soil rich in humus and plant remains in tundra-like habitats. Widespread throughout the Alps above treeline, but not very common.



- 128 Thallus whitish. Apothecial disc often white-pruinose. Hypothecium

<60 µm tall

121 - *Rinodina roscida* (Sommerf.) Arnold



Thallus crustose, whitish grey, thin, areolate, K-, C-, KC-, P-, UV-. Areolae rounded, flattened, smooth, contiguous. Medulla with crystals of oxalates, esp. above and below. Apothecia frequent, lecanorine, sessile, slightly constricted, up to 3 mm diam. Disc black, often white-pruinose. Margin thin, smooth. Epithecium brownish. Hymenium colourless. Hypothecium colourless to pale yellowish. Paraphyses distinctly thickened above. Asci broadly clavate, with a I+ blue tholus, a broad ocular chamber, and a cylindrical to short-conical axial mass. Spores 2-celled, pigmented, ellipsoid, thick-walled, 8 per ascus, 25-36 x 8-13 µm. Photobiont chlorococcoid. With variable amounts of variolaric acid and zeorin. Note: an arctic-alpine, circumpolar species found on soil, bryophytes and plant debris over calcareous substrata in tundra-like habitats. Widespread but not very common throughout the Alps.

128 Thallus brownish. Apothecial disc usually non-pruinose. Hypothecium >60 µm tall

129

129 Medulla K+ red, orange-coloured at least in lower parts

122 - *Rinodina mniaraea* (Ach.) Körb. Var. *cinnamomea* Th.Fr.



Thallus crustose, brown to reddish brown, rather thick, areolate, K-, C-, KC-, P-. Areolae rounded, flattened, smooth, contiguous. Medulla orange at least in lower parts, K+ red. Apothecia frequent, lecanorine, adnate to sessile, slightly constricted, up to 1.5 mm diam. Disc dark brown to reddish brown, flat to mostly convex. Margin thin, smooth. Epithecium brownish orange. Hymenium colourless, with oil droplets. Paraphyses distinctly thickened (to 4 µm) above. Asci broadly clavate, with a I+ blue tholus, a broad ocular chamber, and a cylindrical to short-conical axial mass. Spores 2-celled, pigmented, ellipsoid, thick-walled, 8 per ascus, 21-34 x 10-15 µm. With antraquinones in the medulla, and variable amounts of variolaric acid. Photobiont chlorococcoid. Note: on soil, mosses, plant debris, in tundra-like environments. Rare, but probably more widespread in the Alps, mostly above treeline.

129 Medulla K-, white throughout

123 - *Rinodina mniaraea* (Ach.) Körb. Var. *mniaraea*



Thallus crustose, pale brown to reddish brown, rather thick, areolate, K-, C-, KC-, P-. Areolae rounded, flattened, smooth, contiguous. Medulla white, K-. Apothecia frequent, lecanorine, adnate to sessile, slightly constricted, up to 1.5 mm diam. Disc dark brown, flat to mostly convex. Margin thin, smooth, concolorous with thallus. Epithecium brownish orange. Hymenium colourless. Hypothecium colourless to pale yellowish, with oil droplets. Paraphyses distinctly thickened above (to 4 µm). Asci broadly clavate, with a I+ blue tholus, a broad ocular chamber, and a cylindrical to short-conical axial mass. Spores 2-celled, pigmented, ellipsoid, thick-walled, 8 per ascus, 20-34 x 10-15 µm. Pycnidia dark, immersed. Conidia

bacilliform. Photobiont chlorococcoid. With variolaric acid. Note: an arctic-alpine, circumpolar species, found on soil, mosses, plant debris, in tundra-like environments, mostly above treeline. Rather common and widespread throughout the Alps; to be looked for at least in the Gran Sasso and Majella Massives (C Apennines).

130 Spores non polar-diblastic 131

130 Spores polar-diblastic 132

131 Thallus KC-. Apothecia K+ violet-red, not immersed in thalline warts. Spores 8 per ascus, 22-32 x 3-5 μm

124 - *Caloplaca nivalis* (Körb.) Th.Fr.



Thallus crustose, grey, thin, continuous to minutely granular, K-, C-, KC-, P-. Apothecia frequent, lecanorine to lecideine, sessile, slightly constricted, 0.2-0.5(-0.7) mm diam. Disc flat to mostly strongly convex, rusty-orange, orange-brown, olive-orange to blackish orange. Thalline margin granular, grey, thin, ephemeral. Proper margin orange to often olive-green to blackish, somehow shiny, thin, smooth, K+ red, C-, P-. Epithecium orange, K+ violet-red. Hymenium colourless, ca. 80 μm high. Hypothecium colourless. Paraphyses slender, 1-3 μm thick, not anastomosing, simple or furcate, submoniliform in upper part, distinctly thickened above. Asci clavate, bitunicate, thickened at apex with a broad internal beak, I+ blue in the outer part of the apex. Spores (1-)2-celled, hyaline, fusiform-elongate, sometimes narrower in the centre, with an unclear, thin septum, 8 per ascus, (22-)25-32 x 3-5(-5.5) μm . Photobiont chlorococcoid. With anthraquinones (apothecia), Note: a cool-temperate to boreal-montane, circumpolar species, found on silicolous mosses (esp. *Andreaea* and *Grimmia*) in cold-humid situations. Rare, but probably ranging throughout the Alps. Being also known from Portugal (vidi!), it should be looked for in the high siliceous mountains of Sardegna and perhaps Calabria.

131 Thallus KC+ red. Apothecia K-, immersed in thalline warts. Spores 1 per ascus, 200-400 x 70-140 μm (if spores much smaller, (4-)8 per ascus, see 100: *Anzina carneonivea*)

see 59 - *Varicellaria rhodocarpa* (Körb.) Th.Fr.

132 Spores 4 per ascus

125 - *Caloplaca tetraspora* (Nyl.) H.Olivier



Thallus crustose, grey, thin, continuous to areolate-granulose, mostly poorly evident, K-, C-, KC-, P-. Apothecia frequent, lecanorine, rounded, sessile, slightly constricted, up 0.5-1(-1.5) mm diam. Disc rusty red, first flat, then rapidly strongly convex, with a rough-granulose surface, K+ red. Margin indistinct, thin, smooth, concolorous with disc. Epithecium orange, K+ red. Hypothecium colourless. Asci clavate, bitunicate, thickened at apex with a broad internal beak, I+ blue in the outer part of the apex. Spores 2-celled, hyaline, ellipsoid, polar-diblastic, 4 (sometimes less) per ascus, (22-)24-30(-34) x (12-)14-16(-20) μm , the septa 1-2 m thick. Photobiont chlorococcoid. With anthraquinones (apothecia). Note: a boreal-

montane to arctic-alpine, circumpolar species, found on bryophytes and plant debris in areas with base-rich or somehow calciferous siliceous substrata; certainly widespread, but only locally common, throughout the Alps.

- 132 Spores 8 per ascus 133
 133 Thallus thick, areolate to subsquamulose 134
 133 Thallus thin, film-like to minutely granulose 135
 134 In lowland areas, on mineral soil. Thallus white. Apothecial disc bright rusty red. Spores 12-18 x 7-10 μm

126 - *Caloplaca aetnensis* de Lesd.



Thallus crustose, white, thick, areolate, K-, C-, KC-, P-. Areolae flat to convex, contiguous to rarely scattered, more or less smooth, white-pruinose, usually forming a large crust. Apothecia common, lecanorine, rounded, sessile, slightly constricted, up to 1.5 mm diam. Disc bright rusty red, flat to convex with age, K+ red. Proper margin thick somehow paler than disc, surrounded by a white thalline margin evident in young apothecia. Epithecium K+ red. Hymenium colourless, 70-90 μm high. Hypothecium colourless. Paraphyses branched thickly septate towards the tips, the apical cells enlarged, to 4 μm thick. Spores 2-celled, hyaline, ellipsoid, polar-diblastic, 8 per ascus, 12-18 x 7-10 μm , the septum 1/4-1/5 of spore length. Pycnidia immersed. Conidia ellipsoidal, 1-celled. Photobiont chlorococcoid. With anthraquinones (apothecia). Note: a mild-temperate to (mainly) mediterranean, poorly known lichen, found on soil deriving from volcanic base-rich rocks, but also on weathered calciferous sandstone, esp. on walls; common only in parts of S Italy, esp. in the small volcanic islands, and in the lower parts of the Etna in Sicilia. This species should be compared with *C. albolutescens* (Nyl.) H. Olivier.

- 134 In upland areas, on mosses. Thallus brownish to brownish-grey. Apothecial disc orange. Spores 12-15 x 4-8 μm

127 - *Caloplaca congregiensis* (Nyl.) Zahlbr.



Thallus crustose to subsquamulose, brownish to brownish-grey, thick, K-, C-, KC-, P-. Areolae convex, sometimes subsquamulose, contiguous, tending to form thick pillows. Apothecia frequent, lecanorine, rounded, sessile, 0.3-0.6 mm diam. Disc orange, flat, K+ red. Thalline margin thick, smooth, brownish to brownish grey, K-, C-, KC-, P-. Epithecium K+ red. Hymenium and hypothecium colourless. Asci clavate, bitunicate, thickened at apex with a broad internal beak, I+ blue in the outer part of the apex. Spores 2-celled, hyaline, ellipsoid, polar-diblastic, 8 per ascus, 12-15 x 4-8 μm , the septum >3 μm . Photobiont chlorococcoid. With anthraquinones (apothecia). Note: a montane-subtropical to mild-temperate, mainly mediterranean-atlantic species, found on epilithic mosses overgrowing base-rich, often volcanic, siliceous rocks. For Italy it is known with certainty only from the Etna Volcano and the highest siliceous mountains of Sardegna (see Nimis 1993: 162).

- 135 Apothecial margin grey to brownish 136
 135 Apothecial margin yellow to red 137
 136 Apothecial disc pale greenish-yellow, sometimes becoming darker olive-yellow with age

128 - *Caloplaca cerina* (Hedw.) var. *chloroleuca* (Sm.)

Th.Fr.



Thallus crustose, grey to whitish, thin, more or less continuous to almost leprose, K-, C-, KC-, P-. Apothecia frequent, lecanorine, rounded, sessile, strongly constricted to almost substipitate, 0.5-1(-1.5) mm diam. Disc greenish-yellow, sometimes becoming darker olive-yellow with age, mostly concave to flat, yellow-pruinose or epruinose, K+ red. Proper margin thick, smooth, grey, mostly entire and prominent, sometimes flexuose, K-, C-, KC-, P-. Epitecium K+ red. Hymenium colourless, 70-80 µm high. Paraphyses branched above, the apical cells 3-4 µm thick. Asci clavate, bitunicate, thickened at apex with a broad internal beak, I+ blue in the outer part of the apex. Spores 2-celled, hyaline, ellipsoid, polar-diblastic, 8 per ascus, (10-)12-15(-16) x (4-)6-8.5 µm, septum of 3-8 µm. Photobiont chlorococcoid. With anthraquinones (apothecia). Note: a mainly arctic-alpine, circumpolar lichen found on mosses and plant debris in tundra-like habitats, esp. in areas with calcareous or basic siliceous rocks. Extremely common throughout the Alps and in the Gran Sasso-Majella Massives, but also known from the high mountains of the south, where it is much rarer. To be looked for in the mountains of Sicilia.

- 136 Apothecial disc deep orange

129 - *Caloplaca cerina* (Hedw.) Th.Fr. var. *muscorum*

(A.Massal.) Iatta



Thallus crustose, lead grey to grey, thin, more or less continuous, K-, C-, KC-, P-. Apothecia frequent, lecanorine, rounded, sessile, strongly constricted, to almost substipitate, (0.2-)0.5-1(-1.5) mm diam. Disc deep orange, concave to mostly flat, K+ red. Proper margin thick, smooth, grey, mostly entire and prominent, K-, C-, KC-, P-. Epitecium K+ red. Hymenium colourless, 70-80 µm high. Paraphyses branched above, the apical cells 3-4 µm thick. Asci clavate, bitunicate, thickened at apex with a broad internal beak, I+ blue in the outer part of the apex. Spores 2-celled, hyaline, ellipsoid, polar-diblastic, 8 per ascus, 12-15(-16) x (4-)6-8.5 µm, septum of 3-8 µm. Photobiont chlorococcoid. With anthraquinones (apothecia). Note: on mosses and plant debris, esp. in dry-continental areas with basic siliceous substrata. Common and abundant both in the dry alpine valleys, and in parts of mediterranean Italy with suitable substrata (e.g. in Sardegna), very rare elsewhere.

- 137 Apothecial margin indistinct. Disc rapidly convex 138
 137 Apothecial margin distinct, more or less persistent. Disc long remaining flat 139

- 138 Apothecia rusty red to brownish red. Spores 12-23 x 6-12 μm

130 - *Caloplaca sinapisperma* (Lam. & DC.) Maheu & A. Gillet



Thallus crustose, whitish to pale grey, rather thick, areolate, K-, C-, KC-, P-. Areolae flat to convex, contiguous, sometimes almost subsquamulose, 0.1-0.3 mm broad, smooth, not pruinose, forming a compact crust. Apothecia frequent, lecanorine, sessile, slightly constricted, 0.2-0.6(-0.8) mm diam. Disc rusty red to dark reddish brown, first flat, but rapidly becoming strongly convex, K+ red. Thalline margin indistinct in mature apothecia; proper margin thin, evident only in very young apothecia. Epithecium coarsely granular, orange, K+ red. Hymenium and hypothecium colourless. Asci clavate, bitunicate, thickened at apex with a broad internal beak, I+ blue in the outer part of the apex. Spores 2-celled, hyaline, ellipsoid, polar-diblastic, 8 per ascus (but sometimes 2- to 6 per ascus!), (12)-15-20(-23) x (6-)8-10(-12) μm , the septa 2.5-3 μm thick. Photobiont chlorococcoid. With anthraquinones (apothecia). Note: a holarctic lichen ranging from the arctic zone to the high southern mountains, found on mosses and plant debris on calcareous or base-rich siliceous substrata, sometimes reaching the montane belt in open habitats; common in the Alps, but also present in the highest mountains of the C-Apennines. To be looked for in other calcareous mountains of the south, where - if present - is certainly extremely rare.

- 138 Apothecia ochraceous orange to brownish orange. Spores 13-17 x 5-9 μm

131 - *Caloplaca livida* (Hepp) Iatta



Thallus crustose, pale grey to whitish, thin, continuous, often inconspicuous, K-, C-, KC-, P-. Apothecia frequent, lecanorine, rounded, sessile, strongly constricted, 0.3-0.5(-0.8) mm diam. Disc ochraceous orange to brownish-orange, soon convex, K+ red. Margin thin, K+ red, C-, KC-. Epithecium K+ red. Hymenium and hypothecium colourless. Asci clavate, bitunicate, thickened at apex with a broad internal beak, I+ blue in the outer part of the apex. Spores 2-celled, hyaline, broadly to narrowly ellipsoid, polar-diblastic, 8 per ascus, (13-)15(-17) x (5-)7-8(-9) μm , the septum 2.5-3 μm thick. Photobiont chlorococcoid. With anthraquinones (apothecia). Note: an arctic-alpine species, found on bryophytes and plant debris above acid siliceous rocks, mostly above treeline. Most probably restricted to the Alps in Italy.

- 139 Apothecia, at least when young, bright orange to lemon yellow 140

- 139 Apothecia rusty red to orange-brown 141

- 140 Apothecia bright orange. Spores 10-12(-13) x (4-)6-7(-8) μm

132 - *Caloplaca saxifragarum* Poelt

Thallus crustose, pale grey to whitish, thin, continuous, often



inconspicuous, K-, C-, KC-, P-. Apothecia frequent, lecanorine, rounded, sessile, slightly constricted, 0.3-0.7 mm diam. Disc orange, flat to slightly convex, K+ red. Margin thin, smooth, concolorous with disc or slightly paler, K+ red. Epithecium coarsely granular, K+ red. Hymenium and hypothecium colourless. Asci clavate, bitunicate, thickened at apex with a broad internal beak, I+ blue in the outer part of the apex. Spores 2-celled, hyaline, ellipsoid, polar-diblastic, 8 per ascus, 10-12(-13) x (4-)6-7(-8) μm , the septa up to 5.5 μm thick. Photobiont chlorococcoid. With anthraquinones (apothecia). Note: a circumpolar, arctic-alpine lichen found on plant debris (esp. on dead leaves of *Saxifraga*, *Dryas* and *Carex firma*), and on moribund bryophytes in open habitats over calcareous or dolomitic substrata, mainly above treeline. Very common in the Alps, and also known from the Gran Sasso Massif in the C Apennines; to be looked for in the highest mountains of the south.

- 140 Apothecia lemon yellow, becoming greenish yellow to dark green with age. Spores larger, (11-)14-17(-18) x (6-)7-9(-10.5) μm

133 - *Caloplaca tirolensis* Zahlbr.



Thallus crustose, pale grey to whitish, thin, continuous, often inconspicuous, K-, C-, KC-, P-. Apothecia frequent, lecanorine, sessile, slightly constricted, 0.2-0.5(-1) mm diam. Disc lemon yellow, becoming greenish yellow to dark green or almost blackish with age, flat, K+ red. Margin thin, smooth, often paler than disc, K+ red. Epithecium coarsely granular, K+ red. Hymenium and hypothecium colourless. Asci clavate, bitunicate, thickened at apex with a broad internal beak, I+ blue in the outer part of the apex. Spores 2-celled, hyaline, broadly ellipsoid, polar-diblastic, 8 per ascus, (11-)14-17(-18) x (6-)7-9(-10.5) μm , the septa 3-6 μm thick. Photobiont chlorococcoid. With anthraquinones (apothecia). Note: a holarctic, arctic-alpine species, mainly found on mosses and plant debris in *Carex firma* stands above treeline, often on leaves of *Saxifraga*; common in the Alps, much rarer in the Apennines (Gran Sasso Massif).

- 141 Apothecia rusty red (to dark brown in sun-forms)

see 115 - *Caloplaca ammiospila* (Wahlenb.) H.Olivier

- 141 Apothecia yellow-orange to brownish orange 142

- 142 Spores (16-)18-21 x 7-8(-10) μm . Apothecia 1-1.5(-2) mm diam.

134 - *Caloplaca jungermanniae* (Vahl) Th.Fr.



Thallus crustose, pale grey to whitish, thin, K-, C-, KC-, P-. Apothecia frequent, lecanorine, rounded, sessile, slightly constricted, 1-1.5(-2) mm diam. Disc orange-yellow to mostly brownish orange, flat to weakly convex, roughened, K+ red. Margin thin, smooth, pale (brownish) orange, paler than disc, K+ red. Epithecium coarsely granular, K+ red. Hymenium and hypothecium colourless. Asci clavate, bitunicate, thickened at apex with a broad internal beak, I+ blue in the outer part of the apex. Spores 2-celled, hyaline, ellipsoid, polar-diblastic, 8 per ascus, (16-)18-21 x 7-8(-10) μm , the septa 3.5-

4 µm thick. Photobiont chlorococcoid. With anthraquinones (apothecia). Note: an arctic-alpine, circumpolar species of terricolous bryophytes and plant debris near and above treeline, mostly on base-rich siliceous substrata, less common in areas with pure limestone; certainly much more widespread, throughout the Alps.

142 Spores 10-13 x 6-7.5 µm. Apothecia 0.5-1 mm diam.

135 - *Caloplaca schoeferi* Poelt



Thallus crustose, pale grey to whitish, thin, often inconspicuous, K-, C-, KC-, P-. Apothecia frequent, lecanorine, rounded, sessile, slightly constricted, 0.5-0.8(-1) mm diam. Disc dirty yellow-orange to pale brownish orange, flat to moderately convex, K+ red. Margin thin, smooth, sometimes paler than disc, K+ red. Epithecium K+ red. Hymenium and hypothecium colourless. Asci clavate, bitunicate, thickened at apex with a broad internal beak, I+ blue in the outer part of the apex. Spores 2-celled, hyaline, ellipsoid, polar-diblastic, 8 per ascus, 10-13 x 6-7.5 µm, the septa 1.5-3 µm thick. Photobiont chlorococcoid. With anthraquinones (apothecia). Note: on epilithic mosses over more or less calciferous substrata. A poorly understood, rare species, which needs further study, erroneously reported as *C. fuscolutea* by Nimis (1993: 169) from the mountains of Sardegna, Calabria and Sicilia; certainly present also in the Alps.

143 Apothecia brought on evident, whitish stipes. Thallus KC+ yellow 144

143 Apothecia usually not stipitate. Thallus KC-, KC+ orange, or KC+ red 146

144 Thallus K+ yellow changing to red

136 - *Baeomyces carneus* Flörke



Primary thallus crustose to squamulose, grey-green to dull greenish, K+ yellow changing to red, C-, KC+ yellow, P+ orange. Areolae (squamules) flat to convex, contiguous, 0.2-2 mm long, 0.2-0.7 mm broad, more or less schizidiate, the margin crenulate. Medulla P+ orange, UV-. Apothecia frequent, without a thalline margin, terminal, stipitate, to 2 mm broad, the stipes to 5 mm tall. Disc reddish brown, flat to more frequently convex, K+ red. Paraphyses slender, simple to slightly branched at the tips. Asci unitunicate, cylindrical, thin-walled, the apex truncate, I-. Spores hyaline, fusiform, 8 per ascus, 1-(-2)-celled, 3-11 x 2-2.8 µm. Photobiont chlorococcoid. With norstictic acid. Note: a mainly boreal-montane, perhaps circumpolar, rather poorly known lichen, found on soils high in clay and on weathered siliceous rocks, exceptionally also on acid bark. Known only from Lombardia (an old record by Anzi, which needs re-confirmation, see Nimis 1993: 118), and certainly restricted to the Alps in Italy, where - if really present - it is extremely rare.

144 Thallus K+ yellow 145

145 Thallus and medulla UV-. Apothecia reddish brown. With stictic acid, and variable amounts of norstictic and constictic acids

137 - *Baeomyces rufus* (Huds.) Rebent.

Primary thallus crustose, grey-green to dull greenish white, thick, areolate, K+ yellow, C-, KC+ yellow, P+ orange-yellow, UV-. Areolae convex, contiguous, to 1 mm broad, with a warty to smooth cortex, often powdery soresiate, the soredia greenish grey. Schizidia present occasionally, <0.2 mm diam., disc-like. Medulla UV-. Apothecia frequent, without a thalline margin, terminal, brought on erect, subfruticose, smooth, flattened to subcylindrical, often longitudinally fissured stipes 2-4(-6) mm tall. Disc red brown, flat to convex, the margins often inrolled, most often fissured, to 2.5 mm diam., single or coalescing. Paraphyses simple to poorly branched above, slender, 1-1.8 µm thick. Asci unitunicate, cylindrical, thin-walled, the apex truncate, I-. Spores 1-(2-)celled, hyaline, fusiform, 8 per ascus, 8-13 x 2.5-4.5 µm. Pycnidia rare. Conidia bacilliform. Photobiont chlorococcoid. With stictic acid, and variable amounts of norstictic and constictic acids. Note: a holarctic early coloniser of acid soils with high clay content and of weathered siliceous rocks, often found in disturbed sites; mostly sterile in upland areas. Certainly occurring throughout Italy, mostly in the mountains.



- 145 Thallus and medulla UV+ orange. Apothecia pale pink-coloured. With baeomycesic acid, and variable amounts of squamatic acid and atranorin

138 - *Dibaeis baeomyces* (L. fil.) Rambold & Hertel

Primary thallus crustose, grey, white or pale pinkish, thick, areolate, usually with soft, rounded, white to pale pink, more or less shiny, warty schizidia which reach 1 mm diam. in sterile thalli, K+ yellow, C-, KC+ yellow, P+ yellow to orange, UV+ orange. Areolae convex, contiguous. Medulla P+ yellow to orange, UV+ orange. Apothecia frequent, globose also when young, pink-coloured, 1-4 mm broad, emarginate or with a narrow margin, brought on erect, subfruticose, smooth stipes (podetia), 2-5 mm tall and to 3 mm in diam. Hymenium I+ pale blue (reaction ephemeral!). Hypothecium colourless. Paraphyses simple, not anastomosing, only slightly thickened above. Asci unitunicate, cylindrical, thin-walled, slightly thickened above, I+ blue, the tip deep blue. Spores hyaline, mainly 1-celled (some spores 2-celled), fusiform, 8 per ascus, 10-26 x 2-3 µm. Pycnidia immersed in warts, mostly laminal. Conidia shortly bacilliform. Photobiont chlorococcoid. With baeomycesic acid, and variable amounts of squamatic acid and atranorin. Note: on humid, disturbed clay soil, often in *Calluna*-heaths, mostly sterile near or above treeline; most frequent in the north, to be looked for further on the siliceous mountains of the C and S Apennines.



- 146 Thallus KC+ orange 147
146 Thallus KC+ red or KC- 152
147 Apothecia pink to pale orange-pink

139 - *Icmadophila ericetorum* (L.) Zahlbr.

Thallus crustose, glaucous green to whitish grey, continuous, granulose, not corticate, K+ orange, C-, KC+ orange, P+ orange,



UV+ glaucous. Apothecia frequent, rounded, without a thalline margin, strongly constricted to substipitate, 1-2(3.5) mm diam. Disc pink to pale orange-pink, sometimes faintly pruinose, flat to convex. Margin thin, smooth, often paler than disc, sometimes whitish-pruinose. Epithecium reddish brown, with many small crystals, K+ orange. Hymenium and hypothecium colourless, I+ blue. Paraphyses simple, slender (ca. 1 μ m thick) with swollen apices to 5 μ m broad. Asci cylindrical, I-, except for a thin I+ blue apical cap. Spores (2-)4-celled, hyaline, fusiform-elongate, 8 per ascus, with a gelatinous coat at the two ends, 13-28 x 4-6 μ m. Pycnidia pale, immersed. Conidia bacilliform, 3.5-4 x 0.5-1 μ m. Photobiont chlorococcoid. With thamnolic and perlatolic acids. Note: a cool-temperate to boreal-montane, circumpolar species, found on decaying wood and moribund bryophytes; common in the Alps, from the montane belt to above treeline, with optimum in the oroboreal belt, much rarer on the high Mediterranean mountains (e.g. there is an old record from the mountains of Sardegna, which needs re-confirmation, see Nimis 1993: 324). To be looked for in the northern Apennines, and in the siliceous mountains of Calabria and Sicilia, where - if present - is certainly very rare.

147	Apothecia dark-coloured	148
148	Spores 2-celled, pigmented	149
148	Spores not 2-celled, pigmented or not	150
149	Hypothecium dark brown. Spores <8 μ m thick	

140 - *Buellia hypophana* (Nyl.) Zahlbr.



Thallus crustose, white to greyish white, sometimes with a faint yellowish tinge, thin to rather thick, areolate, K+ yellow, C+ orange, KC+ orange, P-. Areolae flat to mostly convex, forming a continuous crust. Apothecia frequent, black, rounded, without a thalline margin, sessile, strongly constricted, 0.4-1 mm diam. Disc black, flat to moderately convex, margin smooth, thin. Epithecium brownish. Hymenium inspersioned, with oil droplets. Hypothecium dark brown K+ reddish. Paraphyses distinctly thickened above. Asci *Bacidia*-type, distinctly thickened at the apex, with a I+ blue tholus, the outer gelatinous coat I+ pale blue. Spores 2-celled, pigmented, ellipsoid, thin-walled, 8 per ascus, 16-20 x 6-8 μ m. Photobiont chlorococcoid. Note: on epilithic, rarely terricolous mosses near or above treeline, esp. on species of *Grimmia*, known only from S Tyrol in Italy, but probably more widespread in the Alps.

149	Hypothecium colourless. Spores >8 μ m thick	
-----	---	--

141 - *Buellia insignis* (Hepp) Th.Fr.

Thallus crustose, whitish, pale grey, cream-coloured to ochraceous, minutely granulate, K+ yellow, C- or C+ yellowish, KC+ orange, P- or P+ yellowish, UV+ orange. Medulla C+ orange. Apothecia frequent, usually abundant and confluent, without a thalline margin, subimmersed to adnate, 0.5-1.3 mm



diam. Disc black, initially flat, soon convex, epruinose. Margin smooth, black, evident only in young apothecia. Excipulum well developed, 70-100 μm wide, K+ yellow (microscopic section). Epihymenium brownish. Hymenium non-inspersed, colourless, 100-130 μm thick. Hypothecium colourless, with oil droplets. Paraphyses distinctly thickened above, 4-6(-7) μm . Asci *Bacidia*-type, distinctly thickened at the apex, with a I+ blue tholus, the outer gelatinous coat I+ pale blue. Spores 2-celled, pigmented, ellipsoid, thin-walled, 8 per ascus, (19-)21-25(-29) x (8-)9-11(-12) μm , the apices pointed, often curved, roughly ornamented. Photobiont chlorococcoid. With atranorin (traces), 6-0-methylarthothelin, and traces of gyrophoric acid. Note: an arctic-alpine to boreal-montane, circumpolar lichen found on terricolous mosses and plant debris, rarely on rock, lignum and bark, esp. on basal parts of trunks. Perhaps restricted to the Alps in Italy, from the montane belt to above treeline.

150

Spores 4-celled, pigmented, 4-8 per ascus

142 - *Buellia geophila* (Sommerf.) Lynge



Thallus crustose, white to greyish-white, subcontinuous to granulose, usually forming small patches, K+ yellowish or K-, C-, KC+ orange, P-, UV+ orange. Medulla I-. Apothecia frequent, rounded, without a thalline margin, sessile, 0.3-1.5 mm diam., sometimes in clusters or confluent. Disc black to dark brown, rarely whitish-pruinose, first flat, then more or less convex. Margin thin, often whitish-pruinose (crystals of calcium oxalates). Epithecium brown. Hymenium colourless, 70-85 μm thick. Hypothecium dark brown. Paraphyses distinctly thickened above. Asci *Bacidia*-type, distinctly thickened at the apex, with a I+ blue tholus, the outer gelatinous coat I+ pale blue. Spores 4-celled, pigmented, ellipsoid with rather pointed ends, thick-walled and ornamented, the ornamentation microrugulate, 4-8 per ascus, (23-)27-33(-38) x (7-)9-11(-13) μm . Pycnidia rare, black, immersed. Conidia 4-6 x 1 μm . Photobiont chlorococcoid. With O-methyl-trichloro-norlichenxanthone in the cortex. Note: a mainly boreal-montane to arctic-alpine, circumpolar lichen overgrowing terricolous and epilithic mosses on calciferous substrata (mostly calciferous siliceous rocks); restricted to the Alps in Italy, in dry-continental situations.

150 Spores 1-celled, hyaline

151

151 Apothecial disc strongly convex, often bluish-pruinose. Spores (12-)15-19(-24) x 5-7(-9) μm

143 - *Frutidella caesioatra* (Schaer.) Kalb



Thallus crustose, grey to dark grey or almost blackish, granulose, K- (or sometimes K+ weakly yellowish), C-, KC+ orange (esp. in the medulla), P- or P+ faintly yellowish. Areolae convex, granulose to subsidoid and almost subfruticulose, 0.1-0.2 mm in diam., contiguous, forming a crust. Apothecia frequent, rounded, often tuberculate, without a thalline margin, sessile, (0.3-)0.5-1(-1.2) mm diam. Disc black, most often bluish-pruinose, flat to mostly strongly convex. Margin indistinct, esp. in old apothecia. Epithecium deep

bluish green, K+ green, C-, KC-, N+ red. Hypothecium pale reddish brown to almost violet, K+ reddish-orange. Paraphyses anastomosing, simple to slightly ramified, not or only slightly thickened above. Asci with a broad, I+ blue apical dome. Spores 1-celled, hyaline, ellipsoid, 8 per ascus, (12-)15-19(-24) x 5-7(-9) μm . Pycnidia dark, globose to pyriform, ca. 0.1 mm in diam. Conidia thread-like, 12-25 x 0.7-1 μm . Photobiont chlorococcoid, 6-12 μm in diam. With sphaerophorin. Note: an arctic-alpine lichen, found on silicolous mosses, esp. *Andreaea* and *Grimmia*, in sites with a long snow-lie, more rarely on rock, mostly above treeline. Probably restricted to the Alps in Italy.

151 Apothecial disc mostly flat, never bluish-pruinose. Spores 7-16 x (6-)7-8 μm

144 - *Lecidella wulfenii* (Hepp) Körb.



Thallus crustose, whitish to yellowish grey, thin, continuous, K+ yellow, C+ weakly orange, KC+ weakly orange, P+ yellowish. Apothecia frequent, rounded, without a thalline margin, sessile, strongly constricted, up to 1.5 mm diam. Disc black, often whiny, first flat, then convex. Margin evident, smooth, concolorous with disc, sometimes crenate-undulate in old apothecia, in section dirty bluish-black outside, reddish within. Epithecium greenish blue, K-, C-. Hymenium colourless to pale greenish blue, 80-100 μm tall. Hypothecium brown, paler above. Paraphyses simple, slightly thickened above, free. Asci clavate, with a I+ blue tholus, a broad ocular chamber, and a broadly cylindrical axial mass. Spores 1-celled, hyaline, ellipsoid, rather thick-walled, 8 per ascus, 7-16 x (6-)7-8 μm . Pycnidia dark, immersed. Conidia thread-like. Photobiont chlorococcoid. With atranorin and variable amounts of xanthonines. Note: a circumpolar, arctic-alpine lichen, found on moribund bryophytes and plant remains in exposed habitats near or above treeline; common in the Alps, but also known from the Gran Sasso and Majella Massives in the C Apennines; to be looked for in the high mountains of the south.

152 Thallus KC+ red 153

152 Thallus KC- 157

153 Spores 1-celled

see 62 - *Trapeliopsis granulosa* (Hoffm.) Lumbsch

153 Spores 2- to 4-celled 154

154 Spores 2-celled, pigmented 155

154 Spores 4-celled, hyaline 156

155 Hypothecium colourless to very pale brown

145 - *Buellia hypoleuca* H.Magn.

Thallus crustose to subsquamulose, greenish-grey to pale yellowish brown, sometimes weakly pruinose, C+ red, KC+ red, P-. Areolae



contiguous, flat to mostly convex, more or less lobulate at margins, 1-2 mm broad, corticate on both surfaces, forming a crust. Apothecia frequent, without a thalline margin, sessile. Disc black, mostly soon convex, margin smooth, black, indistinct in old apothecia. Epithecium brownish. Hymenium colourless, interspersed with oil droplets. Hypothecium colourless to very pale brown. Paraphyses distinctly thickened above. Asci *Bacidia*-type, distinctly thickened at the apex, with a I+ blue tholus, the outer gelatinous coat I+ pale blue. Spores 2-celled, pigmented, ellipsoid, thin-walled, 8 per ascus, 15-18 x 7-9 μm . Pycnidia dark, immersed. Photobiont chlorococcoid. Note: on plant debris and mosses near or above treeline; not known from Italy; to be looked for in the Alps.

155 Hypothecium dark

146 - *Buellia reagens* H.Magn.



Thallus crustose to subsquamulose, yellowish to yellowish-brown, C+ red, KC+ red, P-. Areolae ca. 0.5 mm broad, not overlapping, K+ yellowish. Apothecia frequent, without a thalline margin, sessile. Disc black, margin smooth, black. Epithecium brownish. Hymenium colourless. Hypothecium dark. Paraphyses distinctly thickened above. Asci *Bacidia*-type, distinctly thickened at the apex, with a I+ blue tholus, the outer gelatinous coat I+ pale blue. Spores 2-celled, pigmented, ellipsoid, thin-walled, 8 per ascus, 15-18 x 7-9 μm . Pycnidia dark, immersed. Photobiont chlorococcoid. Note: a rather poorly known species described from Portugal (Serra de Estrela), occurring on bryophytes overgrowing siliceous rocks; for Italy hitherto known only from the mountains of Sardegnia.

156 Macroconidia less than 50 μm long. Apothecia frequent. Spores (11-)15-23(-24) x 3-5(-6) μm

147 - *Micarea peliocarpa* (Anzi) Coppins & R.Sant.



Thallus crustose, whitish to greyish, thin, areolate, K-, C+ red, KC+ red, P-. Areolae convex, to 0.2 mm in diam. Apothecia frequent, rounded, without a thalline margin, sessile, not constricted, sometimes confluent and tuberculate, up to 0.7 mm diam (usually less). Disc pale-coloured to dark grey-black, flat to usually convex. Margin indistinct, thin, paler than disc. Epithecium K-, C+ red, P-, N+ red. Hymenium K-, C+ red, N+ red. Hypothecium more or less colourless. Paraphyses anastomosing, ramified, slightly thickened at top, conglutinate. Asci clavate, with a I+ blue tholus and an internal, darker I+ tubular structure. Spores 2-6-celled, hyaline, fusiform-elongate, thin-walled, 8 per ascus, (11-)15-23(-24) x 3-5(-6) μm . Pycnidia frequent, pale around the ostiole. Macroconidia curved, 21-45 x 1-1.5 μm . Microconidia generated by smaller, pale pycnidia, fusiform, 6-7 x 0.5-1 μm . Photobiont chlorococcoid, thin-walled, the cells often paired. With gyrophoric and 5-O-methylhiasic acids. Note: a temperate to boreal-montane, ecologically broad-ranging species, found on acid bark of deciduous (esp. old oaks and beech) and coniferous trees, lignum, peat, moribund bryophytes, small pebbles. Certainly more widespread throughout the country, esp. in rainy-humid areas.

- 156 Macroconidia flexuous, thread-like, 50-110 x 1 μm . Apothecia rare. Spores (19-)23-34(-38) x 4.5-6 μm

148 - *Micarea cinerea* (Schaer.) Hedl.



Thallus crustose, grey, thin, areolate, K-, C+ red, KC+ red, P-. Apothecia very rare, rounded, without a thalline margin, sessile, not constricted, up to 0.7 mm diam. Disc pale to dark grey-black, convex. Margin indistinct, thin, paler than disc. Epithecium K-, C+ red, P-, N+ red. Hymenium K-, C+ red, N+ red. Hypothecium colourless. Paraphyses anastomosing, ramified, not apically thickened, conglutinate. Asci clavate, with a I+ blue tholus and an internal, darker I+ tubular structure. Spores (2-)4(-6)-celled, hyaline, fusiform-elongate, thin-walled, 8 per ascus, (19-)23-34(-38) x 4.5-6. Macroconidia generated inside prominent, wart-like pycnidia, flexuous, filiform, 50-110 x 1 μm . Photobiont chlorococcoid, thin-walled, the cells often paired. With gyrophoric acid. Note: a cool-temperate to probably circumboreal-montane species, found on bark of deciduous and coniferous trees, and on epiphytic bryophytes in humid forests, more rarely on lignum of fallen, decorticated trunks. The sterile form, which produces only macroconidia, is restricted to above treeline in the Italian Alps.

- 157 Apothecia orange to orange-brown, K+ red

149 - *Protoblastenia terricola* (Anzi) Lynge



Thallus crustose, mostly white, sometimes with a brownish hue, thick, areolate, K-, C-, KC-, P-. Areolae smooth, contiguous, non imbricate, flat to weakly convex, forming a compact crust. Apothecia frequent, without a thalline margin, not constricted, 0.5-1.5 mm diam. Disc orange to orange-brown, mostly convex, smooth, K+ red. Margin indistinct. Epithecium orange, K+ red, with a layer of granules-crystals. Hymenium colourless to pale orange, I+ blue. Hypothecium orange-brown. Paraphyses rather thick, anastomosing, ramified, only slightly thickened above, conglutinate. Asci bitunicate, cylindrical-clavate, with a I+ blue tholus and an internal, darker I+ tubular structure. Spores 1-celled, hyaline, ellipsoid, thin-walled, 8 per ascus, 9.5-13 x 4.5-6 μm . Photobiont chlorococcoid. With anthraquinones (apothecia). Note: on soil over weakly calcareous or dolomitic substrata, mainly near or above treeline; perhaps this is only a terricolous morph of *P. siebenhaariana*, most frequent in the southern part of its distributional range; to be looked for in the highest mountains of the C Apennines.

- 157 Apothecia not orange, K- 158
 158 Apothecia pale-coloured 159
 158 Apothecia dark-coloured 171
 159 Thallus K+ yellow, with atranorin

150 - *Lecidea rufofusca* (Anzi) Nyl.

Thallus crustose to almost subsquamulose, whitish, greyish to pale greenish brown, granulose-warty, the warts mostly <0.7 mm diam.,



contiguous to slightly dispersed, K+ yellow, C-, KC-, P+ yellowish. Apothecia frequent, rounded, without a thalline margin, sessile, 0.3-0.7(-1) mm diam. Disc pale to dark reddish brown, flat at first, then rapidly convex. Margin thin, distinct only in young apothecia. Epithecium reddish brown, K-. Hymenium colourless, ca. 70 μ m thick. Hypothecium colourless to pale yellowish brown. Excipulum reddish brown in outer part, colourless inside. Paraphyses free. Spores 1-celled, hyaline, ellipsoid to ovoid, 8 per ascus, 11-18 x 6-9 μ m. Photobiont chlorococcoid. With atranorin. Note: on terricolous mosses and plant debris in siliceous areas. A rather poorly known species, worthy of further study, hitherto known only from the Alps, where it might be more widespread near or above treeline. The species certainly does not belong into *Lecidea* s.str. (see Nimis 1993: 389).

- | | | |
|-----|-------------------------------|-----|
| 159 | Thallus K-, without atranorin | 160 |
| 160 | Spores more than 4-celled | 161 |
| 160 | Spores no more than 4-celled | 162 |
| 161 | Spores <4 μ m broad | |

151 - *Absconditella annexa* (Arnold) Vězda



Thallus crustose, more or less greenish to greenish grey, thin, continuous, subgelatinous when wet, K-, C-, KC-, P-. Apothecia frequent, rounded, without a thalline margin, sessile, 0.1-0.3 mm diam. Disc brownish, deeply concave to finally almost flat, smooth, K-, C-, KC-, P-. Margin thin, smooth, yellowish brown, paler than disc. Hymenium I+ or I+ pale yellow. Hypothecium thin, colourless. Paraphyses thin (0.5-1 μ m), mostly simple, slightly thickened above. Asci cylindrical, thin-walled, with a distinct apical dome, I+ brownish red. Spores 6-10-celled, hyaline, acicular, thin-walled, 8 per ascus, 35-50 x 2-4(-6) μ m. Photobiont chlorococcoid. Without lichen substances. Note: an ephemeral lichen found on moribund bryophytes and organic soil on siliceous substrata, mostly near or above treeline. Extremely rare, and restricted to the Alps in Italy.

- | | | |
|-----|-------------------------|--|
| 161 | Spores >4 μ m broad | |
|-----|-------------------------|--|

152 - *Myxobilimbia sabuletorum* (Schreb.) Hafellner

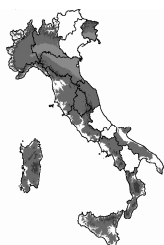


Thallus crustose, whitish to greenish white, granulose, K-, C-, KC-, P-. Apothecia frequent, without a thalline margin, sessile, up to 1(-1.2) mm diam., usually less. Disc pale pinkish brown to blackish brown, convex, sometimes faintly pruinose. Margin thin, smooth, concolorous with disc, not evident in old apothecia. Epithecium almost colourless to brownish, K-. Hymenium I+ blue. Hypothecium pale reddish brown above to almost colourless throughout. Paraphyses simple, slightly thickened above, conglutinate, with a I+ blue tholus and a small axial mass surrounded by a darker I+ tubular structure. Spores 6-10-celled, hyaline, ellipsoid-cylindrical, 8 per ascus, with a gelatinous, finely warted outer coat, 18-40 x (4-)5-8 μ m. Photobiont chlorococcoid.

Without lichen substances. Note: a holarctic, mainly temperate lichen found on mosses overgrowing soil, calciferous, tree bark, also found in urban environments (e.g. on walls). Rather common throughout Italy, especially below treeline.

- 162 Spores 2-celled 163
 162 Spores 1- or 4-celled 165
 163 Apothecial margin indistinct, Thallus composed of goniocysts, finely granular. Paraphyses ramified, anastomosing. Epithecium K+ violet, N+ red

153 - *Micarea prasina* Fr.



Thallus crustose, grey, thin, granulose, K-, C- or very rarely C+ orange, KC-, P-. Apothecia frequent, without a thalline margin, sessile, not constricted, up to 0.5 mm diam. Disc brownish, convex. Margin indistinct. Epithecium olivaceous, K+ violet, C-, P-, N+ red, KC-. Hymenium K+ violet, C-, KC-, P-, N+ red. Hypothecium colourless to yellowish. Paraphyses anastomosing, ramified, not apically thickened, conglutinate. Asci clavate, with a I+ blue tholus and an internal, darker I+ tubular structure. Spores (1-)2(-4)-celled, hyaline, ellipsoid, thin-walled, 8 per ascus, 8-14(-17) x 2-4(-5) μ m. Pycnidia immersed. Photobiont chlorococcoid, thin-walled, the cells often paired. Chemically variable. Note: a temperate to boreal-montane, morphologically and chemically variable species, found on basal parts of old, acid-barked trees in montane forests, and on a broad range of other substrata. One of the most frequent (but never common) species of the genus in Italy, esp. in the north, restricted to humid sites above the mediterranean belt in the south.

- 163 Apothecial margin distinct, usually paler than disc. Thallus not composed of goniocysts, continuous. Paraphyses simple, not anastomosing. Epithecium K-, N- 164
 164 Apothecia whitish, 0.07-0.25 mm diam. Spores 10-15(-17) x 3-5(-6) μ m

154 - *Absconditella delutula* (Nyl.) Coppins & H. Kilius



Thallus crustose, greenish to greenish grey, thin and inconspicuous, continuous, subgelatinous when wet, K-, C-, KC-, P-. Apothecia frequent, without a thalline margin, sessile, 0.07-0.25 mm diam. Disc whitish, concave, smooth, K-, C-, KC-, P-. Margin thin, smooth, whitish. Paraphyses thin (0.5-1 μ m), mostly simple, slightly thickened above. Asci cylindrical, thin-walled, with a distinct apical dome, I+ brownish red. Spores 2-celled, hyaline, narrowly ellipsoid, thin-walled, 8 per ascus, 10-15(-17) x 3-5(-6) μ m. Photobiont chlorococcoid. Without lichen substances. Note: on acid organic soil and siliceous rocks in humid-shaded situations. Never reported from Italy, but known from the Alps, where - if present -, is likely to be extremely rare, a good candidate for red-lists.

- 164 Apothecia whitish-yellowish-pinkish, 0.2-0.4 mm diam. Spores 9-

14 x 2.5-4(-5) μm

155 - *Absconditella sphagnorum* Vězda & Poelt



Thallus crustose, greenish to greenish grey, thin and inconspicuous, continuous, subgelatinous when wet, K-, C-, KC-, P-. Apothecia frequent, without a thalline margin, sessile, 0.2-0.4 mm diam. Disc whitish to pale yellowish-pinkish, concave, smooth, K-, C-, KC-, P-. Margin thin, smooth, whitish. Hymenium colourless, I+ or I+ pale yellow. Hypothecium thin, colourless. Paraphyses thin (0.5-1 μm), mostly simple, slightly thickened above. Asci cylindrical, thin-walled, with a distinct apical dome, I+ brownish red. Spores 2-celled, hyaline, narrowly ellipsoid, thin-walled, 8 per ascus, 9-14 x 2.5-4(-5) μm . Photobiont chlorococcoid. Without lichen substances. Note: an ephemeral lichen, mostly visible only in late summer, found on *Sphagnum*, in bogs of the oroboreal belt. Never reported from Italy, to be looked for in the Alps, where - if present -, is likely to be extremely rare, a good candidate for red-lists.

165 Spores 4-celled 166

165 Spores 1-celled 168

166 Paraphyses contorted, entwining the asci. Thallus composed by gonicysts with short conical outgrowths, usually semi-immersed in the substratum

156 - *Vezdaea aestivalis* (Ohlert) Tscherm.-Woess & Poelt



Thallus crustose, dull green to greenish grey, thin, granulose, K-, C-, KC-, P-. Granules corticate (goniocysts), usually semi-immersed in the substratum, with short conical outgrowths. Apothecia frequent, without a thalline margin, not constricted, 0.3-0.8(-1) mm diam. Disc grey to brownish, often finely tomentose (microscope!), convex, K-, C-, KC-, P-. Margin and hypothecium absent. Paraphyses anastomosing, contorted, entwining the asci. Asci cylindrical, thick-walled, with a thick I+ blue apex. Spores (1-)2(-4)-celled, hyaline, ellipsoid, thick-walled, with a verrucose surface, 8 per ascus, 15-19 x 5-7 μm . Photobiont chlorococcoid (*Leptosira*). Without lichen substances. Note: a mild-temperate to mediterranean-atlantic, ephemeral species, found on epiphytic bryophytes, mosses, plant debris, soil, much more rarely on mossy trunks of deciduous trees with a base-rich bark. For Italy there are only two records: a dubious one from Friuli, and a more reliable one from Calabria (see *ITALIC*). *Vezdaea* was poorly studied in Italy. Several other species are likely to occur in the country.

166 Paraphyses straight, not entwining the asci. Thallus not composed of gonicysts, without conical outgrowths, not immersed in the substratum 167

167 Apothecia whitish to pale yellowish white. Spores broadly ellipsoid to fusiform, (12-)13-22 x 4-7 μm

157 - *Mycobilimbia pilularis* (Körb.) Hafellner & Türk



Thallus crustose, grey, thin, finely-granulose to almost granulose-sorediose, the granules 25-70 μm diam., K-, C-, KC-, P-. Apothecia frequent, rounded, without a thalline margin, sessile, up to 1 mm diam. Disc whitish to pale yellowish white, rarely pale brown when old, strongly convex, K-, C-, KC-, P-. Margin indistinct in most apothecia, very thin, colourless in section. Epithecium colourless, K-, C-, P-, N-, KC-. Hymenium and hypothecium colourless. Paraphyses mostly simple, conglutinate, 3-4 μm thick. Asci clavate, with a I+ blue tholus and an internal, darker I+ tubular structure, the external gel I+ faintly blue. Spores (2-)4-celled, hyaline, broadly ellipsoid to fusiform, 8 per ascus, (12-)13-22 x 4-7 μm . Photobiont chlorococcoid. Without lichen substances. Note: on mosses growing on bark of old deciduous trees, esp. near the base of the trunks, very rarely on thin layers of soil, in old, humid forests. Rare, restricted to forests, mostly below treeline. To be looked elsewhere, e.g. in Sicilia and Sardegna.

168 Apothecia reddish to blackish brown. Spores ellipsoid-cylindrical, 16-30 x 5-6 μm

158 - *Myxobilimbia microcarpa* (Th.Fr.) Hafellner



Thallus crustose, whitish to greenish white, continuous, granulose, K-, C-, KC-, P-. Apothecia frequent, without a thalline margin, sessile, up to 0.7 mm diam. Disc reddish brown to blackish brown, sometimes somehow shiny, first flat, then rapidly convex. Margin indistinct, thin. Epithecium pale brown to reddish-brown, K-. Hymenium I+ blue. Hypothecium pale reddish brown to colourless. Paraphyses simple, slightly thickened above, conglutinate, 2-3 μm thick. Asci clavate, with a I+ blue tholus and an internal, darker I+ tubular structure, the external gel I+ faintly blue. Spores (2-)4(-6)-celled, hyaline, ellipsoid-cylindrical, 8 per ascus, with a gelatinous, finely warted outer coat, 16-30 x 5-6 μm . Photobiont chlorococcoid. Without lichen substances. Note: on mosses in dry grasslands, sometimes on epilithic bryophytes also growing on walls; mainly in upland areas, from Alps to the mountains of Calabria. Probably confused with similar species in the past, and more widespread throughout the country.

168 Spores many more than 8 per ascus 169

168 Spores 8 per ascus 170

169 Spores cylindrical, 8-13 μm long. Apothecia <1 mm diam.

159 - *Biatorella fossarum* (Fr.) Th.Fr.

Thallus crustose, pale grey, thin and inconspicuous, granulose, K-, C-, KC-, P-. Apothecia frequent, without a thalline margin, sessile, not constricted, (0.1-)0.3-0.8(-1.4) mm diam. Disc bright to dull orange-red, paler when wet, rapidly convex. Margin absent in old apothecia. Epithecium almost colourless to pale orange-yellow, K-, with a layer of crystals. Hymenium more or less colourless, I+ blue. Hypothecium pale grey-yellow. Paraphyses anastomosing, simple



below, densely ramified and weakly thickened above, conglutinate. Asci broadly cylindrical, with a I+ blue gelatinous outer coat, without a tholus, but with weakly I+ blue apical structures. Spores 1-celled, hyaline, cylindrical, many per ascus, 8-13 x 2.3-3 μm . Photobiont chlorococcoid. Without lichen substances. Note: on calciferous, often slightly decalcified soil in rather disturbed, shaded-humid habitats; chiefly southern in Europe and restricted to lowland areas in Italy (mainly old records, see Nimis 1993: 128), this species should be looked for further, esp. in the Tyrrhenian part of the country.

169 Spores narrowly ellipsoid, 5-8 μm long. Apothecia mostly >1 mm diam.

160 - *Biatorella hemisphaerica* Anzi



Thallus crustose, pale grey, thin and often inconspicuous, granulose to arachnoid, K-, C-, KC-, P-. Apothecia without a thalline margin, sessile, not constricted, 1-2 mm diam. Disc bright orange-red to reddish brown, weakly to strongly convex. Margin very thin to absent. Epithecium pale to orange-yellow, K-, often with a layer of crystals which appear as a dark yellowish-brown pruina. Hypothecium pale grey-yellow. Paraphyses anastomosing, simple below, densely ramified and distinctly thickened above, conglutinate. Asci broadly cylindrical, with a I+ blue gelatinous outer coat, without a tholus, but with weakly I+ blue apical structures. Spores 1-celled, hyaline, narrowly ellipsoid, many per ascus, 5-8 x 2-3.5 μm . Photobiont chlorococcoid. Without lichen substances. Note: a more or less circumboreal species, found on calciferous soil and amongst bryophytes, most often in rock fissures above or near treeline in rather shaded-humid situations. Certainly rare, but to be looked for throughout the Italian Alps.

170 Paraphyses contorted, entwining the asci

*see 156 - *Veizdaea aestivalis* (Ohlert) Tscherm.-Woess & Poelt*

170 Paraphyses straight, not entwining the asci

171

171 Apothecial margin (section!) colourless outside, pale brown inside. Thallus continuous, whitish grey

161 - *Biatora subduplex* (Nyl.) Printzen



Thallus crustose, whitish grey, continuous, K-, C-, KC-, P-. Apothecia frequent, without a thalline margin, sessile, not constricted. Disc orange-brown to dark brown, K-, C-, KC-, P-. Margin thin, smooth, paler than disc, K-, C-, KC-, P-, in section colourless outside, pale brown inside. Epithecium and hymenium K-, C-, P-, KC-, P-. Hymenium yellowish to brownish. Hypothecium brownish. Paraphyses conglutinate, simple or poorly ramified, only weakly swollen at apices. Asci *Biatora*-type, bitunicate, the outer wall I+ blue. Spores 1(-2)-celled, hyaline, narrowly ellipsoid, 8 per ascus, 8-21 x 3-5.5 μm . Photobiont chlorococcoid. Without lichen substances. Note: this, one of the commonest *Biatora*-species in the

Alps, esp. on plant remains and on basal parts of subalpine shrubs, was largely overlooked or misunderstood in the past. It should be looked for along the Apennines.

- 171 Apothecial margin (section!) more or less pale brown, uniformly coloured. Thallus granulose, greyish-green

162 - *Biatora vernalis* (L.) Fr.

Thallus crustose, greyish-green, granulose, K-, C-, KC-, P-. Granules 0.1-0.25 mm in diam., crowded to form a large crust (up to 10 cm diam.). Apothecia frequent, without a thalline margin, sessile, not constricted, 0.4-0.6(-1.5) mm diam. Disc orange-brown to reddish brown, matt, not pruinose, K-, C-, KC-, P-. Margin thin, smooth, paler than disc, K-, C-, KC-, P-, in section more or less pale brown, uniformly coloured. Epithecium and hymenium K-, C-, P-, KC-. Paraphyses conglutinate, simple or poorly ramified, only weakly swollen at apices. Asci *Biatora*-type, bitunicate, the outer wall I+ blue. Spores 1(-2)-celled, hyaline, narrowly ellipsoid, 8 per ascus, 11.5-23 x 4-6(-7) μ m. Photobiont chlorococcoid. Without lichen substances. Note: a mainly boreal-montane, circumpolar species, found on bryophytes, plant debris, soil and bark, ranging from N Scandinavia to the Alps, the Pyrenées and the Balkan mountains (the species becoming progressively rarer southwards). In Italy it is most frequent in the Alps, but it also occurs - albeit very rarely - in the mountains of the south.



- 172 Thallus K+ yellow 173
 172 Thallus K- 177
 173 Spores 2-celled 174
 173 Spores 1-celled 175
 174 Thallus minutely granulose. Spores 21-25(-29) x 9-11 μ m

see 141 - Buellia insignis (Hepp) Th.Fr.

- 174 Thallus coarsely verrucose. Spores 18-24 x 8-10 μ m

163 - *Buellia papillata* (Sommerf.) Tuck.

Thallus crustose, whitish to pale grey, thick, coarsely verrucose, K+ yellow, C-, KC-, P+ yellowish. Areolae convex, contiguous, forming a compact crust. Apothecia frequent, without a thalline margin, sessile, 0.5-1.2 mm diam. Disc black, soon convex. Margin smooth, black, evident only in young apothecia. Hymenium interspersed, with oil droplets. Paraphyses distinctly thickened above. Asci *Bacidia*-type, distinctly thickened at the apex, with a I+ blue tholus, the outer gelatinous coat I+ pale blue. Spores 2-celled, pigmented, ellipsoid, thin-walled, 8 per ascus, 18-24 x 8-10 μ m. Photobiont chlorococcoid. With atranorin and 6-O-methylarthothelin. Note: a rather poorly known, arctic-alpine lichen of terricolous bryophytes, related to *B. insignis*. Probably more widespread, but not common, in the Alps, mostly near or above treeline.



175 Epithecium bright blue-green

164 - *Lecidea alpestris* Sommerf.



Thallus crustose, whitish to grey, granulose-verrucose, K+ yellow, C-, KC-, P- or P+ faintly yellow. Apothecia frequent, without a thalline margin, sessile, 0.5-1.5 mm diam. Disc black, soon convex. Margin indistinct. Epithecium bright blue-green, K-. Hymenium colourless to weakly blue-green in part. Hypothecium thin, colourless to brownish. Paraphyses conglutinate. Asci *Bacidia*-type, distinctly thickened at the apex, with a I+ blue tholus, the outer gelatinous coat I+ pale blue. Spores 1-celled, hyaline, ellipsoid, 8 per ascus, 14-25 x 3-9 μ m. Photobiont chlorococcoid. Note: a circumpolar, arctic-alpine lichen, found on naked soil, mosses and plant debris over siliceous substrata above treeline, more rarely on bark, on basal parts of conifers in the subalpine belt. Probably restricted to the Alps in Italy.

175 Epithecium greenish brown to brown

176

176 Apothecia dark brown to black. Epithecium dark greenish brown

165 - *Lecidea miscella* Ach.



Thallus crustose, whitish to grey, more or less granulose, rather thick, K+ yellow, C-, KC-, P+ yellowish. Apothecia frequent, without a thalline margin, sessile, 0.3-0.8 mm diam. Disc dark brown to black, flat to slightly convex. Margin indistinct, esp. in old apothecia, thin. Epithecium dark greenish brown, K-. Hymenium colourless. Hypothecium brownish-yellow. Paraphyses conglutinate. Spores 1-celled, hyaline, ellipsoid, 8 per ascus, 12-15(-18) x 5-7 μ m. Photobiont chlorococcoid. With atranorin. Note: on soil and terricolous bryophytes over siliceous substrata. A poorly known species, which deserves further study: hitherto known only from S Tyrol in Italy: the record is dubious (see Nimis 1993: 386).

176 Apothecia pale to dark reddish brown. Epithecium brownish

*see 150 - *Lecidea rufofusca* (Anzi) Nyl.*

177 Thallus P+ red

178

177 Thallus P-

179

178 Epithecium deep bluish green, hypothecium reddish brown. With pannarin. Spores 1-celled, (8-)10-14(-15) x 3-4.5(-5) μ m.

166 - *Protomicarea limosa* (Ach.) Hafellner

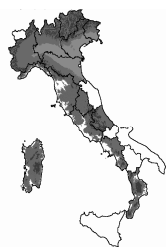


Thallus crustose, whitish grey to grey, sometimes with a white prothallus, granulose to small-areolate, K-, C-, KC-, P+ orange-red. Areolae mostly small, almost granulose, 0.2-0.6 mm diam., and sometimes becoming almost verrucose, reaching up to 1 mm diam., contiguous, forming a more or less compact crust. Apothecia frequent, rounded, without a thalline margin, sessile, (0.4-)0.5-0.7(-1) mm diam. Disc black, strongly convex. Margin indistinct. Epithecium deep bluish green, the colour often extending down to the upper part of the hymenium, K-, C-, KC-. Hypothecium patchy

reddish brown, K+ brownish-orange. Paraphyses poorly branched and anastomosing, not apically thickened. Asci clavate, with a well-developed I+ blue tholus and an internal, darker I+ tubular structure, lacking an ocular chamber. Spores 1-celled, hyaline, fusiform, 8 per ascus, (8-)10-14(-15) x 3-4.5(-5) μm . Conidia bacilliform, 6.7 x 1.5 μm . Photobiont chlorococcoid. With pannarin and triterpenoids. Note: an arctic-alpine to boreal-montane, circumpolar lichen, found on naked soil in sites with a long snow-lie, in clearings of Alpine grasslands, more rarely on moribund bryophytes and plant debris. Probably restricted to the Alps in Italy, to be looked for in the mountains of Friuli and Liguria.

178 Epithecium and hypothecium olivaceous green. With argopsin. Spores 4-8-celled, 16-36(-38) x 4-6(-7) μm

167 - *Micarea lignaria* (Ach.) Hedl. var. *lignaria*



Thallus crustose, whitish to bluish-grey, thin, granulose to areolate, K-, C-, KC-, P+ red. Areolae convex, scattered to confluent, more or less globose, 0.2-0.6(-1) mm diam. Apothecia frequent, without a thalline margin, sessile, not constricted, up to 0.7 mm diam., constricted to substipitate. Disc black to bluish-black, convex, K-, C-, KC-. Margin mostly indistinct, brownish in outer parts (section). Epithecium olivaceous green, K-, C-, P-, N+ red. Hymenium mostly colourless, K-, C-, N+ red, sometimes with minute granules of violet (K+ intensely green) pigment. Hypothecium olivaceous, the central part often colourless to brownish. Paraphyses anastomosing, simple to ramified above, slightly thickened above, conglutinate. Asci clavate, with a I+ blue tholus and an internal, darker I+ tubular structure. Spores 4-8-celled, hyaline, fusiform-elongate, thin-walled, 8 per ascus, 16-36(-38) x 4-6(-7) μm . Pycnidia immersed, of two types, those bearing macroconidia to 100 μm broad, the macroconidia 4-7 x 1.5-2 μm , those bearing microconidia 100-140 μm broad, the microconidia 5-7 x ca. 0.8 μm . Photobiont chlorococcoid, thin-walled, the cells often paired. With argopsin. Note: a widespread temperate to boreal-montane species, the most common of the genus in Italy, found on a wide variety of substrata such as plant remains, bark, and lignum, in humid situations. To be looked for in the mountains of Marche, Molise, Basilicata and Sicilia.

179 Spores 4-celled 180

179 Spores not 4-celled 184

180 Spores pigmented, parasitic on *Physconia muscigena*

168 - *Diplotomma pulverulentum* (Anzi) D.Hawksw.

Thallus crustose, not visible being embedded in the thallus of the host, K-, C-, KC-, P-. Apothecia frequent, rounded, without a thalline margin, initially semi-immersed in the epinecral layer covering the lobes of the host, then sessile, 0.2-0.7 mm diam. Disc black, sometimes white-pruinose, first flat, then more or less convex, smooth. Margin thin, not evident in old apothecia, often pruinose. Epithecium brown, Hymenium colourless, 70-85 μm thick.



Hypothecium dark brown. Asci *Bacidia*-type, distinctly thickened at the apex, with a I+ blue tholus, the outer gelatinous coat I+ pale blue. Spores (2-)4-celled, pigmented, with a microrugulate ornamentation, broadly ellipsoid with rather pointed ends, 8 per ascus, 16-19(-22) x 6-9 μm . Parasitic on *Physconia muscigena*. Photobiont chlorococcoid. Without lichen substances. Note: a holarctic endoparasitic lichen, certainly more widespread in the Alps near or above treeline, but much overlooked in the past, descending below the oroboreal belt in dry-continental areas. Certainly widespread and not rare throughout the Alps and the central Apennines, to be looked for in the mountains of Calabria and Sicilia.

180 Spores hyaline, not on *Physconia muscigena*

181

181 Thallus thick, composed of small lobulate areolae (lens!)

169 - *Myxobilimbia lobulata* (Sommerf.) Hafellner



Thallus small-squamulose to subcrustose, whitish grey to grey, darker in the centre of the squamules, K-, C-, KC-, P-, UV-. Squamules flattened, crenate to lobulate, smooth, contiguous to more or less overlapping, 0.2-1 mm broad, forming a compact crust. Apothecia frequent, without a thalline margin, sessile, 0.3-1 mm diam. Disc black to brown-black, convex. Margin indistinct. Epithecium pale greenish grey, K-, N+ red. Hypothecium red-brown. Paraphyses simple, slightly thickened above, adglutinated. Asci with a I+ blue tholus, the outer gelatinous coat I+ pale blue. Spores 2-4-celled, hyaline, fusiform, 8 per ascus, with a gelatinous, finely warted outer coat, 14-20(-26) x 3-5(-6) μm . Photobiont chlorococcoid. Without lichen substances. Note: a cool-temperate to arctic-alpine, circumpolar lichen, found on terricolous mosses and bare calciferous soil, from the Alps to the high Mediterranean mountains; most common above the submediterranean belt, throughout the country.

181 Thallus thin, continuous, not composed of lobulate areolae

182

182 Spores <15 μm long. Paraphyses ramified and anastomosing

170 - *Micarea botryoides* (Nyl.) Coppins



Thallus crustose, grey, thin, continuous, granulose, K-, C-, KC-, P-. Apothecia rare, without a thalline margin, sessile, often tuberculate, up to 0.4 mm diam. Disc brownish, convex, K-, C-, KC-, P-. Margin indistinct. Epithecium colourless to brownish, K-, C-, P-, N-, KC-. Hymenium K-, C-, KC-, P-, N-. Paraphyses anastomosing, ramified, not apically thickened, conglutinate. Asci clavate, with a I+ blue tholus and an internal, darker I+ tubular structure. Spores 1-4-celled, hyaline, oval, thin-walled, 8 per ascus, 8-13(16) x 2.3-3.7(4) μm . Pycnidia dark, sessile. Photobiont chlorococcoid, thin-walled, the cells often paired. Without lichen substances. Note: in oceanic areas such as the British Isles, this species occurs on a wide variety of substrata, including soil, bryophytes, moribund plants, siliceous rocks, conifer bark, mostly on vertical or underhanging faces. In Italy the species was much overlooked or confused with similar species in the past (there is only a recent record from Marche: see *ITALIC*), but is certainly rare. It should be looked for in humid

habitats throughout the country.

182 Spores >15 µm long. Paraphyses not ramified and anastomosing 183

183 Paraphyses 2-3 µm thick. Apothecial margin indistinct, disc convex

see 158 - Myxobilimbia microcarpa (Th.Fr.) Hafellner

183 Paraphyses <2 µm thick. Apothecial margin distinct, disc flat

171 - Myxobilimbia tetramera (De Not.) Hafellner & Türk

Thallus crustose, whitish, continuous, mostly small-granulose, K-, C-, KC-, P-. Apothecia frequent, without a thalline margin, sessile, 0.5-1.3 mm diam. Disc dark reddish brown to blackish brown, long flat to convex in old apothecia. Margin thin, persistent, smooth, concolorous with disc, often somehow shiny. Epitecium brownish to olive-brown, K-, N-. Hypothecium pale to reddish brown above. Paraphyses simple, slightly thickened above, conglutinate, <2 µm thick. Asci clavate, with a I+ blue tholus and an internal, darker I+ tubular structure, the external gel I+ faintly blue. Spores (2-)4-celled, hyaline, ellipsoid-cylindrical, 8 per ascus, 15-27 x 5-8 µm. Photobiont chlorococcoid. Without lichen substances. Note: most frequent in the upland areas of the north, on mosses and plant debris on calcareous substrata, sometimes on bark, esp. on basal parts of old trunks in open forests, but also known from the mountains of Calabria. To be looked for in the C Apennines.



184 Spores 1-celled 185

184 Spores not 1-celled 192

185 Spores subglobose, 12-16 per ascus

172 - Steinia geophana (Nyl.) Stein

Thallus crustose, pale grey to dull grey-green, thin and film-like, subgelatinous when wet, continuous, more or less ephemeral, K-, C-, KC-, P-, UV-. Goniocysts covered by pseudoparenchymatous hyphae. Apothecia frequent, without a thalline margin, sessile, up to 0.6 mm diam. Disc dark brown, strongly convex. Margin indistinct, composed by a few thread-like hyphae resembling paraphyses. Epitecium reddish brown to brown. Hymenium colourless to often brownish, I+ blue. Hypothecium brown. Paraphyses scarce, immersed in the hymenial jelly, simple, not apically thickened, 0.5-1 µm thick, surrounded by a distinct hymenial gel. Asci clavate-cylindrical, thin-walled. Spores 1-celled, hyaline, subglobose, thick-walled, (12-)16 per ascus, 5-7 x 5-7 µm. Pycnidia dark, immersed. Conidia ellipsoidal. Photobiont chlorococcoid. Without lichen substances. Note: an ephemeral lichen of moist, slightly calciferous soil, rotten wood, small pebbles, terricolous Peltigeras and plant debris, often found in rather disturbed habitats as on earth banks along white roads and on track sides. For Italy it is known only from S Tyrol (see Nimis 1993: 670); being easily overlooked, it should be searched for throughout the Alps, where it is certainly rare.



185 Spores not subglobose, 8 or more than 32 per ascus 186

186 Spores more than 32 per ascus

173 - *Sarcosagium campestre* (Fr.) Poetsch & Schied.



Thallus crustose, greenish to blackish brown, subgelatinous when wet, thin, continuous, mostly granulose, K-, C-, KC-, P-. Apothecia frequent, without a thalline margin, sessile, slightly constricted, (0.1-)0.3-0.5 mm diam. Disc pinkish to dark reddish brown, translucent when wet, concave to flat, smooth, K-, C-. Margin rather thick and prominent, concolorous with disc, but often white-pruinose, paraplectenchymatous in the outer side in section. Paraphyses simple to poorly ramified, distinctly thickened above, free. Asci cylindrical, thin-walled, without a clear apical thickening. Spores 1(-2)-celled, hyaline, ellipsoid-cylindrical, thin-walled, many per ascus, 5-8 x 2-2.3 μm . Photobiont chlorococcoid. Without lichen substances. Note: an early coloniser of calciferous soil, moribund bryophytes, plant debris, sometimes on decaying wood, mostly in rather disturbed habitats. For Italy it is hitherto known only from the Alps of Lombardia, Veneto (see Nimis 1993: 646) and Friuli (see *ITALIC*): to be looked for in suitable habitats throughout the Italian Alps.

186 Spores 8 per ascus 187

187 Hypothecium pale to colourless 188

187 Hypothecium dark 189

188 Thallus gelatinous when wet, granulose. Spores >25 μm long, broadly ellipsoid. Paraphyses simple, not anastomosing. Asci cylindrical

174 - *Aphanopsis coenosa* (Ach.) Coppins & P.James



Thallus crustose, greyish green to brownish green, more or less gelatinous when wet, thin, minutely granular, K-, C-, KC-, P-. Granules (goniocysts) consisting of pseudoparenchymatous hyphae surrounding a few algal cells, the outer cells brownish. Apothecia frequent, without a thalline margin, sessile, hemispherical, 0.2-0.6 mm diam. Disc brown to brown-black, matt, convex. Margin indistinct, very thin in section, composed of vertically arranged, thin-walled hyphae resembling paraphyses, appearing more or less pseudoparenchymatous at the base of the apothecium. Hymenium 150-200 μm thick, colourless, but often with vertical brownish bands, I-, but appearing I+ blue due to the many amyloid asci. Hypothecium shallow, pale brown. Paraphyses simple or sometimes forked, rather stout (2-4 μm thick), apically not thickened, in densely entangled clusters. Asci numerous, cylindrical-clavate, the wall I+ blue, with an apical dome containing a plug-like structure which is K/I+ blue. Spores 1-celled, hyaline to pale brownish, broadly ellipsoid but often with one or both ends pointed, thin-walled, usually with several oil droplets, 8 per ascus (but usually 1-3 spores aborting), 25-38 x 13-18 μm . Pycnidia unknown. Photobiont chlorococcoid, more or less spherical, 7-12 μm in diam., or ellipsoid,

7-14 x 5-8 μm . Without lichen substances. Note: on humid, bare, clayey to sandy soil on track sides in woodlands. For Italy there is a single, old record by Anzi from Lombardia, confirmed by Printzen (see *ITALIC*). The species is easy to overlook, but certainly not common, it should be looked for throughout Italy.

- 188 Thallus not gelatinous when wet, more or less continuous. Spores <25 μm long. Paraphyses ramified, anastomosing. Asci clavate

175 - *Micarea bauschiana* (Körb.) V. Wirth & Vězda



Thallus crustose, grey, thin, continuous, K-, C-, KC-, P-. Apothecia frequent, without a thalline margin, sessile, not constricted, often tuberculate, up to 0.3 mm diam. Disc pale bluish grey to brownish black, convex, K-, C-, KC-, P-. Margin indistinct. Epithecium colourless, K-, C-, P-, N+ red, KC-. Hymenium K-, C-, KC-, P-. Hypothecium colourless. Paraphyses anastomosing, ramified, slightly thickened above, conglutinate. Asci clavate, with a I+ blue tholus and an internal, darker I+ tubular structure. Spores 1-celled, hyaline, ellipsoid, thin-walled, 8 per ascus, 6.5-10.5 x 2.5-4 μm . Pycnidia immersed. Photobiont chlorococcoid, thin-walled, the cells often paired. Without lichen substances. Note: on a wide variety of substrata (rocks, exposed roots, consolidated soil) in shaded-dry situations (e.g. in underhangs), but restricted to humid areas. Much overlooked or confused with similar species in Italy; certainly more widespread, esp. in humid areas, but not common.

- 189 Apothecial margin (section!) deep black, not transparent in thick sections

176 - *Farnoldia muscigena* (Vězda) Tretiach & Hafellner



Thallus crustose, whitish grey to brownish, thin, continuous to subareolate, K-, C-, KC-, P-. Medulla I+ blue. Apothecia frequent, without a thalline margin, sessile, strongly constricted, up to 1.2 mm diam. Disc black, flat, smooth, non pruinose. Margin thick, concolorous with disc, deep black and not transparent in thick sections. Epithecium greenish to brownish green, K-. Hymenium I+ blue, 85-100 μm tall. Hypothecium black to dark brown, often greenish in upper part. Paraphyses thin, anastomosing, ramified, slightly thickened above. Asci bitunicate, clavate, with a well-developed tholus containing a I+ blue tubular structure. Spores 1-celled, hyaline, ellipsoid, 8 per ascus, halonate, 10-18 x 6-8 μm . Pycnidia dark, immersed. Conidia short, bacilliform. Photobiont chlorococcoid. Without lichen substances. Note: known from the Central European mountains (Tatra, Alps), on moribund bryophytes, crustose lichens and plant debris over calcareous substrata, mostly above treeline. For Italy there is only a recent report from Piedmont (see *ITALIC*). The species is probably more widespread in the Alps.

- 189 Apothecial margin (section!) not deep black, transparent 190

- 190 Epithecium greenish to purple-brown, K+ green. Paraphyses densely ramified and anastomosing. Most spores >20 μm long

177 - *Helocarpon pulverulum* (Th.Fr.) Türk & Hafellner



Thallus crustose, whitish to pale grey brown to ash-grey in part, thin, granulose, K-, C-, KC-, P-, UV-. Apothecia frequent, without a thalline margin, sessile to substipitate, up to 0.6 mm diam. Disc dark grey to almost black, flat to weakly convex, K-, C-, KC-, P-. Margin thin, in section greenish in the outer part, the inner part concolorous with the hypothecium. Epithecium greenish to purple-brown above, pale purplish below, K+ green, C-, P-. Hymenium K-, C-. Hypothecium dark purple-brown. Paraphyses anastomosing, ramified, not apically thickened, conglutinate. Asci clavate, with a I+ tholus and an internal, darker tubular structure. Spores 1-2-celled, hyaline, ovoid, thin-walled, 8 per ascus, (9-)20-27(-21) x (2.5-)3-4.5 µm. Pycnidia dark, immersed. Conidia bacilliform, 4.5-5.7 x 1.2-1.5 µm. Photobiont chlorococcoid. Without lichen substances. Note: on bryophytes and plant debris on the ground and amongst rocks, in areas with siliceous substrata, mostly near or above treeline; for Italy known only from South Tyrol and the mountains of Veneto, but probably more widespread in the Alps. The generic rank of this lichen, and its delimitation towards the more northern *H. crassipes* still await further study.

- 190 Epithecium brownish, K-. Paraphyses mostly simple and poorly ramified, not anastomosing. Most spores <20 µm long 191
- 191 Thallus thick, verrucose. Paraphyses distinctly thickened above. Hypothecium without scattered bluish granules reacting K+ green. Spores 1-celled

178 - *Mycobilimbia berengeriana* (A.Massal.) Hafellner & V.Wirth



Thallus crustose, white, thick, coarsely granulose to verrucose, K-, C-, KC-, P-, UV-. Apothecia frequent, without a thalline margin, sessile, up to 1.5 mm diam. Disc dark brown to black, first flat, then convex. Margin thin, smooth, not evident in old apothecia. Epithecium pale brown, K-, N-. Hymenium I+ blue. Hypothecium dark reddish brown, without scattered bluish granules reacting K+ green. Paraphyses simple, distinctly thickened above (4-6 µm), conglutinate. Asci clavate, with a I+ blue tholus and an internal, darker I+ tubular structure, the external gel I+ faintly blue. Spores 1-celled, hyaline, ellipsoid, 8 per ascus, (9.5-)11-16(-19) x 4-5(-6) µm. Photobiont chlorococcoid. Without lichen substances. Note: a circumpolar, arctic-alpine to boreal-montane lichen, found on mosses and plant debris over calcareous substrata; most common in the Alps, but occurring throughout the Apennines; to be looked for in the high mountains of Sicilia and Sardegna.

- 191 Thallus thin, not verrucose. Paraphyses only slightly thickened above. Hypothecium with scattered bluish granules reacting K+ green. Spores 1(-4)-celled

179 - *Mycobilimbia hypnorum* (Lib.) Kalb & Hafellner

Thallus crustose, whitish to pale grey, thin and often inconspicuous,



K-, C-, KC-, P-, UV-. Apothecia frequent, without a thalline margin, sessile, 0.3-0.7(-1.2) mm diam. Disc dark brown to black, flat. Margin thin, smooth, concolorous with disc, often undulate. Epithecium reddish brown to pale brown, K-, N-. Hymenium I+ blue. Hypothecium dark reddish brown, with scattered bluish granules reacting K+ green. Paraphyses simple, slightly thickened above, conglutinate. Asci clavate, with a I+ blue tholus and an internal, darker I+ tubular structure, the external gel I+ faintly blue. Spores 1(-4)-celled, hyaline, ellipsoid, 8 per ascus, (8.5-)10-16(-19) x (3.5-)4.5-6(-7) μ m. Photobiont chlorococcoid. Without lichen substances. Note: a cool-temperate to arctic-alpine, probably circumpolar lichen, found on mosses, plant debris, soil, bark and lignum, esp. in upland areas with calcareous substrata. Most frequent in the Alps and in the C-Apennines.

192 Spores 2-celled	193
192 Spores more than 4-celled	201
193 Spores pigmented	194
193 Spores hyaline	195
194 Spores >15 μ m long, with ornamented wall	

180 - *Buellia epigaea* (Pers.) Tuck.



Thallus crustose, white to yellowish white, thick, areolate, K-, C-, KC-, P-, UV-. Areolae flattened to convex, contiguous, sometimes weakly elongate at margin. Apothecia frequent, without a thalline margin, sessile, 0.5-1.5 mm diam. Disc black, flat to convex, smooth, often whitish pruinose. Margin smooth, black. Epithecium brownish. Hymenium inspersed, colourless. Hypothecium colourless to pale brown. Paraphyses distinctly thickened above. Asci clavate, *Bacidia*-type, distinctly thickened at the apex, with a I+ blue tholus, the outer gelatinous coat I+ pale blue. Spores 2-celled, pigmented, ellipsoid, thin-walled, ornamented, 8 per ascus, (14-)15-21(-26) x (6-)7-10(-12) μ m. Pycnidia dark, immersed, very rare. Conidia bacilliform, 5-7 x 1 μ m. Photobiont chlorococcoid. Without lichen substances. Note: widely distributed in Europe, from submediterranean regions to Scandinavia, on base-rich mineral soil, on weathered gypsum and gypsum soil. Fairly rare in Italy, being restricted to dry mediterranean stands and the warm-dry alpine valleys. Most records from the south need re-confirmation.

194 Spores <15 μ m long, with a smooth wall	
---	--



181 - *Amandinea punctata* (Hoffm.) Coppins & Scheid.

Thallus crustose, pale grey, thin, rimose to areolate, K-, C-, KC-, P-, UV-. Medulla I-. Apothecia frequent, rounded, without a thalline margin, sessile, slightly constricted, 0.2-0.6 mm diam. Disc black, first flat, then rapidly convex. Margin thin, smooth, black, indistinct in old apothecia. Epithecium brown. Hypothecium brown. Paraphyses slightly thickened above. Asci *Bacidia*-type, distinctly thickened at the apex, with a I+ blue tholus, the outer gelatinous coat I+ pale blue. Spores 2-celled, pigmented, ellipsoid, thin-walled, not

ornamented, 8 per ascus, 12-15 x 6-8 μm . Pycnidia dark, immersed, not common. Conidia filiform. Photobiont chlorococcoid. Without lichen substances. Note: in its present circumscription, an almost cosmopolitan lichen, found on a wide variety of substrata, including bark, lignum, siliceous rocks, roofing tiles, brick, and thin layers of soil; the Italian material is heterogeneous and in need of revision; terricolous samples are very rare.

195 Epithecium K+ violet

see 153 - Micarea prasina Fr.

195 Epithecium K- 196

196 Apothecial margin distinct 197

196 Apothecial margin indistinct 198

197 Paraphyses 2-3 μm thick. Spores ellipsoid, 1-(-4)-celled. Hypothecium with scattered bluish granules reacting K+ green

see 179 - Mycobilimbia hypnorum (Lib.) Kalb & Hafellner

197 Paraphyses <2 μm thick. Spores ellipsoid-cylindrical, 2-4-celled. Hypothecium without scattered bluish granules reacting K+ green

see 171 - Mycobilimbia tetramera (De Not.) Hafellner & Türk

198 Hypothecium dark 199

198 Hypothecium pale to colourless 200

199 Epithecium N-. Spores oval, 1-4-celled

see 170 - Micarea botryoides (Nyl.) Coppins

199 Epithecium N+ red. Spores ellipsoid-cylindrical, (1)-2-celled

182 - Micarea melaenida (Nyl.) Coppins

Thallus crustose, greyish, thin, continuous, K-, C-, KC-, P-, UV-. Apothecia frequent, rounded, without a thalline margin, sessile, 0.2-0.6 mm diam. Disc black, convex. Margin indistinct. Epithecium brownish, K-, C-, N+ red. Hypothecium dark brown. Paraphyses anastomosing, ramified, slightly thickened above. Asci clavate, with a I+ blue tholus and an internal, darker I+ tubular structure Spores (1)-2-celled, hyaline, ellipsoid-cylindrical, thin-walled, 8 per ascus, 9-15 x 3-4.5 μm . Pycnidia dark, immersed. Conidia bacilliform. Photobiont chlorococcoid, thin-walled, the cells often paired. Without lichen substances. Note: a mainly mild-temperate, ephemeral species, with optimum on clay soil in rather disturbed habitats. For Italy there is only a recent records from Calabria; the species might be more widespread in humid parts of Tyrrhenian Italy.



200 Spores <15 μm long, oblong-obtuse, 2-celled. Epithecium dark

green



183 - *Catillaria contristans* (Nyl.) Zahlbr.

Thallus crustose, whitish to grey or brownish grey, areolate to coarsely granulose, K-, C-, KC-, P-, UV-. Areolae convex, contiguous. Apothecia frequent, without a thalline margin, sessile, 0.3-0.6(-1) mm diam. Disc black, convex. Margin indistinct. Epithecium dark green, K-, C-, N+ red. Hymenium colourless. Hypothecium colourless to pale brown. Paraphyses slightly thickened above. Asci *Bacidia*-type, clavate, surrounded by a gelatinous I+ blue coat, with a well-developed I+ blue tholus with a darker blue tube and a well-developed ocular chamber. Spores 2-celled, hyaline, oblong-obtuse, constricted at septa, thin-walled, 8 per ascus, 9-16.5 x 2.5-4.5 µm. Pycnidia dark, immersed. Conidia bacilliform. Photobiont chlorococcoid. Without lichen substances. Note: on dead bryophytes (*Andreaea*, *Grimmia*) and soil rich in humus over acid siliceous rocks, mostly near or above treeline. For Italy it is known only from an old record by Anzi (see Nimis 1993: 203), and should be looked for further in the Alps. This species does not belong to *Catillaria* s. str.

200 Spores >15 µm long, ellipsoid-cylindrical, 2-4-celled. Epithecium brownish

*see 158 - *Myxobilimbia microcarpa* (Th.Fr.) Hafellner*

201 Spores muriform/submuriform 202

201 Spores not muriform/submuriform 205

202 Spores <35 µm long 203

202 Spores >35 µm long 204

203 Mostly near or above treeline. Apothecial margin thick, disc brown. Thallus episubstratic. Spores >15 µm broad

184 - *Gyalidea scutellaris* (Bagl. & Carestia) Lettau



Thallus crustose, greyish to green-brown and subgelatinous when wet, darker when dry, thin, continuous, K-, C-, KC-, P-, UV-. Apothecia frequent, without a thalline margin, sessile, 0.5-0.8 mm diam. Disc brownish to dark brown, paler when wet, urceolate to strongly concave. Margin thick, rough, pale brown, paler than disc. Epithecium colourless to very pale brown. Hymenium colourless, I+ yellowish to reddish brown. Hypothecium colourless. Paraphyses simple, not apically thickened. Asci cylindrical, thin-walled, with a weakly developed tholus. Spores hyaline, ovoid, muriform, 4-8 per ascus, with a thin halo, 28-35 x 15-25 µm. Photobiont chlorococcoid. Without lichen substances. Note: an arctic-alpine species, found on humid, acid substrata, such as moribund bryophytes and soil rich in humus; known from a few localities and restricted to the Alps in Italy.

203 Below treeline in warm-humid areas. Apothecial margin thin, disc

black. Thallus endosubstratic. Spores <15 µm broad

185 - *Gyalideopsis athalloides* (Nyl.) Vězda

Thallus crustose, greyish, thin, endosubstratic, continuous, K-, C-, KC-, P-, UV-. Apothecia frequent, more or less pellucid when wet, without a thalline margin, sessile, up to 1.2 mm diam. Disc black, concave. Margin thin, concolorous with disc, composed by a continuous, loose network of anastomosing paraphysoids in a gelatinous matrix. Hymenium colourless, of loosely interwoven hyphae. Paraphyses anastomosing, ramified, conglutinate. Asci markedly thicker at apex (tholus), the wall I-, the content I+ reddish brown. Spores hyaline, ovoid, muriform, 4-8 per ascus, 20-30 x 8-15 µm. Photobiont chlorococcoid. Without lichen substances. Note: an ephemeral, mild-temperate lichen of acid clay soil in disturbed habitats in open, very humid forests. Hitherto known only from Calabria in Italy, to be looked for in other parts of Tyrrhenian Italy.



204 Spores 2-4 per ascus. Epithecium bluish green

186 - *Schadonia alpina* Körb.

Thallus crustose, greyish brown, thin, continuous, granulose, the granules often coralloid, K-, C-, KC-, P-, UV-. Apothecia frequent, without a thalline margin, sessile, 0.5-1.5 mm diam. Disc black, matt, flat, smooth. Margin thick, smooth, often shiny, concolorous with disc. Epithecium bluish green. Hymenium colourless. Hypothecium brown. Paraphyses anastomosing, ramified, apically thickened. Asci cylindrical, with a I+ blue tholus and a small axial mass surrounded by a darker I+, tubular structure. Spores hyaline, broadly ellipsoid, muriform, 2-4 per ascus, 22-41 x 9-15 µm. Photobiont chlorococcoid. Without lichen substances. Note: a mainly arctic-alpine species, found on soil and moribund bryophytes on siliceous substrata above treeline. For Italy there is a single old record by Anzi from Lombardia, confirmed by Hafellner (see Nimis 1993: 647). To be looked for throughout the Alps, where it is certainly very rare.



204 Spores 8 per ascus. Epithecium dark brown

187 - *Schadonia fecunda* (Th.Fr.) Vězda & Poelt

Thallus crustose, greyish brown, thin, continuous, granulose, K-, C-, KC-, P-, UV-. Apothecia frequent, without a thalline margin, sessile, 0.5-1.5 mm diam. Disc black, matt, flat, smooth. Margin thick, smooth, often shiny, concolorous with disc. Epithecium dark brown, K+ brownish. Hymenium colourless. Hypothecium brown. Paraphyses anastomosing, ramified, thin, apically thickened. Asci cylindrical, with a I+ blue tholus and a small axial mass surrounded by a darker I+, tubular structure. Spores hyaline, broadly ellipsoid, muriform, 8 per ascus, 22-40 x 10-18(-20) µm. Photobiont chlorococcoid. Without lichen substances. Note: a mainly arctic-alpine species, found on mosses and plant remains on acid siliceous substrata, mostly above treeline; probably restricted to the Alps in Italy, where it is rare.



205 Parasitic on *Baeomyces*

188 - *Arthrorhaphis grisea* Th.Fr.



Thallus crustose, dark grey-green, thin, immersed in the thallus of the host, appearing as dark spots, K-, C-, KC-, P-, UV-. Apothecia frequent, without a thalline margin, sessile, not constricted. Disc black, at first urceolate, then concave to finally flat, smooth. Margin thick, smooth, black. Epithecium brownish to greenish brown, K-. Hymenium colourless, interspersed with oil droplets, I-. Hypothecium brown below. Excipulum dark brownish green in the outer- and innermost parts, paler inbetween. Paraphyses slender (to 2 µm thick), anastomosing, ramified, not apically thickened, free. Asci bitunicate, clavate, I-, scarcely thickened at apex, with an ocular chamber. Spores 10-16-celled, hyaline, acicular, thin-walled, 8 per ascus, (50-)60-90(-100) x 2.5-4(-4.5) µm. Photobiont chlorococcoid. Without lichen substances. Note: an arctic-alpine species, found on soil and weathered siliceous rocks in sites visited by birds on in eutrophicated Alpine pastures; first parasymbiotic on *Baeomyces*, later an autonomous lichen. Probably much more widespread, but not very common, in the Alps.

- 205 Non parasitic 206
206 Spores more than 4 µm large 207
206 Spores less than 4 µm large 208
207 Hypothecium red-brown. Epithecium bright green

189 - *Myxobilimbia accedens* (Arnold) Hafellner



Thallus crustose, whitish, farinose-granulose, K-, C-, KC-, P-. Apothecia frequent, without a thalline margin, sessile, up to 0.7 mm diam. Disc blackish brown to black, initially flat, then rapidly convex. Margin indistinct in old apothecia. Epithecium bright emerald green to blackish emerald green, K-. Hymenium I+ blue, >60 µm tall. Hypothecium reddish brown at least above. Paraphyses simple, slightly thickened above, conglutinate. Asci clavate, with a I+ blue tholus and an internal, darker I+ tubular structure, the external gel I+ faintly blue. Spores 8-12-celled, hyaline, ellipsoid-cylindrical, 8 per ascus, 30-45 x (5-)6-7(-9) µm. Photobiont chlorococcoid. Without lichen substances. Note: on mosses overgrowing soil and siliceous rocks in upland areas, mostly above or near treeline. Nomenclature and delimitation of this lichen still need further study.

- 207 Hypothecium pale to colourless. Epithecium brownish

see 152 - Myxobilimbia sabuletorum (Schreb.) Hafellner

- 208 Apothecia brownish

190 - *Bacidia herbarum* (Stizenb.) Arnold

Thallus crustose, whitish, continuous to small granulose-verrucose, sometimes inconspicuous, K-, C-, KC-, P-, UV-. Apothecia frequent, without a thalline margin, sessile, up to 0.7 mm diam. Disc reddish brown to brown (sometimes different apothecia of the same thallus



having different hues), flat. Margin thin. Epithecium brownish, K-, Hymenium colourless. Hypothecium pale brown at least in upper part. Paraphyses simple, thickened above. Asci clavate to subcylindrical-clavate, distinctly thickened at the apex, with a I+ blue tholus, the outer gelatinous coat I+ pale blue. Spores 4-8-celled, hyaline, acicular, 8 per ascus, 36-60 x 2-2.5 μm . Photobiont chlorococcoid. Without lichen substances. Note: a cool-temperate to arctic-alpine, probably circumpolar lichen, found on plant remains and moribund bryophytes on calciferous ground; widespread in the Alps near or above treeline, but also known from the high mountains of Calabria; to be looked for in the C-Apennines and elsewhere (e.g. in Sardegna).

208 Apothecia black (sometimes bluish-pruinose)

209

209 Thallus whitish. Apothecia non pruinose. Epithecium bright green. Most spores <2.5 μm broad

191 - *Bacidia bagliettoana* (A.Massal. & De Not.) Iatta



Thallus crustose, whitish, thin, small-granulose to small-verrucose, K-, C-, KC-, P-, UV-. Apothecia without a thalline margin, sessile, strongly constricted, up to 1(-1.4) mm diam. Disc black, flat to finally convex. Margin black, in section reddish brown in upper and outer parts, colourless below. Epithecium bright green-black to bright green, K-, C-, P-, N+ violet, KC-. Hymenium colourless. Hypothecium reddish brown. Paraphyses simple, thickened above. Asci subcylindrical-clavate, distinctly thickened at the apex, with a I+ blue tholus, the outer gelatinous coat I+ pale blue. Spores 4-8-celled, hyaline, acicular, 8 per ascus, 25-45 x 2-2.5(-3) μm . Photobiont chlorococcoid. Without lichen substances. Note: an arctic-alpine to boreal-montane, circumpolar lichen of moribund bryophytes and plant debris in dry grasslands, or in fissures of calcareous rocks and dolomite, most frequent near or above treeline, from the Alps, where it is rather common, to the high mediterranean mountains, where it is rare.

209 Thallus greyish brown. Apothecia often bluish-pruinose. Epithecium dark olivaceous green. Most spores >2.5 μm broad

192 - *Toninia coelestina* (Anzi) Vězda



Thallus squamulose to subcrustose, greyish brown, dull, epruinose, K-, C-, KC-, P-, UV-. Squamules contiguous, mostly in the form of densely proliferating granules forming a thick, verrucose, more or less continuous crust. Medulla K-, C-, KC-, P-. Apothecia frequent, without a thalline margin, sessile, strongly constricted, up to 1.6 mm diam. Disc black, often bluish-pruinose, flat to weakly convex, smooth. Margin distinct, smooth. Margin (section) dark brown with a greenish-black rim, lacking crystals. Epithecium dark olivaceous green, K-, C-, P-, N+ violet, KC-. Hymenium colourless. Hypothecium dark brown. Paraphyses anastomosing, distinctly thickened above, free. Asci *Bacidia*-type, clavate, surrounded by a gelatinous I+ blue coat, with a well-developed I+ blue tholus with a darker blue tube and a well-developed ocular chamber. Spores (4-)8-celled, hyaline, acicular, 8 per ascus, 19-40 x 2.5-3.5 μm . Photobiont

chlorococcoid. Without lichen substances. Note: a rare species, found on cyanobacterial lichens or cyanobacterial colonies developing on weathered calciferous schist in upland areas; known only from the type locality in Lombardia; to be looked for in suitable habitats throughout the Alps.

Key 5 - Leprose lichens

- 1 Thallus deep yellow to bright greenish yellow 2
- 1 Thallus not bright-coloured 4
- 2 Thallus deep, bright yellow

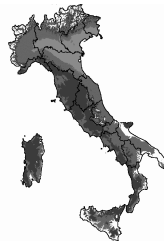
1 - *Chrysothrix chlorina* (Ach.) J.R.Laundon



Thallus leprose, bright yellow, forming a thick, continuous to cracked crust. Granules convex to spherical, 0.1-0.2 mm diam., K- or K+ faintly orange, C-, KC- or KC+ red, P-. Hyphae 2-4 µm thick, anastomosing, colourless. Thallus containing numerous, small colourless crystals. Apothecia unknown. Photobiont chlorococcoid, the cells spherical, to 18 µm diam. With calycin and vulpinic acid. Note: a widespread lichen found in underhangs and crevices of siliceous rocks in shaded, humid situations, very rarely occurring on siliceous soil; limited to areas with high air humidity; widespread, but usually not very common, throughout the Alps, extending to the high mountains of the south.

- 2 Thallus greenish yellow to pale lemon yellow 3
- 3 Cells of the photobiont elongated-cylindrical. With vulpinic and pulvinic acids. Thallus greenish yellow

2 - *Chaenotheca furfuracea* (L.) Tibell



Thallus crustose to subleprose, consisting of a thick mat of soredia-like granules, yellowish green, K-, C-, KC-, P-. Apothecia rather frequent, on long stalks, pin-like, 1.6-3 mm high. Capitulum, maezedium and stalk covered by a dense yellowish green pruina. Asci disintegrating early, often producing a mass of spores (maezedium) which accumulates on the surface of the apothecia. Spores 1-celled, pigmented, globose, with a minute verrucose ornamentation, many per ascus, 2.3-3 µm in diam. Photobiont chlorococcoid, with elongated cells (*Stichococcus*). With vulpinic and pulvinic acids. Note: a widespread holarctic lichen, found beneath overhanging faces protected from rain, esp. in forests, often on exposed roots, but rather indifferent to the substrata (also found on siliceous rocks and lignum); in the Mediterranean belt it is restricted to very humid forests.

- 3 Cells of the photobiont isodiametric. With rhizocarpic acid. Thallus pale lemon yellow

3 - *Psilolechia lucida* (Ach.) M.Choisy

Thallus leprose, to 0.5 mm thick, consisting of a mass of spherical granules, pale lemon yellow, wide-spreading, usually not well-delimited, K-, C-, KC-, P-, UV+ dull to bright orange. Granules more or less globose, 18-30(-40) µm in diam. Thallus hyphae and algal cells covered by yellowish crystals of different size. Apothecia very rare (never found in Italian material), strongly convex to almost



spherical, without a thalline margin, 0.1-0.3 mm diam., rarely confluent-tuberculate and to 0.7 mm diam. Disc convex, yellow-green to yellow-orange when old. Margin indistinct. Epithecium yellowish, with small yellowish crystals which do not dissolve in K. Hymenium colourless, I+ blue. Hypothecium colourless, I-. Paraphyses conglutinate, simple or sparingly forked, rather stout (1.2-2 μm thick), the apices often larger, to 3 μm thick. Asci cylindrical-clavate, the wall I-, the external gel I+ blue, the apical tholus K/I+ pale blue, with a central, elongate, dark blue tube structure. Pycnidia unknown. Photobiont chlorococcoid (usually *Trebouxia*). With rhizocarpic acid. Note: in underhangs of siliceous rocks protected from rain in humid areas, but also on a wide range of substrata (soil, exposed roots, bases of ancient trees); in Italy restricted to natural habitats, and more frequent in the Alps and the in the most humid parts of the Mediterranean belt.

- | | | |
|---|-------------------|----|
| 4 | Thallus K- | 5 |
| 4 | Thallus K+ yellow | 16 |
| 5 | Thallus C+ yellow | |

4 - *Leproloma diffusum* J.R.Laundon



Thallus leprose, whitish to greenish white, forming a thick, continuous crust of powdery granules, K- or K+ yellow, C+ yellow, P+ reddish orange to pink. Granules spherical, 100-300 μm in diam., covered by loosely entangled hyphae which often project outwards. Thallus margin not well-delimited, usually without lobes. Hypo/prothallus whitish grey. Hyphae 1-4 μm thick, anastomosing, obscured by numerous colourless crystals. Medulla white. Photobiont chlorococcoid, the cells spherical, to 15 μm in diam. With 4-oxypannaric acid-2-methylester, with or without pannaric acid, rarely also with roccellic acid. Note: in niches and fissures of calcareous or dolomitic boulders, but also on soil in dry grasslands; probably occurring throughout the country.

- | | | |
|---|--|---|
| 5 | Thallus C- | 6 |
| 6 | Thallus KC+ orange to reddish orange | 7 |
| 6 | Thallus KC- | 8 |
| 7 | On more or less calciferous substrata, usually in shaded situations below treeline. Thallus powdery, thick. P+ orange. Medulla white, generally evident. With alectorialic, barbatolic and protocetraric acids | |

5 - *Lepraria eburnea* J.R.Laundon

Thallus leprose, whitish to greenish grey, often with a yellowish tinge, sharply delimited, orbicular at least when young, usually without marginal lobes, but sometimes almost sublobate, consisting of a mass of powdery, spherical granules, K- or K+ yellowish, C-, KC+ reddish orange (reaction sometimes ephemeral), P+ yellow slowly becoming orange or P+ rapidly orange. Granules up to 200



µm, with protruding hyphae, but never clam-shaped. Medulla white, generally evident, UV+ violet, the hyphae 2-5 µm thick, covered by small colourless crystals. Photobiont chlorococcoid, the cells up to 20 µm diam. With alectorialic, barbatolic and protocetraric acids. Note: a recently-described species, growing in underhangs protected from rain, mostly on rocks, but also found at the base of old boles and on thin layers of soil, e.g. on walls in urban areas; certainly more common, throughout the country.

- 7 On acid siliceous substrata, usually in exposed situations near or above treeline. Thallus granular, P+ yellow. Medulla greyish white, rarely exposed. With alectorialic and angardianic acids, occasionally with rangiformic acid

6 - *Lepraria neglecta* (Nyl.) Lettau



Thallus leprose, whitish to whitish grey, often somehow darker in the centre, consisting in a mass of convex granules, K- or K+ yellowish, C- or C+ reddish orange, KC+ reddish orange, P+ lemon yellow. Granules <100 µm, sometimes grouped into larger units (consoredia) up to 300 µm diam., without projecting hyphae, coarse, not powdery, forming an unclearly delimited crust. Medulla greyish white, rarely exposed, the hyphae 2-5 µm thick, covered in places by small, colourless crystals. Photobiont chlorococcoid, the hyphae up to 17 µm in diam. With alectorialic and angardianic acids, occasionally with rangiformic acid. Note: a mainly arctic-alpine lichen, found on moss cushions and stony siliceous ground, mostly in snow-beds.

- 8 Thallus P- 9
 8 Thallus P+ orange 11
 9 Thallus yellowish green. With vulpinic and pulvinic acids

see 2 - *Chaenotheca furfuracea* (L.) Tibell

- 9 Thallus not yellowish green. Without vulpinic and pulvinic acids 10
 10 With cyanobacteria

7 - *Moelleropsis nebulosa* (Hoffm.) Gyeln.



Thallus crustose, pale blue-grey to dark blue-black, granulose-subleprose, the granules 0.03-0.1 mm diam., forming a thick, compact to cracked crust, K-, C-, KC-, P-, UV-. Apothecia frequent, lecanorine, semi-immersed in the thallus, to 1.5 mm diam. Disc brown, margin granulose. Epithecium brownish. Hymenium colourless, K/I+ blue-green turning reddish brown. Hypothecium brownish, of intricately interwoven hyphae. Paraphyses simple, scarcely swollen at tips, adglutinated. Asci narrowly cylindrical, thin-walled, apically thickened, the apex with a I+ blue apical dome. Spores 1-celled, hyaline, ellipsoid, 8 per ascus, uni- to biseriate in the asci, (11-)13-17(-20) x 6-8 µm, sometimes attenuated at one end, with a single oil droplet. Pycnidia unknown. Photobiont cyanobacterial (*Nostoc*), in short chains. Without lichen substances.

Note: a mild-temperate early coloniser of clay-sandy soil, esp. earth banks along unpaved roads, in humid areas with siliceous substrata; most frequent in Tyrrhenian Italy, from the lowlands (in very humid areas) to the mountains.

- 10 With green algae 12
- 11 Thallus whitish to pale yellowish-greenish grey, sharply delimited. Thallus UV+ reddish violet, without divaricatic acid and zeorin.

8 - *Lepruloma vouauxii* (Hue) J.R.Laundon



Thallus leprose, forming obscurely lobed rosettes to irregularly delimited, composed of a mass of powdery granules, whitish to pale yellowish-greenish grey, with a whitish grey to brownish hypothallus, K-, C-, KC-, P- to P+ reddish orange. Granules <400 µm, with protruding hyphae, but never clam-shaped. Hypo/prothallus whitish grey to pale brown. Medulla white, UV+ violet. Hyphae of thallus 2-4 µm thick, anastomosing, most often covered by numerous colourless crystals. Photobiont chlorococcoid, the cells spherical, to 20 µm in diam. With pannaric acid-6 methylester, rarely with atranorin and roccellic acid, with or without pannaric acid. Note: on isolated deciduous trees, in shaded positions which are seldom wetted by rain, sometimes on brick walls and soil; certainly more common throughout Italy.

- 11 Thallus whitish to greenish/bluish grey, not sharply delimited. Thallus UV+ white to bluish, with divaricatic acid and zeorin

9 - *Lepraria incana* (L.) Ach.



Thallus leprose, greenish/bluish grey to whitish grey, not sharply delimited, without marginal lobes, consisting of a thick, soft mass of powdery granules, K- or rarely K+ yellow, C-, KC- or rarely KC+ violet-red, P- or rarely P+ orange, UV+ white to bluish. Granules spherical, up to 100 µm, with protruding hyphae. Soredia diffuse, granular. Medulla white, poorly developed to absent, the hyphae 2-5 µm thick. Photobiont chlorococcoid, ca. 18 µm in diam. With divaricatic acid, zeorin, rarely gyrophoric acid and atranorin. Note: on acid bark of coniferous and deciduous trees, in sites protected from rain, sometimes on siliceous rocks, soil and lignum. Often confused with other species in the past.

- 12 Thallus not sharply delimited 13
- 12 Thallus sharply delimited, orbicular at least when young, sometimes almost sublobate at margin 14
- 13 With atranorin, stictic and constictic acids, zeorin. Thallus greenish grey to whitish grey

10 - *Lepraria lobificans* Nyl.

Thallus leprose, greenish grey to whitish grey, rarely bluish green, usually diffuse, without marginal lobes, or, more rarely, faintly sublobate at margin, composed by convex granules forming a thick, powdery crust, K- or K+ yellow, C-, KC- or KC+ yellow, P+ orange.



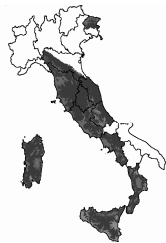
Granules up to 500 μm in diam., with protruding short hyphae, but never clam-shaped. Medulla thick, white, UV+ reddish violet, the hyphae 1.5-5 μm thick. Photobiont chlorococcoid, the cells spherical, to 21 μm diam. With atranorin and stictic acid, and variable amounts of constictic acid and zeorin. Note: in the lower parts of trunks, but also on rocks, lignum, soil and mosses; also occurring in rather polluted areas and on faces wetted by rain; one of the most common species of the genus in Italy, often confused with *L. incana* in the past. Certainly widespread throughout the country.

- 13 With pannaric acid-6 methylester, rarely with atranorin and roccellic acid, with or without pannaric acid. Thallus whitish to pale yellowish-greenish grey

see 8 - Lepruloma vouauxii (Hue) J.R.Laundon

- 14 On calcareous substrata

11 - Lepraria nivalis J.R.Laundon



Thallus leprose, cream-coloured to whitish or pale grey, sharply delimited, orbicular at least when young, sometimes almost sublobate, composed by a thick mass of powdery, convex granules, forming a compact, often folded or membranous crust, K- or K+ yellow, C-, KC- or KC+ yellow, P+ reddish orange (but medulla P-). Granules up to 400 μm diam., with protruding hyphae. Soredia diffuse, granular. Medulla white, poorly developed, UV+ violet, the hyphae 1.5-5 μm thick, covered by numerous colourless granular crystals. Photobiont chlorococcoid, the cells spherical, ca. 13 μm in diam. With atranorin; different chemotypes, with or without protocetraric, fumarprotocetraric, roccellic, stictic, psoromic acids. Note: on lime-rich rocks, but also on mosses, on steeply inclined or underhanging faces protected from rain.

- 14 On acid siliceous substrata

15

- 15 Usually found below treeline, in rather shaded situations. Thallus yellowish at least at margin, very well delimited, thick, sublobate. With pannaric and roccellic acids, and with or without atranorin

12 - Lepruloma membranaceum (Dicks.) Vain.



Thallus leprose, very well delimited, thick, forming powdery rosettes with more or less distinct marginal lobes, grey-yellowish, more distinctly yellowish at the margin, with a whitish grey to brownish hypothallus, K- to rarely K+ yellowish, C-, KC-, P+ orange. Lobes broadening towards the tips, rounded, more or less flat, the margin flat or slightly raised, 1-18 mm wide. Granules up to ca. 500 μm diam., covered by loosely entangled hyphae which often project outwards. Medulla whitish. Hyphae of the thallus 2-5 μm thick, anastomosing, often covered by numerous colourless crystals. Photobiont chlorococcoid, the cells spherical, to 23 μm in diam. With pannaric and roccellic acids, and with or without atranorin. Note: on steeply inclined to weakly underhanging siliceous rocks, sometimes on epilithic bryophytes, much more rarely on bark, often forming monospecific stands; certainly much more widespread, with

optimum in Tyrrhenian Italy, below the montane belt.

- 15 Usually found near or above treeline, in rather exposed situations. Thallus whitish to grey, not yellowish, granular. With atranorin, angardianic or rangiformic acids or both

13 - *Lepraria caesioalba* (de Lesd.) J.R.Laundon



Thallus leprose, whitish to pale grey, often darker in the centre, the thallus assuming a zoned appearance, marginally well-delimited, often rosette-shaped, usually without lobes, but sometimes indistinctly lobulate, formed by a mass of convex granules, K- or K+ yellow, C-, KC- or KC+ yellow, P-, P+ yellow or P+ reddish orange. Granules up to 50 µm thick, mostly grouped in larger consoredia 80-200 µm diam., with or without short projecting hyphae. Medulla greyish white, rarely exposed, the hyphae 1.5-5 µm thick, often covered by colourless, irregular, granular crystals. Photobiont chlorococcoid, the cells spherical to 19 µm in diam. With atranorin, angardianic or rangiformic acids or both, with or without fumarprotocetraric, psoromic and stictic acids. Note: on bryophytes, more rarely on siliceous rocks wetted by rain, esp. on basal parts of siliceous boulders with a long snow-lie. Widespread in the Alps, and also known from the high mediterranean mountains (Sardegna); to be looked for in the siliceous mountains of the south (e.g. Calabria, Sicilia)

- 16 Thallus P- 17
16 Thallus P+ 18
17 Mostly near or above treeline in rather exposed situations. Thallus whitish to pale grey, often darker in the centre, marginally well-delimited, often rosette-shaped and indistinctly lobulate. With atranorin, porphyritic acid, and with either roccellic, angardianic or rangiformic acids.

14 - *Lepraria cacuminum* (A.Massal.) Loht.



Thallus crustose-leprose, powdery in the shaded to granular in more exposed situations, whitish grey to cream-coloured, often darker in the centre, marginally well-delimited, rosette-shaped, without lobes or indistinctly lobulate, thick, K+ yellow, C-, P- or rarely P+ faintly yellowish. Granules coarse, spherical, up to 700 µm diam., covered by entangled projecting hyphae. Medulla white, frequently exposed in places. Hyphae of thallus 1-3 µm thick, covered by numerous granules. Hyphae of the poorly developed hypothallus 1-5 µm thick. Photobiont chlorococcoid, the cells spherical, to 15 µm in diam. With atranorin and porphyritic acid, and with either roccellic, angardianic or rangiformic acids. Note: on epilithic mosses and soil in grasslands on acid siliceous substrata. Known both from the Alps, where it is widespread, and the high mediterranean mountains.

- 17 Mostly below treeline in rather shaded situations. Thallus whitish to greenish/bluish grey, not sharply delimited. With divaricatic acid, zeorin (rarely with gyrophoric acid and atranorin)

see 9 - Lepraria incana (L.) Ach.

- 18 Thallus C+ orange, with alectorialic and angardianic acids (if C+ yellow, with pannaric acid derivatives, *see 4: Lepruloma diffusum*)

see 6 - Lepraria neglecta (Nyl.) Lettau

- 18 Thallus C- 19
19 Thallus P+ yellow 20
19 Thallus P+ orange 22
20 Granules with protruding, very long hyphae, igle-shaped; mostly epiphytic

15 - *Lepraria rigidula (de Lesd.) Tønsberg*



Thallus leprose, whitish to pale bluish grey, not sharply delimited, forming a soft, thick, more or less continuous, irregularly spreading crust, unlobed or obscurely lobed in young thalli, K+ yellow, C-, KC+ yellow, P+ yellow, UV-, or UV+ dull pink. Granules up to 60 µm in diam., coarse, simple or aggregated into consoredia, <300 µm diam., with projecting long (<120 µm) hyphae, almost igle-shaped. Medulla white, usually poorly developed. Photobiont chlorococcoid, the cells up to 20 µm diam. With atranorin and nephrosteranic acid. Note: an ecologically wide-ranging, mostly epiphytic species sometimes occurring on terricolous mosses; certainly more common, also in the Alps, and to be looked for there.

- 20 Granules without protruding hyphae, or with short protruding hyphae, not igle-shaped 21
21 Mostly near or above treeline in rather exposed situations. Granules up to 700 µm diam. With atranorin, porphyrilic acid, and with either roccellic, angardianic or rangiformic acids.

see 14 - Lepraria cacuminum (A.Massal.) Loht.

- 21 Mostly below treeline in rather shaded situations. Granules <300 µm diam. With thamnolic and roccellic acids, occasionally with atranorin

16 - *Lepraria nylanderiana Kümmerl. & Leuckert*



Thallus leprose, whitish to pale grey, marginally well-delimited, thick, often rosette-shaped and indistinctly lobulate, with a distinct greyish hypothallus, K+ yellow, C-, KC-, P+ yellow. Granules coarse, up to 300 µm diam., without protruding short hyphae. Hyphae of the thallus 3-5 µm thick. Medulla thick, whitish. Photobiont chlorococcoid, the cells 7-15 µm in diam. With thamnolic and roccellic acids, occasionally with traces of atranorin. Note: on base-rich siliceous rocks and soil; much overlooked or confused with similar species in the past, hence Italian distribution poorly known, but mainly Tyrrhenian and mediterranean.

- 22 Thallus KC+ orange
see 5 - Lepraria eburnea J.R.Laundon
- 22 Thallus KC+ yellow, or KC- 23
- 23 Thallus KC+ yellow 24
- 23 Thallus KC- 26
- 24 Thallus not sharply delimited. With zeorin
see 10 - Lepraria lobificans Nyl.
- 24 Thallus sharply delimited, orbicular at least when young, sometimes almost sublobate. Without zeorin 25
- 25 On calcareous substrata. Thallus cream-coloured to whitish. With atranorin, with or without roccellic, protocetraric, fumarprotocetraric, stictic and psoromic acids
see 11 - Lepraria nivalis J.R.Laundon
- 25 On acid siliceous substrata. Thallus whitish to pale grey, often darker in the centre. With atranorin, angardianic or rangiformic acids or both, with or without fumarprotocetraric, psoromic and stictic acids
see 13 - Lepraria caesioalba (de Lesd.) J.R.Laundon
- 26 Thallus thin, not sharply delimited. With thamnolic acid
17 - Lepraria umbricola Tønsberg
-
- Thallus leprose, greyish green to greenish, marginally not well-delimited, not lobulate, consisting in a powdery mass of spherical granules forming a thin crust, K+ bright yellow, C-, KC-, P+ deep orange. Granules very small, less than 10 µm diam., sometimes aggregated into larger consoredia (<40(-60) µm diam.), with or without protruding short hyphae. Hyphae 1-4 µm thick. Medulla undifferentiated. Photobiont chlorococcoid, the cells globose to irregular, arranged in clusters, small, up to 13 µm in diam. With thamnolic acid, occasionally with roccellic acid. Note: on sheltered siliceous rocks and on mosses, sometimes on basal parts of old trunks and on shaded sandy soil; certainly more widespread, perhaps with optimum in Tyrrhenian Italy.
- 26 Thallus thick, sharply delimited, orbicular at least when young, sometimes almost sublobate. With or without thamnolic acid 27
- 27 Thallus yellowish at least at margin, very well delimited, thick, sublobate. With pannaric acid
see 12 - Leproloma membranaceum (Dicks.) Vain.
- 27 Thallus whitish to grey, not yellowish. Without pannaric acid 28

- 28 Mostly near or above treeline in exposed situations. With atranorin, angardianic or rangiformic acids or both, without thamnolic acid
see 13 - Lepraria caesioalba (de Lesd.) J.R.Laundon
- 28 Mostly below treeline in shaded situations. With thamnolic and roccellic acids, occasionally with atranorin
see 16 - Lepraria nylanderiana Kümmerl. & Leuckert

Simplified Keys

Key A: subalpine-alpine, on acid to subacid substrata

For lichens collected in the Alps or in the highest peaks of the N- C- Apennines, near or above treeline (in the Alps, above 1800-2000 m), on acid siliceous substrata (granite, quartzite, acid sandstone, etc., or rotting wood).

Fruticose lichens: subkey A1, p. 253

Foliose lichens: subkey A2, p. 259

Squamulose lichens: subkey A3, p. 261

Crustose lichens: subkey A4, p. 262

Leprose lichens: see general key, p. 243

Subkey A1 - Fruticose lichens

- | | | |
|----|---|--|
| 1 | Thallus dark-coloured, black to dark brown | 2 |
| 1 | Thallus not dark-coloured | 10 |
| 2 | Thallus filamentous (thread-like) | 3 |
| 2 | Thallus non filamentous and without a central cavity (if with a central cavity, go to 25) | 6 |
| 3 | With cyanobacteria; branches <0.2 mm thick | |
| | <i>Polychidium muscicola (Sw.) Gray</i> | |
| 3 | With green algae; branches >0.2 mm thick | 4 |
| 4 | Without pseudocyphellae. Medulla P- | |
| | <i>Bryoria chalybeiformis (L.) Brodo & D.Hawksw.</i> | |
| 4 | With linear pseudocyphellae. Medulla P+ yellow or P+ red | 5 |
| 5 | Medulla K+ faintly yellow to reddish, KC+ red, C+ red, P+ yellowish, with alectorialic and barbatolic acids | |
| | <i>Alectoria nigricans (Ach.) Nyl.</i> | |
| 5 | Medulla K-, KC-, C-, P+ red, with fumarprotocetraric acid | |
| | <i>Bryoria bicolor (Ehrh.) Brodo & D.Hawksw.</i> | |
| 6 | Lobes >4 mm broad. Medulla P+ yellow to orange, with fumarprotocetraric acid | |
| | <i>Cetraria islandica (L.) Ach.</i> | |
| 6 | Lobes <4 mm broad. Medulla P-, without fumarprotocetraric acid | 7 |
| 7 | Lobes canaliculate, with enrolled margins | <i>Cetraria ericetorum Opiz</i> |
| 7 | Lobes not canaliculate, the margins not enrolled | 8 |
| 8 | Medulla yellowish, C+ yellow, with secalonic acid C. Branches more or less adpressed to the substratum, not forming tufts. Rare, restricted to above treeline | |
| | <i>Cetraria obtusata (Schaer.) Van den Boom & Sipman</i> | |
| 8 | Medulla white, C-, with lichesterinic and protolichesterinic acids. Branches ascending, forming tufts. More common, from the lowlands to above treeline | 9 |
| 9 | Branches flattened, uneven, to ca. 1 mm diam., branching open and coarse; pseudocyphellae concave, elongate | |
| | <i>Cetraria aculeata (Schreb.) Fr.</i> | |
| 9 | Branches rounded, even, delicate, to ca. 0.5 mm diam., branching dense and spinulose; pseudocyphellae flat, circular | <i>Cetraria muricata (Ach.) Eckfeldt</i> |
| 10 | Thallus filamentous (thread-like) | 11 |
| 10 | Thallus non filamentous | 12 |
| 11 | Thallus not greenish, K+ yellow, KC+ red, C+ red, with alectorialic and barbatolic acids | |
| | <i>Alectoria nigricans (Ach.) Nyl.</i> | |
| 11 | Thallus greenish at least in part, K-, CK+ yellowish, C-, with diffractaic acid | |

	<i>Alectoria ochroleuca</i> (Hoffm.) A.Massal.	
12	Thallus thin, flat in section	13
12	Thallus thick, inflated to round in section, cream-coloured (if thallus brownish, go back to option 6)	14
13	Thallus smooth, lobes channelled, deep red-purple at the base	
	<i>Flavocetraria cucullata</i> (Bellardi) Kärnefelt & Thell	
13	Thallus reticulate-sulcate, lobes not channelled, yellowish brown at the base	
	<i>Flavocetraria nivalis</i> (L.) Kärnefelt & Thell	
14	Thallus without a central cavity (section!)	15
14	Thallus with a central cavity	25
15	Thallus (fruticose thallus parts) prostrate to ascending, densely covered by greenish soredia-like granules, or by grey, small, scale-like structures (phyllocladia)	16
15	Thallus (fruticose thallus parts) erect, naked	21
16	Thallus P+ orange, with stictic acid. Podetia tomentose, on soil (if podetia naked, firmly attached to the rock: <i>Stereocaulon vesuvianum</i> Pers.)	
	<i>Stereocaulon tomentosum</i> Fr.	
16	Thallus P- or P+ yellow, without stictic acid	17
17	Crustose primary thallus persistent, consisting of more or less scattered phyllocladia	18
17	Crustose primary thallus disappearing.	19
18	Pseudopodetia non tomentose, loosely attached. Cephalodia with <i>Stigonema</i> (microscopic section!), dark brown, with a rough surface. Apothecia frequent	
	<i>Stereocaulon condensatum</i> Hoffm.	
18	Pseudopodetia tomentose, firmly attached. Cephalodia with <i>Nostoc</i> (microscopic section!), brown to bluish green, with a smooth surface. Apothecia rare	
	<i>Stereocaulon glareosum</i> (Savicz) H.Magn.	
19	Pseudopodetia not dorsiventral, without an evident upper and lower surface	
	<i>Stereocaulon incrustatum</i> Flörke	
19	Pseudopodetia dorsiventral, the upper surface looking different from the lower one	20
20	Cephalodia bluish green. Pseudopodetia not very brittle when dry	
	<i>Stereocaulon alpinum</i> Laurer	
20	Cephalodia violet brown. Pseudopodetia very brittle when dry	
	<i>Stereocaulon rivulorum</i> H.Magn.	
21	Fruticose thallus parts mostly sterile, >1.5 cm tall. Crustose primary thallus absent	
	<i>Sphaerophorus fragilis</i>	
21	Fruticose thallus parts in the form of erect stipes bearing apothecia, <1.5 cm tall. Crustose primary thallus evident	22
22	Crustose primary thallus with evident (to 6 mm broad) radiating marginal lobes	
	<i>Baeomyces placophyllus</i> Ach.	
22	Crustose primary thallus without marginal lobes	23
23	Thallus K+ yellow rapidly changing to red	
	<i>Baeomyces carneus</i> Flörke	
23	Thallus K+ yellow, sometimes slowly changing to red	24
24	Apothecia brownish, concave to flat and marginate at first, later swollen and with reflexed margin. Thallus and medulla UV-. Asci I-. With stictic acid, and variable amounts of norstictic and constictic acids	
	<i>Baeomyces placophyllus</i> Ach.	
24	Apothecia pink-coloured, soon swollen and emarginate. Thallus and medulla UV+ orange. Asci I+ blue. With baeomycesic acid, and variable amounts of squamatic acid and atranorin	
	<i>Dibaeis baeomyces</i> (L. fil.) Rambold & Hertel	
25	Thallus densely ramified, shrub-like	26
25	Thallus not or scarcely ramified, never shrub-like	38
26	Podetia without cortex (surface arachnoid under a strong lens), always without squamules. Primary thallus crustose, ephemeral and rarely seen	27

26	Podetia with cortex, with or without squamules. Primary thallus mostly evident, squamulose	32
27	Thallus K+ yellow	28
27	Thallus K-	29
28	Pycnidial jelly colourless (microscope!), bases of podetia not black, or, if black, without white spots. Very common in the Alps	
	<i>Cladonia rangiferina</i> (L.) F.H. Wigg.	
28	Pycnidial jelly reddish (microscope!), bases of podetia black, with scattered white spots. Very rare in the Alps, and restricted to bogs	
	<i>Cladonia stygia</i> (Fr.) Ruoss	
29	Thallus P+ yellow	
	<i>Cladonia arbuscula</i> (Wallr.) Flot. subsp. <i>arbuscula</i>	
29	Thallus P+ red, or P-	30
30	Thallus P+ red, with fumarprotocetraric acid	
	<i>Cladonia arbuscula</i> (Wallr.) Flot. subsp. <i>squarrosa</i> (Wallr.) Ruoss	
30	Thallus P-, without fumarprotocetraric acid	31
31	Main branches much thicker than lateral ones. Top of podetia not dome-shaped	
	<i>Cladonia arbuscula</i> (Wallr.) Flot. subsp. <i>mitis</i> (Sandst.) Ruoss	
31	Most branches of the same thickness. Top of podetia regularly dome-shaped	
	<i>Cladonia stellaris</i> (Opiz) Pouzar & Vězda	
32	With cups	33
32	Without cups	34
33	Thallus yellowish, KC+ yellowish, UV-, with usnic acid. Podetia without squamules	
	<i>Cladonia amaurocraea</i> (Flörke) Schaer.	
33	Thallus greenish grey to brown, KC-, UV+ white, without usnic acid. Podetia mostly with squamules, at least at the base	
	<i>Cladonia crispata</i> (Ach.) Flot.	
34	Thallus K+ brownish	
	<i>Cladonia furcata</i> (Huds.) Schrad.	
34	Thallus K+ yellow, or K-	35
35	Thallus P+ red	
	<i>Cladonia furcata</i> (Huds.) Schrad.	
35	Thallus P-	36
36	Thallus greenish grey to brown, KC-, without usnic acid	
	<i>Cladonia crispata</i> (Ach.) Flot.	
36	Thallus pale yellowish, KC+ yellowish, with usnic acid	37
37	With usnic acid only. Ramifications mainly tri-to tetrachotomous. Surface of central canal not powdery	
	<i>Cladonia uncialis</i> (L.) F.H. Wigg. subsp. <i>uncialis</i>	
37	With usnic and squamatic acid. Ramifications predominantly dichotomous. Surface of central canal white-powdery	
	<i>Cladonia uncialis</i> subsp. <i>biuncialis</i>	
38	With cups	39
38	Without cups	68
39	With soredia (do not confuse schizidia-like, corticate structures with true soredia!)	40
39	Without soredia	54
40	Apothecia and pycnidia scarlet red, K+ blood red (if apothecia are absent, look at the margins of cups for pycnidia !)	41
40	Apothecia and pycnidia pale to dark brown, K-	44
41	Primary squamules large (>0.5 cm diam.). Thallus K+ yellow, KC- or KC+ yellowish, P+ orange, with thamnolic acid, without usnic acid	
	<i>Cladonia digitata</i> (L.) Hoffm.	
41	Primary squamules small to middle-sized (<0.5 cm diam.). Thallus K-, KC+ yellow, P-, with usnic acid, without thamnolic acid	42
42	Podetia with broad cups and short stalks (like <i>C. pyxidata</i>)	
	<i>Cladonia pleurota</i> (Flörke) Schaer.	
42	Podetia slender, with long stalks and narrow cups	43
43	Podetia mostly without cups, and then with pointed ends, but sometimes with narrow, lacerated cups. With usnic and sometimes squamatic acids, without zeorin. Thallus UV+ white or UV-	
	<i>Cladonia sulphurina</i> (Michx.) Fr.	

43	Podetia with narrow, more or less regular cups, more rarely pointed, squamulose esp. toward the base. With usnic acid and zeorin. Thallus always UV-	
	<i>Cladonia deformis</i> (L.) Hoffm.	
44	Thallus K+ yellow turning to red, C+ red, KC+ red, with cryptochlorophaeic acid	
	<i>Cladonia cryptochlorophaea</i> Asahina	
44	Thallus K+ yellow or K-, without cryptochlorophaeic acid	45
45	Soredia granular (here we include also some species with schizidia)	46
45	Soredia farinose	48
46	Thallus KC+ red, with merochlorophaeic acid (warning! the reaction is visible in extracts only!)	
	<i>Cladonia merochlorophaea</i> Asahina	
46	Thallus KC-, without merochlorophaeic acid	47
47	Thallus UV-. With fumarprotocetraric acid only	<i>Cladonia chlorophaea</i>
47	Thallus UV+ bluish white. With grayanic and fumarprotocetraric acids	
	<i>Cladonia grayi</i> Sandst.	
48	Cups regular (like those of <i>C. pyxidata</i> or <i>C. fimbriata</i>)	49
48	Cups, when present, irregular	50
49	Podetia with broad cups and short stalks, like those of <i>C. pyxidata</i> . Thallus P-, with zeorin, without fumarprotocetraric acid. Apothecia and pycnidia waxy yellowish brown	
	<i>Cladonia carneola</i> (Fr.) Fr.	
49	Podetia with small cups and long stalks. Thallus P+ orange-red, without zeorin, with fumarprotocetraric acid. Apothecia and pycnidia medium to dark brown.	
	<i>Cladonia fimbriata</i> (L.) Fr.	
50	Thallus P+ yellow changing to orange-red	<i>Cladonia rei</i> Schaer.
50	Thallus P-, or P+ red	51
51	Thallus P-	52
51	Thallus P+ red	53
52	Cups open at the bottom (i.e. with a hole). With squamatic acid	
	<i>Cladonia cenotea</i> (Ach.) Schaer.	
52	Cups closed at the bottom. With homosekikaic acid	<i>Cladonia rei</i> Schaer.
53	Podetia >4 cm tall, corticate only at base, non squamulose	
	<i>Cladonia subulata</i> (L.) F.H.Wigg.	
53	Podetia <4 cm tall, squamulose-granular to partly decorticate	
	<i>Cladonia ramulosa</i> (With.) J.R.Laundon	
54	Apothecia and pycnidia scarlet red	55
54	Apothecia and pycnidia brown	58
55	With squamatic acid (UV+ white). Podetia >3 cm tall, densely squamulose, with long stalks and narrow cups	
	<i>Cladonia bellidiflora</i> (Ach.) Schaer.	
55	Without squamatic acid (UV-). Podetia <3 cm tall, scarcely or non-squamulose, with short stalks and broad cups, similar to those of <i>C. pyxidata</i> (if you cannot assess chemical differences among the following taxa, your samples could be called " <i>Cladonia coccifera</i> (L.) Willd. s.lat.")	56
56	With usnic and barbatic acids	<i>Cladonia borealis</i> S. Stenroos
56	With usnic acid and zeorin	57
57	Squamules on podetia scarce to absent. Podetia 1-2(-3) cm tall, with conspicuous corticate, convex granules, esp. within the cups, sometimes sparsely squamulose at the base	
	<i>Cladonia coccifera</i> (L.) Willd.	
57	Squamules on podetia abundant. Podetia to 2(-3) cm tall, squamulose at the base, microsquamulose-granulose in upper part and inside the cups	
	<i>Cladonia diversa</i> Asperges	
58	Thallus K+ yellow	59
58	Thallus K-	62
59	Thallus P+ orange, with thamnolic and barbatic acids	
	<i>Cladonia squamosa</i> Hoffm. var. <i>subsquamosa</i> (Leight.) Vain.	
59	Thallus P+ red, with fumarprotocetraric acid	60
60	Podetia >4 cm tall	<i>Cladonia ecmocyna</i> Leight.

60	Podetia <4 cm tall	61
61	Squamules pure white below. Mostly near or above treeline	
	<i>Cladonia macrophyllodes</i> Nyl.	
61	Squamules pinkish grey below. Mostly below treeline	
	<i>Cladonia firma</i> (Nyl.) Nyl.	
62	Thallus P-, with squamatic acid, without fumarprotocetraric acid	
	<i>Cladonia squamosa</i> Hoffm. var. <i>squamosa</i>	
62	Thallus P+ red, with fumarprotocetraric acid	63
63	Podetia <4 cm tall	64
63	Podetia >4 cm tall	65
64	Squamules bluish-grey below. Podetia proliferating from the centre	
	<i>Cladonia cervicornis</i> (Ach.) Flot. subsp. <i>cervicornis</i>	
64	Squamules white below. Podetia non proliferating or proliferating from the margin	
	<i>Cladonia pyxidata</i> (L.) Hoffm.	
65	Podetia proliferating from the centre (forming several stocks of superimposed cups); squamules bluish grey below	
	<i>Cladonia cervicornis</i> (Ach.) Flot. subsp. <i>verticillata</i> (Hoffm.) Ahti	
65	Podetia non proliferating, or proliferating from the margin; squamules white below	66
66	Podetia 2-5 mm thick, very tall (to 12 cm)	<i>Cladonia macroceras</i> (Delise) Hav.
66	Podetia 1-2 mm thick, usually up to 6 cm tall	67
67	Squamules on podetia scarce to absent. Tips of podetia not tomentose (microscope!). Thallus brownish grey to dark brown	
	<i>Cladonia gracilis</i> (L.) Willd.	
67	Squamules on podetia abundant. Tips of podetia faintly tomentose. Thallus pale grey to pale brownish grey	
	<i>Cladonia phyllophora</i> Hoffm.	
68	With soredia	69
68	Without soredia	81
69	Apothecia and pycnidia scarlet red	70
69	Apothecia and pycnidia brown	72
70	Thallus K-, without thamnolic acid	go back to option 43
70	Thallus K+ yellow, with thamnolic acid	71
71	Podetia mostly simple, bacilliform. With thamnolic acid, and variable amounts of barbatic and didymic acids. Primary squamules small (less than 1.5 mm long)	
	<i>Cladonia macilenta</i> Hoffm. subsp. <i>macilenta</i>	
71	Podetia often with a few ramifications. With thamnolic acid only. Primary squamules to 3 mm long	
	<i>Cladonia polydactyla</i> (Flörke) Spreng.	
72	Thallus K+ yellow changing to orange-red, with atranorin and norstictic acid	
	<i>Cladonia acuminata</i> (Ach.) Norrl.	
72	Thallus K-	73
73	Thallus KC+ yellow, with barbatic acid	<i>Cladonia cyanipes</i> (Sommerf.) Nyl.
73	Thallus KC-, without barbatic acid	74
74	Thallus P+ yellow, slowly changing to orange-red	<i>Cladonia rei</i> Schaer.
74	Thallus P+ rapidly red, or P-	75
75	Thallus P-, without fumarprotocetraric acid	76
75	Thallus P+ red, with fumarprotocetraric acid	78
76	Podetia corticate and often squamulose at the base. With homosekikaic acid	
	<i>Cladonia rei</i> Schaer.	
76	Podetia ecorticate at the base. Without homosekikaic acid	77
77	With perlatolic acid. Podetia with cortex disrupted into patches which tend to become subsquamulose, sometimes with granular soredia	
	<i>Cladonia decorticata</i> (Flörke) Spreng.	
77	With squamatic acid. Podetia with a single inconspicuous longitudinal fissure, without squamules, or with a few squamules below, farinose-sorediate	
	<i>Cladonia glauca</i> Flörke	

78	Podetia >4 cm tall	79
78	Podetia <4 cm tall	80
79	Podetia brownish, up to 10 cm tall, with the soredia in rounded patches toward the upper part, a large part of the base corticate. Primary squamules scarcely incised. Rather common in the Alps <i>Cladonia cornuta</i> (L.) Hoffm.	
79	Podetia pale grey to whitish, up to 5(-7) cm tall, mostly evenly covered with soredia, only a small part of the base corticate. Primary squamules inconspicuous, elongate and deeply incised. Extremely rare in the Alps <i>Cladonia subulata</i> (L.) F.H.Wigg.	
80	Soredia farinose, podetia non-squamulose, or squamulose only at the base <i>Cladonia coniocraea</i> (Flörke) Spreng.	
80	Soredia granulose, podetia densely and minutely squamulose <i>Cladonia ramulosa</i> (With.) J.R.Laundon	
81	Thallus K+ yellow	82
81	Thallus K-	89
82	Thallus P+ yellow, with baeomycic and squamatic acids <i>Thamnolia vermicularis</i> (Sw.) Schaer. var. <i>subuliformis</i> (Ehrh.) Schaer.	
82	Thallus P+ orange, P+ red or P-, with a different chemistry	83
83	Thallus P+ orange, with thamnolic acid	84
83	Thallus P+ red or P-, without thamnolic acid	85
84	Primary thallus present, podetia scabrid, squamulose, grey to greenish grey, not becoming pinkish in the herbarium <i>Cladonia squamosa</i> Hoffm. var. <i>subsquamosa</i> (Leight.) Vain.	
84	Primary thallus absent, "podetia" smooth, non-squamulose, pure white, becoming pinkish in the herbarium <i>Thamnolia vermicularis</i> (Sw.) Schaer. var. <i>vermicularis</i>	
85	Thallus P+ red, with fumarprotocetraric acid	86
85	Thallus P-, without fumarprotocetraric acid	87
86	Podetia not very thick-walled, medullary hyphae not running parallel to the surface. Primary squamules large, conspicuous, 5-20 mm long, to 7 mm broad <i>Cladonia turgida</i> Hoffm.	
86	Podetia very thick-walled, medullary hyphae running parallel to the surface. Primary squamules small to middle-sized, to 7 mm long and 2 mm broad <i>Cladonia cariosa</i> (Ach.) Spreng.	
87	Thallus KC+ yellowish, with usnic acid. Apothecia and pycnidia pale yellowish brown <i>Cladonia botrytes</i> (K.G.Hagen) Willd.	
87	Thallus KC-, without usnic acid. Apothecia and pycnidia dark brown	88
88	Primary thallus squamulose. Podetia >0.5 mm diam., very thick-walled, with medullary hyphae running parallel to the surface <i>Cladonia cariosa</i> (Ach.) Spreng.	
88	Primary thallus crustose. Podetia <0.5 mm diam., thin-walled <i>Pycnothelia papillaria</i> (Ehrh.) Dufour	
89	Apothecia and pycnidia scarlet red	90
89	Apothecia and pycnidia brown	91
90	Thallus KC+ yellow, with usnic and squamatic acids, yellowish green. Podetia densely squamulose, 3-5 cm tall <i>Cladonia bellidiflora</i> (Ach.) Schaer.	
90	Thallus KC-, with barbatic and (rarely) thamnolic acids, greenish grey. Podetia non-squamulose, or squamulose only at the base, 1-3 cm tall <i>Cladonia macilenta</i> Hoffm. subsp. <i>floerkeana</i> (Fr.) V.Wirth	
91	Thallus C+ bright emerald green, with baeomycesic and squamatic acids, and strepsilin. Extremely rare, presence in Italy dubious <i>Cladonia strepsilis</i> (Ach.) Grognot	
91	Thallus C-, with a different chemistry	92
92	Thallus P+ yellow, with psoromic acid <i>Cladonia macrophylla</i> (Schaer.) Stenh.	
92	Thallus P+ red or P-, without psoromic acid	93

- 93 Thallus P-, without fumarprotocetraric acid 94
 93 Thallus P+ red, with fumarprotocetraric acid 95
 94 Podetia thin, non squamulose, greenish-yellowish, to 5 mm tall. Apothecia and pycnidia very pale yellowish brown. With usnic acid, without squamatic acid. Medulla UV- *Cladonia botrytes* (K.G.Hagen) Willd.
 94 Podetia thick, densely squamulose, whitish grey, to 5 cm tall. Apothecia and pycnidia medium to dark brown. Without usnic acid, with squamatic acid. Medulla UV+ white *Cladonia squamosa* Hoffm. var. *squamosa*
 95 Podetia thick (2-5 mm), very tall (to 12 cm) *Cladonia macroceras* (Delise) Hav.
 95 Podetia (if present) thinner, much smaller *Cladonia caespiticia* (Pers.) Flörke

Subkey A2 - Foliose lichens

- 1 Thallus bright yellow to orange 2
 1 Thallus of other colours 3
 2 Lobes convex, 0.5-1 mm broad. Thallus deep orange to orange-red
 Xanthoria elegans (Link) Th.Fr. subsp. *elegans*
 2 Lobes flattened, 1-2 mm broad. Thallus orange
 Xanthoria elegans (Link) Th.Fr. subsp. *orbicularis* (Schaer.) Clauzade & Cl.Roux
 3 Thallus dark, from black to dark brown 4
 3 Thallus not dark 9
 4 With soredia or isidia 5
 4 Without soredia or isidia 7
 5 With soredia. Thallus heteromerous, not gelatinous when wet (if thallus heteromerous, see *Massalongia carnosa*) *Nephroma parile* (Ach.) Ach.
 5 With isidia. Thallus homeomerous, gelatinous when wet 6
 6 Isidia granulose, not flattened *Collema tenax* (Sw.) Ach.
 6 Isidia flattened, spathulate *Massalongia carnosa* (Dicks.) Körb.
 7 Thallus thick, without cortex *Collema tenax* (Sw.) Ach.
 7 Thallus thin, with an evident cortex composed by a single layer of angular cells (observe a lobe under the microscope from above) 8
 8 Edge of lobes more or less entire *Leptogium gelatinosum* (With.) J.R.Laundon
 8 Edge of lobes deeply dilacerate-fringed *Leptogium lichenoides* (L.) Zahlbr.
 9 Photobiont cyanobacterial (*Nostoc*) (photobiont layer bluish green in section) 10
 9 Photobiont chlorococcoid (photobiont layer bright green in section) 22
 10 With soredia or isidia 11
 10 Without soredia or isidia 13
 11 With soredia *Peltigera didactyla* (With.) J.R.Laundon
 11 With isidia 12
 12 Isidia peltate (attached by a single point in the centre), scattered on the upper surface. Thallus usually <1 cm broad. Veins flattened
 Peltigera lepidophora (Vain.) Bitter
 12 Isidia spathulate (flattened, and erect, attached by the basis), mostly located along cracks. Thallus usually >5 cm broad. Veins raised
 Peltigera praetextata (Sommerf.) Zopf
 12 Veins on lower surface absent (either lower surface uniformly pale at the margin and dark in the centre, or lower surface black, with scattered white spots) 13
 12 Veins on lower surface present (to observe the veins, carefully clean the entire lower surface!) 14
 13 Lower surface black, with white spots. Upper surface without hairs. Thallus shiny, often with some cracks above *Peltigera elisabethae* Gyeln.
 13 Lower surface without white spots. Upper surface with thin transparent hairs (use

	lens!). Thallus matt, usually without cracks	<i>Peltigera malacea</i> (Ach.) Funck	
14	Thallus with a clearly roughened, scabrous surface (lens!). Very rare in Italy		
		<i>Peltigera scabrosa</i> Th.Fr.	
14	Thallus more or less smooth. More common species		15
15	Thallus non tomentose		16
15	Thallus tomentose at least at the margin of lobes (lens!)		20
16	Veins and rhizines whitish to pale ochraceous brown	<i>Peltigera degenii</i> Gyeln.	
16	Veins and rhizines dark brown to black, at least at thallus centre		17
17	Lobes >3 cm broad, rhizines mostly slender >5 mm long		
		<i>Peltigera neopolydactyla</i> (Gyeln.) Gyeln.	
17	Lobes <3 cm broad, rhizines <5 mm long		18
18	Lower surface pale at margin, dark in the centre, with indistinct venation. Lobes often faintly pruinose at margin	<i>Peltigera neckeri</i> Müll.Arg.	
18	Lower surface with a very distinct pattern of reticulated, dark veins. Lobes not pruinose at margin		19
19	Apothecia horizontal, rounded. Rhizines fasciculate, separate, arranged in concentric lines (clean carefully the lower face!)		
		<i>Peltigera horizontalis</i> (Huds.) Baumg.	
19	Apothecia erect, saddle-shaped. Rhizines becoming confluent, not arranged in concentric lines	<i>Peltigera polydactyla</i> (Neck.) Hoffm.	
20	Lobes 6-10 mm broad	<i>Peltigera rufescens</i> (Weiss) Humb.	
20	Lobes >10 mm broad		21
21	Rhizines slender, more or less simple	<i>Peltigera praetextata</i> (Sommerf.) Zopf	
21	Rhizines squarrose	go to subkey B2, option 30	22
22	With soredia or isidia		23
22	Without soredia or isidia		25
23	Without pseudocyphellae	<i>Phaeophyscia hispidula</i> (Ach.) Essl.	
23	With linear pseudocyphellae		24
24	With isidia	<i>Parmelia saxatilis</i> (L.) Ach.	
24	With soredia	<i>Parmelia sulcata</i> Taylor	
25	With linear pseudocyphellae	<i>Parmelia omphalodes</i> (L.) Ach.	
25	Without pseudocyphellae		26
26	Lower surface orange	<i>Solorina crocea</i> (L.) Ach.	
26	Lower surface not orange		27
27	Lower surface dark, from black to dark brown, esp. in the centre		28
27	Lower surface pale throughout		29
28	Lobes <3 mm broad	<i>Physconia muscigena</i> (Ach.) Poelt var. <i>muscigena</i>	
28	Lobes >5 mm broad	<i>Nephroma expallidum</i> (Nyl.) Nyl.	
29	Veins on lower surface present		30
29	Veins on lower surface absent		32
30	Apothecia laminal, rounded, semi-immersed in the upper surface		
		<i>Solorina saccata</i> (L.) Ach.	
30	Apothecia absent, or if present not semi-immersed in the thallus		31
31	Apothecia common, disc flattened-horizontal, lobes fan-shaped, small (1-2 cm diam.), attached by a single stout rhizine	<i>Peltigera venosa</i> (L.) Hoffm.	
31	Apothecia rare, saddle-shaped. Lobes elongate, very broad (>5 cm diam.), with numerous rhizines	<i>Peltigera aphthosa</i> (L.) Willd.	
32	Lobes long and narrow (<1 mm broad); thallus brownish		
		<i>Anaptychia bryorum</i> Poelt	
32	Lobes not long and narrow, generally >1 mm broad; if less, reduced to a broad collar around the apothecia; thallus usually greenish		33
33	Thallus K+ yellow. Medulla K+ yellow changing to red, with salazinic acid. Apothecia lecanorine, sessile, strongly constricted. Spores 1-celled, hyaline		
		<i>Xanthoparmelia somloënsis</i> (Gyeln.) Hale	
33	Thallus and medulla K-, without salazinic acid. Apothecia non lecanorine, semi-		34

- immersed in the thallus. Spores 2-celled, pigmented
- 34 Spores 2 per ascus 35
- 34 Spores 4 per ascus 36
- 35 Internal pseudo-cephalodia well-developed, forming a thallus with *Nostoc*. Spores 60-100 x 27-60 µm *Solorina bispora* Nyl. subsp. *bispora*
- 35 Internal pseudo-cephalodia absent, or very scarce. Spores 95-140 x 45-60 µm *Solorina bispora* Nyl. subsp. *macrospora* (Harm.) Burgaz & I. Martínez
- 36 Lobes 0.5-1 mm broad. Thallus reduced to a collar around the urceolate apothecia *Solorina spongiosa* (Ach.) Anzi
- 36 Lobes 4-10 mm broad. Thallus well developed, of elongate lobes *Solorina saccata* (L.) Ach.

Subkey A3 - Squamulose lichens

- 1 Photobiont cyanobacterial (photobiont layer bluish green in section) 2
- 1 Photobiont chlorococcoid (photobiont layer bright green in section) 6
- 2 Thallus brownish, not dark-coloured
- Protopannaria pezizoides* (Weber) M.Jørg. & S.Ekman
- 2 Thallus dark, from black to dark brown 3
- 3 Thallus not gelatinous when wet, rather thick. Photobionts restricted to a well-delimited layer (section!). Apothecia restricted at the base, never immersed to semi-immersed in the thallus (if so, see the previous species)
- Massalongia carnosa* (Dicks.) Körb.
- 3 Thallus more or less gelatinous when wet, thin. Photobionts homogeneously spread throughout the thallus (section!) 4
- 4 Most squamules <1 mm broad (measure the squamules in the central part!)
- Leptogium imbricatum* M.Jørg.
- 4 Most squamules >1 mm broad 5
- 5 Edge of lobes deeply dilacerate *Leptogium lichenoides* (L.) Zahlbr.
- 5 Edge of lobes more or less entire *Leptogium gelatinosum* (With.) J.R.Laundon
- 6 Squamules subfoliose, ascending, bifacial (*Cladonia*) 7
- 6 Squamules of different forms, but not subfoliose, ascending, and bifacial 15
- 7 Squamules with soredia *Cladonia digitata* (L.) Hoffm.
- 7 Squamules without soredia 8
- 8 Thallus K+ yellow 9
- 8 Thallus K- 11
- 9 Thallus P+ orange, with thamnolic acid, without fumarprotocetraric acid
- Cladonia squamosa* Hoffm. var. *subsquamosa* (Leight.) Vain.
- 9 Thallus P+ red, without thamnolic acid, with fumarprotocetraric acid 10
- 10 Squamules 5-10 mm broad, to 3 cm long, with a bluish tinge above, white below
- Cladonia macrophyllodes* Nyl.
- 10 Squamules 2-7 mm broad, to 2 cm long, greyish-green, without a bluish tinge above, pale cream-coloured below *Cladonia turgida* Hoffm.
- 11 Thallus C+ bright emerald green, with baeomycesic and squamatic acids and strepsilin *Cladonia strepsilis* (Ach.) Grognot
- 11 Thallus C-, with a different chemistry 12
- 12 Thallus P+ yellow, with psoromic acid *Cladonia macrophylla* (Schaer.) Stenh.
- 12 Thallus P- or P+ red, without psoromic acid 13
- 13 Thallus P-, without fumarprotocetraric acid
- Cladonia squamosa* Hoffm. var. *squamosa*
- 13 Thallus P+ red, with fumarprotocetraric acid 14
- 14 Squamules white below *Cladonia caespiticia* (Pers.) Flörke
- 14 Squamules grey to pale yellowish below *Cladonia cervicornis* (Ach.) Flot. subsp. *cervicornis*

15	With apothecia (thallus positive or negative to K, C, KC and P)	16
15	With perithecia (thallus always K-, C-, KC-, P-)	18
16	Thallus bright yellowish green. Spores pigmented	
	<i>Catolechia wahlenbergii</i> (Ach.) Körb.	
16	Thallus of other colours. Spores hyaline	17
17	Most spores more than 5-celled, needle-shaped	
	<i>Toninia squalida</i> (Ach.) A.Massal.	
17	Most spores less than 5-celled, not needle-shaped	
	<i>Toninia albilabra</i> (Dufour) H.Olivier	
18	Rhizohyphae pale	
	<i>Placidium lachneum</i> (Ach.) de Lesd.	
18	Rhizohyphae dark (make a section of the squamule, and carefully observe the rhizohyphae under the microscope)	19
19	Lower cortex present, dark, paraplectenchymatous (section!). Thallus brownish grey, often faintly pruinose especially toward the centre, and darker toward the margin. Old perithecia with a dark wall. Asci 65-70 x 16-22 µm. Spores (15-)17-23(-25) x (6-)6.5-8.5(-9.5) µm	
	<i>Catapyrenium cinereum</i> (Pers.) Körb.	
19	Lower cortex absent. Thallus brownish grey, often faintly pruinose especially towards the centre, never darker at margin. Most perithecia with a pale to colourless wall. Asci 75-85 x 17-20 µm Spores (15-)17-22(-24) x (5-)6-8(-9) µm	
	<i>Catapyrenium daedaleum</i> (Kremp.) Stein	

Subkey A4 - Crustose lichens

1	With cyanobacteria (photobiont layer bluish-green in section)	
	<i>Moelleropsis nebulosa</i> (Hoffm.) Gyeln.	
1	Without cyanobacteria (photobiont layer bright green to orange-green in section)	2
2	Thallus dark, from black to very dark brown	3
2	Thallus not dark	10
3	With perithecia. With <i>Trentepohlia</i> (photobiont layer orange-green in section)	
	<i>Porina mammillosa</i> (Th.Fr.) Vain.	
3	With apothecia. With chlorococcoid algae (photobiont layer bright green in section)	4
4	With soredia	
	<i>Trapeliopsis gelatinosa</i> (Flörke) Coppins & P.James	
4	Without soredia	5
5	Thallus KC+ red, with gyrophoric acid	
	<i>Placynthiella icmalea</i> (Ach.) Coppins & P.James	
5	Thallus KC-, without gyrophoric acid	6
6	Spores many-celled, muriform	
	<i>Lopadium pezizoideum</i> (Ach.) Körb.	
6	Spores 1-celled	7
7	Thallus thick, composed by lobulate areolae at least 0.5 mm broad	
	<i>Lecidoma demissum</i> (Rutstr.) Gotht.Schneid. & Hertel	
7	Thallus thin, smooth to minutely granulose, the granules <0.3 mm in diam.	8
8	Thallus smooth. Spores subglobose, >16 µm long	
	<i>Japewia tornöensis</i> (Nyl.) Tønsberg	
8	Thallus granulose. Spores ellipsoid, <16 µm long. Epithecium brown (if epithecium green see option 4: <i>Trapeliopsis gelatinosa</i>)	9
9	Granules wart-like (100-300 µm), becoming yellowish green when wet	
	<i>Placynthiella oligotropa</i> (J.R.Laundon) Coppins & P.James	
9	Granules small, less than 100 µm, not becoming yellowish green when wet	
	<i>Placynthiella uliginosa</i> (Schrad.) Coppins & P.James	
10	Thallus bright (greenish-) yellow to orange	11
10	Thallus not bright yellow to orange	21
11	With soredia	
	<i>Arthrorhaphis citrinella</i> (Ach.) Poelt	
11	Without soredia	12

12	Thallus composed by very small (<0.4 mm diam.), rounded, scattered, bright yellow-green granules. Apothecia perithecioid to urceolate, small (<0.5 mm diam.), immersed in the granules	13
12	Thallus and apothecia different	17
13	Disc of the apothecia not exposed (apothecia perithecioid, the warts opening through a narrow pore)	14
13	Disc of the apothecia at least partly exposed	15
14	Spores oblong-obtuse, 3-4(-5) x 1-1.5 µm. Paraphyses absent, substituted by paraphyses.	
	<i>Thelocarpon intermediellum</i> Nyl.	
14	Spores subglobose to broadly ellipsoid, 1.5-4(-6) x 1.5-2 µm. Paraphyses present.	
	<i>Thelocarpon laureri</i> (Flot.) Nyl.	
15	Paraphyses absent. Paraphyses branched (carefully observe many paraphyses under the microscope!). Asci I+ pale blue, on <i>Baeomyces</i>	
	<i>Thelocarpon lichenicola</i> (Fuckel) Poelt & Hafellner	
15	Paraphyses present. Paraphyses not branched. On bare soil, or, if on <i>Baeomyces</i> , asci I-	16
16	Asci I+ blue. Spores 4-5 x 1-2 µm	<i>Thelocarpon citrum</i> (Wallr.) Rossman
16	Asci I-. Spores 4-7(-12) x 1.7-2.5(-3) µm	<i>Thelocarpon epibolum</i> Nyl.
17	Apothecia non lecanorine, without a thalline margin	18
17	Apothecia lecanorine, with a thalline margin containing algal cells	20
18	Thallus P+ orange-yellow, parasitic on <i>Baeomyces</i>	
	<i>Epilichen scabrosus</i> (Ach.) Clem.	
18	Thallus P-, parasitic or not	19
19	Most spores longer than 23 µm, 8-12-celled, (20-)25-45(-60) x 3-4.5 µm	
	<i>Arthrorhaphis alpina</i> (Schaer.) R.Sant.	
19	Most spores shorter than 23 µm, 4-5-celled, 16-23 x 3 µm	
	<i>Arthrorhaphis vacillans</i> Th.Fr.	
20	Mostly on wood, very rarely on soil. Thallus of closely packed, granular elements. Apothecia rare	
	<i>Candelariella kuusamoënsis</i> Räsänen	
20	Mostly on siliceous rocks, but not unfrequent on mosses and mineral soil over siliceous substrata. Thallus from granulose to small-lobulate, with flat lobules, not forming convex pillows of densely packed coralloid elements. Apothecia frequent	
	<i>Candelariella vitellina</i> (Hoffm.) Müll.Arg.	
21	Photobiont trentepohlioid (algal layer more or less orange)	22
21	Photobiont chlorococcoid (algal layer bright green)	25
22	With perithecia	23
22	With apothecia	24
23	Perithecia dark-coloured, mostly black	<i>Porina mammillosa</i> (Th.Fr.) Vain.
23	Perithecia not dark-coloured	<i>Belonia russula</i> Nyl.
24	Apothecia perithecioid, <0.5 mm diam	<i>Belonia russula</i> Nyl.
24	Apothecia not perithecioid, with an evident disc, >0.5 mm diam.	<i>Gyalecta friesii</i> Körb.
25	With soredia or isidia	26
25	Without soredia or isidia	35
26	Thallus with isidia	<i>Pertusaria oculata</i> (Dicks.) Th.Fr.
26	Thallus with soredia	27
27	Thallus K+ yellow	28
27	Thallus K-	31
28	Thallus KC+ yellow, with stictic acid	<i>Baeomyces rufus</i> (Huds.) Rebert.
28	Thallus KC- or KC+ red, without stictic acid	29
29	Thallus KC-	<i>Lecanora bryopsora</i> (Doppelb. & Poelt) Hafellner & Türk
29	Thallus KC+ red	30
30	Thallus P-, with gyrophoric acid, without alectorialic and barbatolic acids. Spores 8 per ascus	<i>Ochrolechia inaequatula</i> (Nyl.) Zahlbr.
30	Thallus P+ yellow-orange, with alectorialic and barbatolic acids, without	

	gyrophoric acid. Spores 2 per ascus	<i>Pertusaria geminipara</i> (Th.Fr.) Brodo	
31	Thallus greenish, entirely leprose-sorediate, KC-, with pulvinic acid derivatives		
		<i>Chaenotheca furfuracea</i> (L.) Tibell	
31	Thallus not greenish, not entirely leprose-sorediate, KC+ red to orange, without pulvinic acid derivatives		32
32	Thallus with lecanoric acid. Spores 1 per ascus, 2-celled		
		<i>Varicellaria rhodocarpa</i> (Körb.) Th.Fr.	
32	Thallus with gyrophoric acid. Spores 8 per ascus, 1-celled		33
33	Thallus with orange-red, K+ red patches (anthraquinones)		
		<i>Trapeliopsis pseudogranulosa</i> Coppins & P.James	
33	Thallus without orange-red, K+ red patches (no anthraquinones)		34
34	Thallus C+, KC+ orange-red. Soredia grouped into maculiform soralia. Apothecia lecanorine, >2 mm diam. Spores >30 µm long		
		<i>Ochrolechia androgyna</i> (Hoffm.) Arnold	
34	Tallus C+, KC+ red. Soredia diffuse. Apothecia non-lecanorine, <2 mm diam. Spores <15 µm long		
		<i>Trapeliopsis granulosa</i> (Hoffm.) Lumbsch	
35	Thallus with radiating marginal lobes	<i>Baeomyces placophyllus</i> Ach.	
35	Thallus without marginal lobes		36
36	With perithecia		37
36	With apothecia		44
37	Spores 2-celled		38
37	Spores not 2-celled		39
38	Spores 32 per ascus, with filiform appendages at both ends, fusiform, <2.5 µm broad		
		<i>Epigloea grummannii</i> Döbbeler	
38	Spores 8 per ascus, without appendages at the ends, ellipsoid, >3 µm broad		
		<i>Epigloea soleiformis</i> Döbbeler	
39	Spores 4-celled	<i>Epigloea medioincrassata</i> (Grummann) Döbbeler	
39	Spores not 4-celled		40
40	Perithecia pale-coloured	<i>Belonia incarnata</i> Th.Fr.	
40	Perithecia dark-coloured		41
41	Spores submuriform		
		<i>Protothelenella sphinctrinoidella</i> (Nyl.) H.Mayrhofer & Poelt	
41	Spores strongly muriform		42
42	Thallus thick, evident	<i>Polyblastia sendtneri</i> Kremp.	
42	Thallus inconspicuous, reduced to a thin film		43
43	Perithecial wall pale below. Perithecia >0.4 mm diam.		
		<i>Protothelenella sphinctrinoides</i> (Nyl.) H.Mayrhofer & Poelt	
43	Perithecial wall dark throughout. Perithecia <0.4 mm diam.		
		<i>Polyblastia evanescens</i> Arnold	
44	Apothecia lecanorine, with a thalline margin containing algal cells		45
44	Apothecia non lecanorine, without a thalline margin		61
45	Thallus K+ rapidly red, with norstictic acid		46
45	Thallus K+ yellow or K-, without norstictic acid		48
46	Thallus KC+ yellow-red, P+ yellow	<i>Pertusaria glomerata</i> (Ach.) Schaer.	
46	Thallus KC-, P- (rarely P+ orange)		47
47	Spores <17 µm long. Thallus thin, greyish	<i>Bryonora castanea</i> (Hepp) Poelt	
47	Spores >17 µm long. Thallus thick, grey to brownish grey		
		<i>Bryodina rhyariza</i> (Nyl.) Hafellner & Türk	
		<i>Lecanora epibryon</i> (Ach.) Ach.	
48	Thallus K+ yellow		
48	Thallus K-		49
49	Spores 4-celled	<i>Bryonora curvescens</i> (Mudd) Poelt	
49	Spores not 4-celled		50
50	Spores more than 4-celled	<i>Belonia incarnata</i> Th.Fr.	
50	Spores 1- to 2-celled		51
51	Spores 1-celled		52

51	Spores 2-celled		55
52	Thallus C and KC+ red, with gyrophoric acid	<i>Trapelia coarctata</i> (Sm.) M.Choisy	
52	Thallus C and KC-, without gyrophoric acid		53
53	Thallus yellowish green to greenish	<i>Lecanora leptacina</i> Sommerf.	
53	Thallus not yellowish green to greenish		54
54	Thallus thin. Apothecial margin smooth. Spores < 8 µm broad. Apothecia K- (if apothecia K+red see opt. 59: <i>Caloplaca nivalis</i>)	<i>Bryonora curvescens</i> (Mudd) Poelt	
54	Thallus thick. Apothecial margin rough, with warts or squamules. Spores > 8 µm broad	<i>Psoroma hypnorum</i> (Vahl) Gray	
55	Apothecia dark-coloured		56
55	Apothecia bright yellow to orange		58
56	Spores hyaline	<i>Caloplaca ammiospila</i> (Wahlenb.) H.Olivier	
56	Spores pigmented		57
57	Apothecial cortex I- (section!). Apothecial disc brown, to 0.7 mm diam. Spores 16-24 x 7-10 µm	<i>Rinodina olivaceobrunnea</i> C.W.Dodge & G.E.Baker	
57	Apothecial cortex I+ blue. Apothecial disc black, to 1.7 mm diam. Spores 24-34 x 9-14 µm	<i>Rinodina turfacea</i> (Wahlenb.) Körb.	
58	Spores non polar-diblastic		59
58	Spores polar-diblastic		60
59	Thallus KC-. Apothecia K+ violet-red, not immersed in thalline warts. Spores 8 per ascus, 22-31 x 3-5(-6) µm	<i>Caloplaca nivalis</i> (Körb.) Th.Fr.	
59	Thallus KC+ red. Apothecia K-, immersed in thalline warts. Spores 1 per ascus, 200-400 x 70-140 µm (if spores much smaller, (4-)8 per ascus, see <i>Anzina carneonivea</i>)	<i>Varicellaria rhodocarpa</i> (Körb.) Th.Fr.	
60	Apothecial margin indistinct. Disc rapidly convex	<i>Caloplaca livida</i> (Hepp) Jatta	
60	Apothecial margin distinct, more or less persistent. Disc long remaining flat	<i>Caloplaca ammiospila</i> (Wahlenb.) H.Olivier	
61	Thallus KC+ yellow. Apothecia stipitate	<i>Dibaeis baeomyces</i> (L. fil.) Rambold & Hertel	
61	Thallus KC-, KC+ orange, or KC+ red. Apothecia usually not stipitate		62
62	Thallus KC+ orange		63
62	Thallus KC+ red or KC-		67
63	Apothecia pink to pale orange-pink	<i>Icmadophila ericetorum</i> (L.) Zahlbr.	
63	Apothecia dark-coloured		64
64	Spores 2-celled, pigmented		65
64	Spores not 2-celled, pigmented or not		66
65	Spores <8 µm thick	<i>Buellia hypophana</i> (Nyl.) Zahlbr.	
65	Spores >8 µm thick	<i>Buellia insignis</i> (Hepp) Th.Fr.	
66	Thallus K-, with sphaerophorin	<i>Frutidella caesioatra</i> (Schaer.) Kalb	
66	Thallus K+ yellow, without sphaerophorin	<i>Lecidella wulfenii</i> (Hepp) Körb.	
67	Thallus KC+ red		68
67	Thallus KC-		70
68	Spores 1-celled	<i>Trapeliopsis granulosa</i> (Hoffm.) Lumbsch	
68	Spores 2- to 4-celled		69
69	Macroconidia less than 50 µm long. Apothecia frequent. Spores (11-)15-23(-24) x 3-5(-6) µm	<i>Micarea peliocarpa</i> (Anzi) Coppins & R.Sant.	
69	Macroconidia flexuous, filiform, 50-110 x 1 µm. Apothecia rare. Spores (19-)23-34(-38) x 4.5-6 µm	<i>Micarea cinerea</i> (Schaer.) Hedl.	
70	Apothecia pale-coloured		71
70	Apothecia dark-coloured		78
71	Thallus K+ yellow, with atranorin	<i>Lecidea rufofusca</i> (Anzi) Nyl.	
71	Thallus K-, without atranorin		72
72	Spores more than 4-celled	<i>Absoconditella annexa</i> (Arnold) Vězda	
72	Spores no more than 4-celled		73

73	Spores 2-celled		74
73	Spores 1- or 4-celled		75
74	Apothecial margin indistinct, Thallus composed of goniocysts, finely granular. Paraphyses ramified, anastomosing. Epithecium K+ violet, N+ red	<i>Micarea prasina Fr.</i>	
74	Apothecial margin distinct, usually paler than disc. Thallus not composed of gonicysts, continuous. Paraphyses simple, not anastomosing. Epithecium K-, N-	<i>Absconditella sphagnum Vězda & Poelt</i>	
75	Spores 4-celled		76
75	Spores 1-celled		77
76	Apothecia whitish to pale yellowish white. Spores broadly ellipsoid to fusiform, (12-)13-22 x 4-7 µm	<i>Mycobilimbia pilularis (Körb.) Hafellner & Türk</i>	
76	Apothecia reddish to blackish brown. Spores ellipsoid-cylindrical, 16-30 x 5-6 µm	<i>Myxobilimbia microcarpa (Th.Fr.) Hafellner</i>	
77	Apothecial margin (section!) colourless outside, pale brown inside. Thallus continuous, whitish grey	<i>Biatora subduplex (Nyl.) Printzen</i>	
77	Apothecial margin (section!) more or less pale brown, uniformly coloured. Thallus granulose, greyish-green	<i>Biatora vernalis (L.) Fr.</i>	
78	Thallus K+ yellow		79
78	Thallus K-		82
79	Spores 2-celled	<i>Buellia insignis (Hepp) Th.Fr.</i>	
79	Spores 1-celled		80
80	Epithecium bright blue-green	<i>Lecidea alpestris Sommerf.</i>	
80	Epithecium greenish brown to brown		81
81	Apothecia dark brown to black. Epithecium dark greenish brown	<i>Lecidea miscella Ach.</i>	
81	Apothecia pale to dark reddish brown. Epithecium brownish	<i>Lecidea rufofusca (Anzi) Nyl.</i>	
82	Thallus P+ red		83
82	Thallus P-		84
83	Epithecium deep bluish green, hypothecium reddish brown. With pannarin. Spores 1-celled, (8-)10-14(-15) x 3-4.5(-5) µm.	<i>Protomicarea limosa (Ach.) Hafellner</i>	
83	Epithecium and hypothecium olivaceous green. With argopsin. Spores 4-8-celled, 16-36(-38) x 4-6(-7) µm	<i>Micarea lignaria (Ach.) Hedl. var. lignaria</i>	
84	Spores 4-celled	<i>Myxobilimbia microcarpa (Th.Fr.) Hafellner</i>	
84	Spores not 4-celled		85
85	Spores 1-celled		86
85	Spores not 1-celled		88
86	Spores subglobose, 12-16 per ascus	<i>Steinia geophana (Nyl.) Stein</i>	
86	Spores not subglobose, 8 or more than 32 per ascus		87
87	Epithecium K+ green	<i>Helocarpon pulverulum (Th.Fr.) Türk & Hafellner</i>	
87	Epithecium K-	<i>Mycobilimbia hypnorum (Lib.) Kalb & Hafellner</i>	
88	Spores 2-celled		89
88	Spores more than 4-celled		93
89	Spores pigmented	<i>Amandinea punctata (Hoffm.) Coppins & Scheid.</i>	
89	Spores hyaline		90
90	Epithecium K+ violet	<i>Micarea prasina Fr.</i>	
90	Epithecium K-		91
91	Apothecial margin distinct	<i>Mycobilimbia hypnorum (Lib.) Kalb & Hafellner</i>	
91	Apothecial margin indistinct		92
92	Spores <15 µm long, oblong-obtuse, 2-celled. Epithecium dark green	<i>Catillaria contristans (Nyl.) Zahlbr.</i>	
92	Spores >15 µm long, ellipsoid-cylindrical, 2-4-celled. Epithecium brownish	<i>Myxobilimbia microcarpa (Th.Fr.) Hafellner</i>	

93	Spores muriform/submuriform		94
93	Spores not muriform/submuriform		96
94	Spores <35 µm long	<i>Gyalidea scutellaris</i> (Bagl. & Carestia) Lettau	
94	Spores >35 µm long		95
95	Spores 2-4 per ascus. Epithecium bluish green	<i>Schadonia alpina</i> Körb.	
95	Spores 8 per ascus. Epithecium dark brown	<i>Schadonia fecunda</i> (Th.Fr.) Vězda & Poelt	
96	Parasitic on <i>Baeomyces</i>	<i>Arthrorhaphis grisea</i> Th.Fr.	
96	Non parasitic	<i>Myxobilimbia accedens</i> (Arnold) Hafellner	

**Key B: subalpine-alpine, on subneutral to basic (calcareous)
substrata**

You can use this key if your lichen was collected in the Alps, or in the highest peaks of the N- C- Apennines, near or above treeline (in the Alps, above 1800-2000 m), on calcareous or dolomitic substrata, on in areas with base-rich siliceous rocks such as calciferous schist, calciferous sandstone, basalt, etc. If your species was collected on rotting wood, you better go to key A.

Fruticose lichens: subkey B1, p. 269

Foliose lichens: subkey B2, p. 271

Squamulose lichens: subkey B3, p. 274

Crustose lichens: subkey B4, p. 277

Leprose lichens: see general key, p. 243

Subkey B1 - Fruticose lichens

- | | | | |
|----|---|--|---|
| 1 | Thallus orange, K+ red | | <i>Xanthoria contortuplicata (Ach.) Boistel</i> |
| 1 | Thallus of other colours, K- or K+ yellow | | 2 |
| 2 | Thallus dark-coloured, black to dark brown | | 3 |
| 2 | Thallus not dark-coloured | | 7 |
| 3 | Thallus filamentous (thread-like), with cyanobacteria | | |
| | | | <i>Polychidium muscicola (Sw.) Gray</i> |
| 3 | Thallus non filamentous, with green algae, without squamules at the base (if these are present, go to 15) | | 4 |
| 4 | Lobes >3 mm broad. Medulla P+ yellow to orange, with fumarprotocetraric acid | | |
| | | | <i>Cetraria islandica (L.) Ach.</i> |
| 4 | Lobes <3 mm broad. Medulla P-, without fumarprotocetraric acid | | 5 |
| 5 | Lobes canaliculate, with enrolled margins | | <i>Cetraria ericetorum Opiz</i> |
| 5 | Lobes not canaliculate, the margins not enrolled | | 6 |
| 6 | Branches flattened, uneven, to ca. 1 mm diam., branching open and coarse; pseudocyphellae concave, elongate | | <i>Cetraria aculeata (Schreb.) Fr.</i> |
| 6 | Branches rounded, even, delicate, to ca. 0.5 mm diam., branching dense and spinulose; pseudocyphellae flat, circular | | <i>Cetraria muricata (Ach.) Eckfeldt</i> |
| 7 | Thallus filamentous (thread-like) | | <i>Alectoria ochroleuca (Hoffm.) A.Massal.</i> |
| 7 | Thallus non filamentous | | 8 |
| 8 | Thallus thin, flat in section | | 9 |
| 8 | Thallus thick, inflated to round in section | | 11 |
| 9 | Thallus grey, with prominent marginal cilia | | <i>Anaptychia ciliaris (L.) Körb.</i> |
| 9 | Thallus cream-coloured, without marginal cilia (if thallus pale brown, go back to option 4) | | 10 |
| 10 | Thallus smooth, lobes channelled, deep red-purple at the base | | |
| | | | <i>Flavocetraria cucullata (Bellardi) Kärnefelt & Thell</i> |
| 10 | Thallus reticulate-sulcate, lobes not channelled, yellowish brown at the base | | |
| | | | <i>Flavocetraria nivalis (L.) Kärnefelt & Thell</i> |
| 11 | Thallus without a central cavity (section!) | | 12 |
| 11 | Thallus with a central cavity | | 15 |
| 12 | Thallus (fruticose thallus parts) densely covered by greenish soredia-like granules or by grey small scale-like structures (phyllocladia) | | |
| | | | <i>Stereocaulon rivulorum H.Magn.</i> |

12	Thallus (fruticose thallus parts) erect, naked		13
13	Pseudocyphellae present	<i>Aspicilia hispida</i> Mereschk.	
13	Pseudocyphellae absent		14
14	Fruticose thallus parts mostly sterile, >1.5 cm tall. Crustose primary thallus absent	<i>Allocetraria madreporiformis</i> (Ach.) Kärnefelt & Thell	
14	Fruticose thallus parts in the form of erect stipes bearing apothecia, <1.5 cm tall. Crustose primary thallus evident	go to subkey A1, option 22	
15	Thallus densely ramified, shrub-like		16
15	Thallus not or scarcely ramified, never shrub-like		22
16	Podetia without cortex (surface arachnoid under a strong lens), without squamules. Primary thallus crustose, ephemeral and rarely seen		17
16	Podetia with cortex, with or without squamules. Primary thallus mostly evident, squamulose		19
17	Thallus grey, K+ yellow	<i>Cladonia rangiferina</i> (L.) F.H. Wigg.	
17	Thallus cream-coloured, K-		18
18	Thallus P+ yellow	<i>Cladonia arbuscula</i> (Wallr.) Flot. subsp. <i>arbuscula</i>	
18	Thallus P+ red		
		<i>Cladonia arbuscula</i> (Wallr.) Flot. subsp. <i>squarrosa</i> (Wallr.) Ruoss	
19	Thallus K+ brownish	<i>Cladonia furcata</i> (Huds.) Schrad.	
19	Thallus K+ yellow, or K-		20
20	Thallus K+ yellow, with atranorin	<i>Cladonia rangiformis</i> Hoffm.	
20	Thallus K-, without atranorin		21
21	Thallus KC+ yellow, with usnic acid. Squamules absent. Restricted to above treeline	<i>Dactylina ramulosa</i> (Hook.) Tuck.	
21	Thallus KC-, without usnic acid. Squamules usually present, at least at the base of the podetia. Mainly below treeline	<i>Cladonia furcata</i> (Huds.) Schrad.	
22	With cups		23
22	Without cups		31
23	With soredia (do not confuse schizidia-like, corticate structures with true soredia!)		24
23	Without soredia		28
24	Soredia granular (here we include also some species with schizidia)		25
24	Soredia farinose		26
25	Thallus UV-. With fumarprotocetraric acid only	<i>Cladonia chlorophaea</i>	
25	Thallus UV+ bluish white. With grayanic and fumarprotocetraric acids		
		<i>Cladonia grayi</i> Sandst.	
26	Cups regular	<i>Cladonia fimbriata</i> (L.) Fr.	
26	Cups, when present, irregular		27
27	Thallus P-	<i>Cladonia cenotea</i> (Ach.) Schaer.	
27	Thallus P+ red	<i>Cladonia subulata</i> (L.) F.H. Wigg.	
28	Apothecia and pycnidia scarlet red	<i>Cladonia coccifera</i> (L.) Willd.	
28	Apothecia and pycnidia brown		29
29	Podetia >4 cm tall	<i>Cladonia macroceras</i> (Delise) Hav.	
29	Podetia <4 cm tall		30
30	Thallus more or less brownish. Primary squamules 0.5-2 mm thick, flat, forming a thick subrosulate crust	<i>Cladonia pocillum</i> (Ach.) O.J. Rich.	
30	Thallus greyish-green. Primary squamules <0.5 mm thick, more or less ascending, never forming a thick subrosulate crust		
		<i>Cladonia pyxidata</i> (L.) Hoffm.	
31	With soredia		32
31	Without soredia		35
32	Thallus K+ yellow changing to orange-red, with atranorin and norstictic acid		
		<i>Cladonia acuminata</i> (Ach.) Norrl.	
32	Thallus K-		33
33	Podetia <4 cm tall	<i>Cladonia coniocraea</i> (Flörke) Spreng.	

33	Podetia >4 cm tall	34
34	Podetia brownish, up to 10 cm tall, with the soredia in rounded patches toward the upper part, a large part of the base corticate. Primary squamules scarcely incised. Rather common in the Alps	
	<i>Cladonia cornuta</i> (L.) Hoffm.	
34	Podetia pale grey to whitish, up to 5(-7) cm tall, mostly evenly covered with soredia, only a small part of the base corticate. Primary squamules inconspicuous, elongate and deeply incised. Extremely rare in the Alps	
	<i>Cladonia subulata</i> (L.) F.H.Wigg.	
35	Thallus K+ red, with norstictic acid	
	<i>Cladonia symphycarpa</i> (Flörke) Fr.	
35	Thallus K+ yellow or K-, without norstictic acid	36
36	Thallus K+ yellow	37
36	Thallus K-	41
37	Thallus P+ yellow, with baeomycic and squamatic acids	
	<i>Thamnolia vermicularis</i> (Sw.) Schaer. var. <i>subuliformis</i> (Ehrh.) Schaer.	
37	Thallus P+ orange, P+ red or P-, with a different chemistry	38
38	Thallus P+ orange, with thamnolic acid	
	<i>Thamnolia vermicularis</i> (Sw.) Schaer. var. <i>vermicularis</i>	
38	Thallus P+ red or P-, without thamnolic acid	39
39	Thallus P+ red, with fumarprotocetraric acid	
	<i>Cladonia cariosa</i> (Ach.) Spreng.	
39	Thallus P-, without fumarprotocetraric acid	40
40	Primary thallus squamulose. Podetia >0.5 mm diam., very thick-walled, with medullary hyphae running parallel to the surface	
	<i>Cladonia cariosa</i> (Ach.) Spreng.	
40	Primary thallus crustose. Podetia <0.5 mm diam., thin-walled	
	<i>Pycnothelia papillaria</i> (Ehrh.) L.M.Doufur	
41	Podetia thick (2-5 mm), very tall (to 12 cm)	
	<i>Cladonia macroceras</i> (Delise) Hav.	
41	Podetia (if present) thinner, much smaller	
	<i>Cladonia caespiticia</i> (Pers.) Flörke	

Subkey B2 - Foliose lichens

1	Thallus bright yellow to orange	2
1	Thallus of other colours	5
2	Thallus K-, with vulpinic and pinastric acids	
	<i>Vulpicida tubulosus</i> (Schaer.) J.E.Mattsson & M.J.Lai	
2	Thallus K+ red, with xanthones	3
3	Lobes >3 mm broad, most frequent in lowland areas	
	<i>Xanthoria calcicola</i> Oksner	
3	Lobes <2 mm broad, most frequent in the mountains	4
4	Lobes convex, 0.5-1 mm broad. Thallus deep orange to orange-red	
	<i>Xanthoria elegans</i> (Link) Th.Fr. subsp. <i>elegans</i>	
4	Lobes flattened, 1-2 mm broad. Thallus orange	
	<i>Xanthoria elegans</i> (Link) Th.Fr. subsp. <i>orbicularis</i> (Schaer.) Clauzade & Cl.Roux	
5	Thallus dark, from black to dark brown	6
5	Thallus not dark	15
6	With soredia or isidia	7
6	Without soredia or isidia	8
7	With soredia. Thallus heteromerous, not gelatinous when wet	
	<i>Nephroma parile</i> (Ach.) Ach.	
7	With isidia. Thallus homeomerous, gelatinous when wet	
	<i>Collema tenax</i> (Sw.) Ach.	
8	Thallus with thin transparent hairs, esp. at the margin	
	<i>Leptochidium albociliatum</i> (Desm.) M.Choisy	
8	Thallus without hairs	9
9	Thallus thin, with an evident cortex composed by a single layer of angular cells	10

	(observe a lobe under the microscope from above)	
9	Thallus thick, without cortex	11
10	Edge of lobes more or less entire <i>Leptogium gelatinosum</i> (With.) J.R.Laundon	
10	Edge of lobes deeply dilacerate-fringed <i>Leptogium lichenoides</i> (L.) Zahlbr.	
11	Spores 4-celled <i>Collema tenax</i> (Sw.) Ach.	
11	Spores not 4-celled	12
12	Spores 1-celled <i>Lempholemma polyanthes</i> (Bernh.) Malme	
12	Spores more than 4-celled	13
13	Spores yellowish brown at maturity (a very rare species restricted to alpine areas) <i>Collema bachmanianum</i> (Fink) Degel.	
13	Spores hyaline	14
14	Spores 8 per ascus. A common species <i>Collema tenax</i> (Sw.) Ach.	
14	Spores (2-)4 per ascus. A rare species <i>Collema ceranicum</i> Nyl.	
15	Photobiont cyanobacterial (<i>Nostoc</i>) (photobiont layer bluish green in section)	16
15	Photobiont chlorococcoid (photobiont layer bright green in section)	32
16	With soredia or isidia	17
16	Without soredia or isidia	19
17	With soredia <i>Peltigera didactyla</i> (With.) J.R.Laundon	
17	With isidia	18
18	Isidia peltate (attached by a single point in the centre), scattered on the upper surface. Thallus usually <1 cm broad. Veins flattened <i>Peltigera lepidophora</i> (Vain.) Bitter	
18	Isidia spatulate (flattened, and erect, attached by the basis), mostly located along cracks. Thallus usually >5 cm broad. Veins raised <i>Peltigera praetextata</i> (Sommerf.) Zopf	
19	Veins on lower surface absent (either lower surface uniformly pale at the margin and dark in the centre, or lower surface black, with scattered white spots) <i>Peltigera elisabethae</i> Gyeln.	
19	Veins on lower surface present (to observe the veins, carefully clean the entire lower surface!)	20
20	Thallus non tomentose	21
20	Thallus tomentose at least at the margin of lobes (lens!)	26
21	Veins and rhizines whitish to pale ochraceous brown	22
21	Veins and rhizines dark brown to black, at least at thallus centre	23
22	Veins distinctly raised, whitish, sometimes pale brown in the centre <i>Peltigera degenii</i> Gyeln.	
22	Veins flattened, pale ochraceous brown <i>Peltigera hymenina</i> (Ach.) Delise	
23	Lobes >3 cm broad, rhizines mostly slender >5 mm long <i>Peltigera neopolydactyla</i> (Gyeln.) Gyeln.	
23	Lobes <3 cm broad, rhizines <5 mm long	24
24	Lower surface pale at margin, dark in the centre, with indistinct venation. Lobes often faintly pruinose at margin <i>Peltigera neckeri</i> Müll.Arg.	
24	Lower surface with a very distinct pattern of reticulated, dark veins. Lobes not pruinose at margin	25
25	Apothecia horizontal, rounded. Rhizines fasciculate, separate, arranged in concentric lines (clean carefully the lower face!) <i>Peltigera horizontalis</i> (Huds.) Baumg.	
25	Apothecia erect, saddle-shaped. Rhizines becoming confluent, not arranged in concentric lines <i>Peltigera polydactyla</i> (Neck.) Hoffm.	
26	Lobes 6-10 mm broad	27
26	Lobes >10 mm broad	29
27	Rhizines and veins long remaining pale <i>Peltigera ponojensis</i> Gyeln.	
27	Rhizines and veins soon darkening	28
28	Rhizines near the margin slender, simple, or with a few branches only <i>Peltigera monticola</i> Vitik.	

28	Rhizines conspicuously and richly branched also at margin. Tomentum appressed (if tomentum erect see <i>P. kristinssonii</i>)	<i>Peltigera rufescens</i> (Weiss) Humb.	
29	Rhizines slender, more or less simple	<i>Peltigera praetextata</i> (Sommerf.) Zopf	
29	Rhizines squarrose		30
30	Upper surface with sparse erect tomentum at the margin, glossy towards centre. Veins flat	<i>Peltigera kristinssonii</i> Vitik.	
30	Tomentum not erect. Veins raised		31
31	Rhizines confluent, penicillated (brush-like). Veins soon darkened towards centre	<i>Peltigera canina</i> (L.) Willd.	
31	Rhizines separate, with numerous branches perpendicular to the main axis (bottle-brush-like). Veins conspicuously erect-tomentose and pale, also in thallus centre	<i>Peltigera membranacea</i> (Ach.) Nyl.	
32	With soredia or isidia		33
32	Without soredia or isidia		34
33	Without pseudocyphellae	<i>Phaeophyscia hispidula</i> (Ach.) Essl.	
33	With linear pseudocyphellae	<i>Parmelia sulcata</i> Taylor	
34	With conspicuous marginal cilia	<i>Anaptychia ciliaris</i> (L.) Körb.	
34	Without marginal cilia		35
35	Lower surface dark, from black to dark brown, esp. in the centre		36
35	Lower surface pale throughout		37
36	Medulla white, K-, KC-	<i>Physconia muscigena</i> (Ach.) Poelt var. <i>muscigena</i>	
36	Medulla yellowish, K+ yellowish, KC+ yellow-orange	<i>Physconia muscigena</i> (Ach.) Poelt var. <i>bayeri</i> (Nád.) Poelt	
37	Veins on lower surface present		38
37	Veins on lower surface absent		41
38	Apothecia laminal, rounded, semi-immersed in the upper surface		39
38	Apothecia absent, or if present not semi-immersed in the thallus		40
39	Spores 8 per ascus, 35-40 x 18-21 µm	<i>Solorina octospora</i> (Arnold) Arnold	
39	Spores 4 per ascus, 30-60 x 18-28 µm	<i>Solorina saccata</i> (L.) Ach.	
40	Apothecia common, disc flattened-horizontal, lobes fan-shaped, small (1-2 cm diam.), attached by a single stout rhizine	<i>Peltigera venosa</i> (L.) Hoffm.	
40	Apothecia rare, saddle-shaped. Lobes elongated, very broad (>5 cm diam.), with numerous rhizines	<i>Peltigera leucophlebia</i> (Nyl.) Gyeln.	
41	Lobes long and narrow (<1 mm broad); thallus brownish	<i>Phaeophyscia constipata</i> (Norrl. & Nyl.) Moberg	
41	Lobes not long and narrow, generally >1 mm broad; if less, reduced to a broad collar around the apothecia; thallus usually greenish		42
42	Thallus K+ yellow. Medulla K+ yellow changing to red, with salazinic acid. Apothecia lecanorine, sessile, strongly constricted	<i>Xanthoparmelia somloënsis</i> (Gyeln.) Hale	
42	Thallus and medulla K-, without salazinic acid. Apothecia non lecanorine, semi-immersed in the thallus		43
43	Spores 8 per ascus	<i>Solorina octospora</i> (Arnold) Arnold	
43	Spores 2 to 4 per ascus		44
44	Spores 2 per ascus		45
44	Spores 4 per ascus		46
45	Internal pseudo-cephalodia well-developed, forming a thallus with <i>Nostoc</i> . Spores 60-100 x 27-60 µm	<i>Solorina bispora</i> Nyl. subsp. <i>bispora</i>	
45	Internal pseudo-cephalodia absent, or very scarce. Spores 95-140 x 45-60 µm	<i>Solorina bispora</i> Nyl. subsp. <i>macrospora</i> (Harm.) Burgaz & I. Martínez	
46	Lobes 0.5-1 mm broad. Thallus reduced to a collar around the urceolate apothecia	<i>Solorina spongiosa</i> (Ach.) Anzi	
46	Lobes 4-8 mm broad. Thallus well developed, of elongated lobes	<i>Solorina saccata</i> (L.) Ach.	

Subkey B3 - Squamulose lichens

1	Photobiont cyanobacterial (photobiont layer bluish green in section)	2
1	Photobiont chlorococcoid (photobiont layer bright green in section)	12
2	Thallus dark, from black to dark brown	3
2	Thallus not dark	10
3	Thallus thick, subfruticulose, inflated to round in section	
	<i>Leptogium schraderi</i> (Bernh.) Nyl.	
3	Thallus thin, flat in section, not subfruticulose	4
4	Thallus not gelatinous when wet. Photobionts restricted to a well-delimited layer (section!)	
	<i>Fuscopannaria praetermissa</i> (Nyl.) M.Jørg.	
4	Thallus more or less gelatinous when wet. Photobionts homogeneously spread throughout the thallus (section!)	5
5	Thallus with thin transparent hairs (lens!)	
	<i>Leptochidium albociliatum</i> (Desm.) M.Choisy	
5	Thallus without thin transparent hairs	6
6	Most squamules <1 mm broad (measure the squamules in the central part!)	7
6	Most squamules >1 mm broad	9
7	Thallus not entirely paraplectenchymatous, i.e. the cortex not extending throughout its thickness (section!)	
	<i>Leptogium intermedium</i> (Arnold) Arnold	
7	Thallus entirely paraplectenchymatous, i.e. the cortex extending throughout its thickness (section!)	8
8	Alpine to subalpine. Thallus composed of densely imbricated, 0.5-1 mm broad squamules with entire to dissected, never coralloid margins. Apothecia 0.5-1 mm diam.	
	<i>Leptogium imbricatum</i> M.Jørg.	
8	Mostly below the Alpine belt. Thallus composed of small (<0.5 mm broad) squamules with strongly dissected margins which tend to become coralloid. Apothecia 1-4 mm diam.	
	<i>Leptogium tenuissimum</i> (Dicks.) Körb.	
9	Edge of lobes deeply dilacerate	
	<i>Leptogium lichenoides</i> (L.) Zahlbr.	
9	Edge of lobes more or less entire	
	<i>Leptogium gelatinosum</i> (With.) J.R.Laundon	
10	Thallus forming rosettes to 2-3 cm diam., subcrustose in the centre, with radiating, fan-shaped, marginal lobes of 2 x 3 mm	
	<i>Pannaria hookeri</i> (Sm.) Nyl.	
10	Thallus never forming rosettes, without marginal lobes	11
11	Apothecia lecanorine, with a clear, thick, prominent thalline margin containing algal cells	
	<i>Protopannaria pezizoides</i> (Weber) M.Jørg. & S.Ekman	
11	Apothecia non lecanorine, without a thalline margin	
	<i>Heppia adglutinata</i> (Kremp.) A.Massal.	
12	Squamules subfoliose, ascending, bifacial (<i>Cladonia</i>)	13
12	Squamules of different forms, but not subfoliose, ascending, and bifacial	16
13	Thallus K+ rapidly blood red	
	<i>Cladonia symphyocarpa</i> (Flörke) Fr.	
13	Thallus K+, or K+ yellow	14
14	Thallus K+ yellow	
	<i>Cladonia macrophyllodes</i> Nyl.	
14	Thallus K-	15
15	Squamules greenish grey, >0.4 mm thick, ascending	
	<i>Cladonia caespiticia</i> (Pers.) Flörke	
15	Squamules more or less brownish, 1-2 mm thick, forming a subrosulate crust	
	<i>Cladonia pocillum</i> (Ach.) O.J. Rich.	
16	With punctiform pseudocyphellae	
	<i>Toninia physaroides</i> (Opiz) Zahlbr.	
16	Without pseudocyphellae	17
17	With apothecia (thallus positive or negative to K, C, KC and P)	18
17	With perithecia (thallus always K-, C-, KC-, P-)	39
18	Thallus bright-coloured, yellowish-green, orange or red	19
18	Thallus not bright-coloured, of other colours	21
19	Thallus K-, more or less reddish	
	<i>Psora decipiens</i> (Hedw.) Hoffm.	
19	Thallus K+ red, yellow to orange-coloured	20

20	With radiating marginal lobes	go to subkey B4, option 10	
20	Without radiating marginal lobes	go to subkey B4, option 12	
21	Apothecia lecanorine, with a thalline margin containing algal cells		22
21	Apothecia non lecanorine, without a thalline margin containing algal cells		24
22	Apothecial disc dark, from black to dark brown. Spores 2-celled, pigmented		
		<i>Phaeorrhiza nimbosa</i> (Fr.) H.Mayrhofer & Poelt	
22	Apothecial disc from greenish-brown to pale brown. Spores 1-celled, hyaline		23
23	Medulla P-, without psoromic acid		
		<i>Squamarina cartilaginea</i> (With.) P.James f. <i>pseudocrassa</i> Mattick	
23	Medulla P+ yellow, with psoromic acid		
		<i>Squamarina cartilaginea</i> (With.) P.James f. <i>cartilaginea</i>	
24	Most spores more than 5-celled, needle-shaped		25
24	Most spores less than 5-celled, not needle-shaped		26
25	Hypotheceum pale to colourless. Squamules not granulose, dark brown, with a greyish tinge, often with shallow fissures in the cortex. Apothecia black, not bluish-pruinose	<i>Toninia squalida</i> (Ach.) A.Massal.	
25	Hypotheceum dark. Squamules granulose, pale greyish brown. Apothecia black, often bluish-pruinose	<i>Toninia coelestina</i> (Anzi) Vězda	
26	Spores (2-)4-celled		27
26	Spores 1-2-celled		28
27	Squamules flattened, crenate-lobulate, forming a compact crust. Spores fusiform, 14-20(-26) x 3-5(-6) µm	<i>Myxobilimbia lobulata</i> (Sommerf.) Hafellner	
27	Squamules flat to convex, not crenate-lobulate, scattered to contiguous, not forming a compact crust. Spores ellipsoid-cylindrical, 11-22.5 x 4-5.5 µm	<i>Toninia aromatica</i> (Sm.) A.Massal.	
28	Spores 1-celled		29
28	Spores 2-celled		32
29	Thallus yellowish green. With usnic acid	<i>Psora rubiformis</i> (Ach.) Hook.	
29	Thallus not yellowish green. Without usnic acid		30
30	Squamules bullate. Epitheceum K-		
		<i>Toninia tristis</i> (Th.Fr.) Th.Fr. subsp. <i>pseudotabacina</i> Tindal	
30	Squamules not bullate. Epitheceum K+ red		31
31	Squamules with a conspicuous white margin	<i>Psora vallesiaca</i> (Schaer.) Tindal	
31	Squamules without a conspicuous white margin	<i>Psora globifera</i> (Ach.) A.Massal.	
32	Thallus chestnut brown, often with punctiform depressions. Epitheceum K-		33
32	Thallus rarely chestnut brown, without depressions or pores. Epitheceum K+ violet		34
33	Hypotheceum without orange and yellow pigments. Epitheceum brown. Spores 13.5-20.5 x 3.5-5 µm	<i>Toninia tristis</i> (Th.Fr.) Th.Fr. subsp. <i>tristis</i>	
33	Hypotheceum with orange (K+red) and yellow (K-) pigments. Epitheceum brownish to greenish brown. Spores 12.5-19 x 3.5-5.5 µm	<i>Toninia tristis</i> (Th.Fr.) Th.Fr. subsp. <i>asiae-centralis</i> (H.Magn.) Tindal	
34	Hypotheceum pale brown to colourless		35
34	Hypotheceum dark		36
35	Thallus densely covered by a white, granular pruina, with shallow fissures in the cortex	<i>Toninia rosulata</i> (Anzi) H.Olivier	
35	Thallus olivaceous brown, epruinose, with regular, evident fissures in the cortex	<i>Toninia taurica</i> (Szatala) Oksner	
36	Thallus entirely pruinose; pruina granular	<i>Toninia diffracta</i> (A.Massal.) Zahlbr.	
36	Thallus non-pruinose, or only partly pruinose, the pruina composed of very small crystals, not granular		37
37	Squamules more or less flat, with a white-pruinose rim		
		<i>Toninia albilabra</i> (Dufour) H.Olivier	
37	Squamules bullate, or - if flat - without white-pruinose rim		38
38	Squamules (2-)3-6 mm broad, bullate, vertically flattened when old, more or less		

	imbricate	<i>Toninia opuntioides</i> (Vill.) Tindal	
38	Squamules weakly convex to bullate, 1-2(-3) mm broad, not vertically flattened and not imbricate	<i>Toninia sedifolia</i> (Scop.) Tindal	
39	Spores submuriform to muriform		40
39	Spores 1-2-celled		41
40	Squamules small, <0.5 mm long. Perithecia without hymenial algae	<i>Agonimia tristicula</i> (Nyl.) Zahlbr.	
40	Squamules >0.5 mm long. Perithecia with hymenial algae	<i>Endocarpon pusillum</i> Hedw.	
41	Spores 2-celled		42
41	Spores 1-celled		43
42	Thallus grey to brownish grey, often faintly pruinose. Squamules scattered or aggregated in small groups, rounded to lobed. Spores ellipsoid, 15-19 x 7.5-9 µm	<i>Placidiopsis pseudocinerea</i> Breuss	
42	Thallus brownish, non pruinose. Squamules densely aggregated, incised. Spores broadly ellipsoid, 13-17 x 9-11 µm	<i>Placidiopsis tiroliensis</i> Breuss	
43	Rhizohyphae dark (make a section of the squamule, and carefully observe the rhizohyphae under the microscope)		44
43	Rhizohyphae pale		46
44	Perithecia developing on the dark hypothallus between the squamules, with involucrellum (section!)	<i>Involucropyrenium waltheri</i> (Kremp.) Breuss	
44	Perithecia immersed in the squamules, without involucrellum		45
45	Lower cortex present, dark, paraplectenchymatous (section!). Thallus brownish grey, often faintly pruinose especially toward the centre, and darker toward the margin. Old perithecia with a dark wall. Asci 65-70 x 16-22 µm. Spores (15-)17-23(-25) x (6-)6.5-8.5(-9.5) µm	<i>Catapyrenium cinereum</i> (Pers.) Körb.	
45	Lower cortex absent. Thallus brownish grey, often faintly pruinose especially towards the centre, never darker at margin. Most perithecia with a pale to colourless wall. Asci 75-85 x 17-20 µm Spores (15-)17-22(-24) x (5-)6-8(-9) µm	<i>Catapyrenium daedaleum</i> (Kremp.) Stein	
46	Perithecia with involucrellum, developing on the dark hypothallus between the squamules	<i>Involucropyrenium tremniacense</i> (A.Massal.) Breuss	
46	Perithecia without involucrellum, developing on the squamules		47
47	Pycnidia laminal, fully immersed in the squamules, or absent (observe carefully several squamules!)	<i>Placidium squamulosum</i> (Ach.) Breuss	
47	Pycnidia marginal, prominent		48
48	Cells of lower cortex arranged in vertical rows (section!). Conidia 5-7 µm long		49
48	Cells of lower cortex not arranged in vertical rows, Conidia 3-5 µm long		50
49	Mostly below treeline. Most squamules >6 mm broad, with a thin margin	<i>Placidium adami-borosi</i> Szatala	
49	Mostly above or near treeline. Most squamules <6 mm broad, with a distinctly thickened margin	<i>Placidium lachneum</i> (Ach.) de Lesd.	
50	Squamules with very thin hairs, at least at the periphery (this character is difficult to observe: carefully examine several squamules under the binocular!)	<i>Placidium pilosellum</i> (Breuss) Breuss	
50	Squamules without hairs		51
51	Squamules more or less rounded, 2-5 mm long, brownish. A very rare species, probably restricted to the Alps, mostly on soil	<i>Placidium imbecillum</i> (Breuss) Breuss	
51	Squamules clearly elongated, >5 mm long, reddish brown. A rather common species throughout Italy, mostly on rock	<i>Placidium rufescens</i> (Ach.) A.Massal.	

Subkey B4 - Crustose lichens

- | | | |
|----|---|----|
| 1 | With cyanobacteria (photobiont layer bluish-green in section) | 2 |
| 1 | Without cyanobacteria (photobiont layer bright green to orange-green in section) | 3 |
| 2 | Spores 1-celled. Thallus bluish-grey, subleprose | |
| | <i>Moelleropsis nebulosa</i> (Hoffm.) Gyeln. | |
| 2 | Spores many-celled, submuriform. Thallus dark brown to black, granulose | |
| | <i>Leptogium byssinum</i> (Hoffm.) Nyl. | |
| 3 | Thallus dark, from black to very dark brown | 4 |
| 3 | Thallus not dark | 6 |
| 4 | With perithecia. With <i>Trentepohlia</i> (photobiont layer orange-green in section) | |
| | <i>Porina mammillosa</i> (Th.Fr.) Vain. | |
| 4 | With apothecia. With chlorococcoid algae (photobiont layer bright green in section) | 5 |
| 5 | Thallus thick, composed of lobulate areolae at least 0.5 mm broad | |
| | <i>Lecidoma demissum</i> (Rutstr.) Goth.Schneid. & Hertel | |
| 5 | Thallus thin, smooth to minutely granulose, the granules <0.3 mm in diam. | |
| | <i>Japewia tornöensis</i> (Nyl.) Tønsberg | |
| 6 | Thallus bright (greenish-) yellow to orange | 7 |
| 6 | Thallus not bright yellow to orange | 21 |
| 7 | With soredia | 8 |
| 7 | Without soredia | 9 |
| 8 | Thallus K-, without anthraquinones. Apothecia black | |
| | <i>Arthrorhaphis citrinella</i> (Ach.) Poelt | |
| 8 | Thallus K+ red, with anthraquinones. Apothecia orange | |
| | <i>Caloplaca bryochryson</i> Poelt | |
| 9 | Thallus with radiating marginal lobes | 10 |
| 9 | Thallus without radiating marginal lobes | 12 |
| 10 | Spores 1-celled | |
| | <i>Fulgensia fulgens</i> (Sw.) Elenkin | |
| 10 | Spores 2-celled | 11 |
| 11 | Spores ellipsoid, 12-20 x 4-6 µm. Thallus non-pruinose | |
| | <i>Caloplaca aurea</i> (Schaer.) Zahlbr. | |
| 11 | Spores fusiform, 18-27 x 5-8 µm. Thallus pruinose | |
| | <i>Fulgensia pruinosa</i> (Körb.) Poelt | |
| 12 | Thallus composed by very small (<0.4 mm diam.), rounded, scattered, bright yellow-green granules. Apothecia perithecioid to urceolate, small (<0.5 mm diam.), immersed in the granules | |
| | <i>Thelocarpon laureri</i> (Flot.) Nyl. | |
| 12 | Thallus and apothecia different | 13 |
| 13 | Apothecia non lecanorine, without a thalline margin | |
| | <i>Arthrorhaphis alpina</i> (Schaer.) R.Sant. | |
| 13 | Apothecia lecanorine, with a thalline margin containing algal cells | 14 |
| 14 | Thallus K-, or K+ orange | 15 |
| 14 | Thallus K+ deep red | 17 |
| 15 | Spores 8 per ascus, > 15 µm long | |
| | <i>Candelariella unilocularis</i> (Elenkin) Nimis | |
| 15 | Spores 12-32 per ascus, < 15 µm long | 16 |
| 16 | Mostly on wood, very rarely on soil. Thallus of closely packed, granular elements. Apothecia rare | |
| | <i>Candelariella kuusamoensis</i> Räsänen | |
| 16 | Mostly on siliceous rocks, but not unfrequent on mosses and mineral soil over siliceous substrata. Thallus from granulose to small-lobulate, with flat lobules, not forming convex pillows of densely packed coralloid elements. Apothecia frequent | |
| | <i>Candelariella vitellina</i> (Hoffm.) Müll.Arg. | |
| 17 | Spores 1-celled | 18 |
| 17 | Spores 2-celled | 20 |
| 18 | With schizidia (flattened to convex, exfoliating, scale-like areoles) | |

	<i>Fulgensia bracteata</i> (Hoffm.) Räsänen subsp. <i>deformis</i> (Erichsen) Poelt		
18	Without schizidia		19
19	Areolae convex, thick, little dissected at margin, more or less pruinose. Apothecial margin thick		
	<i>Fulgensia bracteata</i> (Hoffm.) Räsänen subsp. <i>bracteata</i>		
19	Areolae flat thin, dissected at margin, not or only faintly pruinose. Apothecial margin thin		
	<i>Fulgensia bracteata</i> (Hoffm.) Räsänen var. <i>alpina</i> (Th.Fr.) Räsänen		
20	Mostly on soil, in fissures of calciferous rocks. Spores not constricted at septum. Restricted to above treeline	<i>Caloplaca aurea</i> (Schaer.) Zahlbr.	
20	Mostly on pulvinate mosses. Spores constricted at septum. From the lowlands to above treeline	<i>Fulgensia schistidii</i> (Anzi) Poelt	
21	Photobiont trentepohlioid		22
21	Photobiont chlorococcoid		27
22	With perithecia		23
22	With apothecia		25
23	Perithecia not dark-coloured	<i>Belonia russula</i> Nyl.	
23	Perithecia dark-coloured, mostly black		24
24	Spores 8 per ascus, fusiform, > 20 µm long. Thallus continuous		
	<i>Porina mammillosa</i> (Th.Fr.) Vain.		
24	Spores much more than 8 per ascus, oblong-obtuse, <20 µm long. Thallus granulose	<i>Thelopsis melathelia</i> Nyl.	
25	Apothecia sessile	<i>Gyalecta peziza</i> (Mont.) Anzi	
25	Apothecia more or less immersed in the thallus, not constricted at the base		26
26	All septa of the spores parallel. Spores 10-16(-20) x 5-6(-7) µm. Apothecia up to 1(-2) mm diam.	<i>Gyalecta foveolaris</i> (Ach.) Schaer.	
26	Some septa of the spores not parallel with each other. Spores 9-14(-16) x 4-7 µm. Apothecia up to 0.6 mm diam.	<i>Gyalecta geoica</i> (Ach.) Ach.	
27	With soredia or isidia		28
27	Without soredia or isidia		31
28	Thallus with isidia	<i>Pertusaria oculata</i> (Dicks.) Th.Fr.	
28	Thallus with soredia		29
29	Thallus KC+ yellow, with stictic acid	<i>Baeomyces rufus</i> (Huds.) Rebent.	
29	Thallus KC- or KC+ red, without stictic acid		30
30	Thallus KC-	<i>Lecanora bryopsora</i> (Doppelb. & Poelt) Hafellner & Türk	
30	Thallus KC+ red	<i>Ochrolechia inaequatula</i> (Nyl.) Zahlbr.	
31	Thallus with radiating marginal lobes		32
31	Thallus without marginal lobes		34
32	Lobes short, contiguous > 2 mm broad. Thallus KC+ orange, with stictic acid. Apothecia pale-coloured, stipitate. Spores hyaline	<i>Baeomyces placophyllus</i> Ach.	
32	Lobes elongate, strongly pruinose, < 1 mm broad. Thallus KC-, without stictic acid. Apothecia black, sessile. Spores pigmented		33
33	Spores 4 per ascus	<i>Buellia asterella</i> Poelt & Sulzer	
33	Spores 8 per ascus	<i>Buellia elegans</i> Poelt	
34	With perithecia		35
34	With apothecia		48
35	Spores 2-celled		36
35	Spores not 2-celled		37
36	Spores 32 per ascus, with filiform appendages at both ends, fusiform, <2.5 µm broad	<i>Epigloea grumannii</i> Döbbeler	
36	Spores 8 per ascus, without appendages at the ends, ellipsoid, >3 µm broad	<i>Epigloea soleiformis</i> Döbbeler	
37	Spores 4-celled	<i>Epigloea medioincrassata</i> (Grumann) Döbbeler	
37	Spores not 4-celled		38
38	Perithecia pale-coloured	<i>Leucocarpia biatorella</i> (Arnold) Vězda	

38	Perithecia dark-coloured	39
39	Spores 1-celled	40
39	Spores more than 4-celled	43
40	Thallus thick, subsquamulose-sublobate	41
40	Thallus thin, inconspicuous	42
41	Lower cortex present, dark, paraplectenchymatous (section!). Thallus brownish grey, often faintly pruinose especially toward the centre, and darker toward the margin. Old perithecia with a dark wall. Asci 65-70 x 16-22 μm . Spores (15-)17-23(-25) x (6-)6.5-8.5(-9.5) μm	
	<i>Catapyrenium cinereum</i> (Pers.) Körb.	
41	Lower cortex absent. Thallus brownish grey, often faintly pruinose especially towards the centre, never darker at margin. Most perithecia with a pale to colourless wall. Asci 75-85 x 17-20 μm Spores (15-)17-22(-24) x (5-)6-8(-9) μm	
	<i>Catapyrenium daedaleum</i> (Kremp.) Stein	
42	Paraphyses present. Perithecia covered by a thalline layer. Spores often clavate	
	<i>Thrombium epigaeum</i> (Pers.) Wallr.	
42	Paraphyses absent, substituted by periphyses. Perithecia not covered by a thalline layer. Spores narrowly ellipsoid, never clavate	
	<i>Verrucaria xyloxena</i> Norman	
43	Spores pigmented	
	<i>Polyblastia helvetica</i> Th.Fr.	
43	Spores hyaline	44
44	Spores 2-4 per ascus	
	<i>Chromatochlamys muscorum</i> (Fr.) H.Mayrhofer & Poelt var. <i>muscorum</i>	
44	Spores more than 4 per ascus	45
45	Spores 6-8 per ascus	
	<i>Chromatochlamys muscorum</i> (Fr.) H.Mayrhofer & Poelt var. <i>octospora</i> (Nyl.) H.Mayrhofer & Poelt	
45	Spores 8 per ascus	46
46	Thallus inconspicuous, reduced to a thin film	
	<i>Polyblastia evanescens</i> Arnold	
46	Thallus thick, evident	47
47	Spores <40 μm long. Thallus grey-white, sometimes tinged brown, composed of coarse, subsquamulose, cartilaginous granules becoming subgelatinous when wet	
	<i>Polyblastia sendtneri</i> Kremp.	
47	Spores >40 μm long. Thallus pale greenish grey to brownish, subsquamulose to coarsely granular, often cracked, not subgelatinous when wet	
	<i>Polyblastia terrestris</i> Th.Fr.	
48	Apothecia lecanorine, with a thalline margin containing algal cells	49
48	Apothecia non lecanorine, without a thalline margin	81
49	Spores strongly muriform	50
49	Spores not muriform (or at most with a only a few longitudinal septa)	51
50	Apothecia up to 7 mm diam. Thallus C-, KC-, with norstictic and connorstictic acids	
	<i>Diploschistes ocellatus</i> (Vill.) Norman	
50	Apothecia up to 3 mm diam. Thallus C+ and KC+ red, with lecanoric and diploschistes acids	
	<i>Diploschistes muscorum</i> (Scop.) R.Sant.	
51	Thallus K+ rapidly red, with norstictic acid	52
51	Thallus K+ yellow or K-, without norstictic acid	54
52	Thallus KC+ yellow-red, P+ yellow	
	<i>Pertusaria glomerata</i> (Ach.) Schaer.	
52	Thallus KC-, P- (rarely P+ orange)	53
53	Spores <17 μm long. Thallus thin, greyish	
	<i>Bryonora castanea</i> (Hepp) Poelt	
53	Spores >17 μm long. Thallus thick, grey to brownish grey	
	<i>Bryodina rhypariza</i> (Nyl.) Hafellner & Türk	
54	Thallus K+ yellow	55
54	Thallus K-	57
55	Thallus C+ and KC+ red, with gyrophoric acid. Spores 1 per ascus, > 100 μm long	
	<i>Pertusaria bryontha</i> (Ach.) Nyl.	
55	Thallus KC-, without gyrophoric acid. Spores 8 per ascus, < 35 μm long	56
56	Spores 1-celled, hyaline	
	<i>Lecanora epibryon</i> (Ach.) Ach.	

56	Spores 2-celled, pigmented		
		<i>Rinodina mniaraea</i> (Ach.) Körb. var. <i>mniaraeiza</i> (Nyl.) H.Magn.	
57	Spores 4-celled		58
57	Spores not 4-celled		59
58	Spores pigmented. Apothecial margin thin, smooth	<i>Rinodina conradii</i> Körb	
58	Spores hyaline. Apothecial margin thick, crenulate	<i>Bryonora curvescens</i> (Mudd) Poelt	
59	Spores 1-celled		60
59	Spores 2-celled		64
60	Thallus C and KC+ red, with gyrophoric acid	<i>Trapelia coarctata</i> (Sm.) M.Choisy	
60	Thallus C and KC-, without gyrophoric acid		61
61	Thallus grey-brown to brownish green	<i>Bryonora curvescens</i> (Mudd) Poelt	
61	Thallus whitish to pale whitish grey		62
62	Apothecial disc black (sometimes covered by a white pruina), and spores at least 20 µm broad	<i>Megaspora verrucosa</i> (Ach.) Hafellner & V.Wirth var. <i>verrucosa</i>	
62	Apothecial disc not black, or, if black, spores <7 µm broad		63
63	Apothecia <0.8 mm diam., with a thin, pruinose, often crenulate margin. Spores small, 10-16 x 5-7 µm. Apothecial disc K- (if K+ violet-red see opt. 72: <i>Caloplaca nivalis</i>)	<i>Lecanora hagenii</i> (Ach.) Ach. var. <i>fallax</i> Hepp	
63	Apothecia > 0.8 mm diam., with a thick, smooth, non-crenulate margin. Spores large, (45-)50-75 x 25-40(-50) µm	<i>Ochrolechia upsaliensis</i> (L.) A.Massal.	
64	Apothecia dark-coloured		65
64	Apothecia bright yellow to orange		72
65	Spores hyaline		66
65	Spores pigmented		68
66	Apothecia K+ red. Spores polar-diblastic	<i>Caloplaca ammiospila</i> (Wahlenb.) H.Olivier	
66	Apothecia K -. Spores non polar-diblastic		67
67	Spores 8 per ascus, 16-23 x 6-8 µm. Thallus not reduced to triangular units arranged all around the apothecium	<i>Halecania lecanorina</i> (Anzi) M.Mayrhofer & Poelt	
67	Spores more than 32 per ascus, 7-17 x 2-4 µm. Thallus reduced to small triangular units arranged all around the apothecium	<i>Solorinella asteriscus</i> Anzi	
68	Thallus forming a thick, areolate crust	<i>Phaeorrhiza nimbose</i> (Fr.) H.Mayrhofer & Poelt	
68	Thallus thin, film-like		69
69	Apothecial margin (section!) with a well-developed cortex (section!)	<i>Rinodina olivaceobrunnea</i> C.W.Dodge & G.E.Baker	
69	Apothecial margin without a well-developed cortex		70
70	Hypothecium <60 µm tall	<i>Rinodina roscida</i> (Sommerf.) Arnold	
70	Hypothecium >60 µm tall		71
71	Medulla K+ red, orange-coloured at least in lower parts	<i>Rinodina mniaraea</i> (Ach.) Körb. var. <i>cinnamomea</i> Th.Fr.	
71	Medulla K-, white throughout	<i>Rinodina mniaraea</i> (Ach.) Körb. var. <i>mniaraea</i>	
72	Spores non polar-diblastic	<i>Caloplaca nivalis</i> (Körb.) Th.Fr.	
72	Spores polar-diblastic		73
73	Spores 4 per ascus	<i>Caloplaca tetraspora</i> (Nyl.) H.Olivier	
73	Spores 8 per ascus		74
74	Thallus thick, areolate to subsquamulose, never film-like	<i>Caloplaca congregiens</i> (Nyl.) Zahlbr.	
74	Thallus thin, film-like		75
75	Apothecial margin grey to brownish		76
75	Apothecial margin yellow to orange		77
76	Apothecial disc pale greenish-yellow, sometimes becoming darker olive-yellow with age	<i>Caloplaca cerina</i> (Hedw.) var. <i>chloroleuca</i> (Sm.) Th.Fr.	

76	Apothecial disc deep orange		
		<i>Caloplaca cerina</i> (Hedw.) Th.Fr. var. <i>muscorum</i> (A.Massal.) Jatta	
77	Apothecial margin indistinct. Disc rapidly convex		
		<i>Caloplaca sinapisperma</i> (Lam. & DC.) Maheu & A. Gillet	
77	Apothecial margin distinct, more or less persistent. Disc long remaining flat		78
78	Apothecia, at least when young, bright orange to lemon yellow		79
78	Apothecia rusty red to orange-brown		80
79	Apothecia bright orange. Spores 10-12(-13) x (4-)6-7(-8) µm		
		<i>Caloplaca saxifragarum</i> Poelt	
79	Apothecia lemon yellow, becoming greenish yellow to dark green with age. Spores larger, (11-)14-17(-18) x (6-)7-9(-10.5) µm	<i>Caloplaca tirolensis</i> Zahlbr.	
80	Apothecia rusty red (to dark brown in sun-forms)		
		<i>Caloplaca ammiospila</i> (Wahlenb.) H.Olivier	
80	Apothecia yellow-orange to brownish orange		
		<i>Caloplaca jungermanniae</i> (Vahl) Th.Fr.	
81	Thallus KC+ yellow. Apothecia stipitate	<i>Baeomyces rufus</i> (Huds.) Rebert.	
81	Thallus KC-, KC+ orange, or KC+ red. Apothecia usually not stipitate		82
82	Thallus KC+ orange		83
82	Thallus KC+ red or KC-		86
83	Apothecia pink to pale orange-pink	<i>Icmadophila ericetorum</i> (L.) Zahlbr.	
83	Apothecia dark-coloured		84
84	Spores 2-celled, pigmented	<i>Buellia insignis</i> (Hepp) Th.Fr.	
84	Spores not 2-celled, pigmented or not		85
85	Spores 4-celled, pigmented, 4-8 per ascus	<i>Buellia geophila</i> (Sommerf.) Lynge	
85	Spores 1-celled, hyaline, 8 per ascus	<i>Lecidella wulfenii</i> (Hepp) Körb.	
86	Apothecia orange, K+ red	<i>Protoblastenia terricola</i> (Anzi) Lynge	
86	Apothecia not orange, K-		87
87	Apothecia pale-coloured		88
87	Apothecia dark-coloured		91
88	Spores more than 4-celled	<i>Myxobilimbia sabuletorum</i> (Schreb.) Hafellner	
88	Spores no more than 4-celled		89
89	Spores 1-celled	<i>Biatorella hemisphaerica</i> Anzi	
89	Spores 4-celled		90
90	Apothecia whitish to pale yellowish white. Spores broadly ellipsoid to fusiform, (12-)13-22 x 4-7 µm	<i>Mycobilimbia pilularis</i> (Körb.) Hafellner & Türk	
90	Apothecia reddish to blackish brown. Spores ellipsoid-cylindrical, 16-30 x 5-6 µm	<i>Myxobilimbia microcarpa</i> (Th.Fr.) Hafellner	
91	Thallus K+ yellow		92
91	Thallus K-		93
92	Thallus minutely granulose. Spores 21-25(-29) x 9-11 µm		
		<i>Buellia insignis</i> (Hepp) Th.Fr.	
92	Thallus coarsely verrucose. Spores 18-24 x 8-10 µm	<i>Buellia papillata</i> (Sommerf.) Tuck.	
93	Spores 4-celled		94
93	Spores not 4-celled		97
94	Spores pigmented, parasitic on <i>Physconia muscigena</i>		
		<i>Diplotomma pulverulentum</i> (Anzi) D.Hawksw.	
94	Spores hyaline, not on <i>Physconia muscigena</i>		95
95	Thallus thick, composed of small lobulate areolae (lens!)	<i>Myxobilimbia lobulata</i> (Sommerf.) Hafellner	
95	Thallus thin, continuous, not composed of lobulate areolae		96
96	Paraphyses 2-3 µm thick. Apothecial margin indistinct, disc convex		
		<i>Myxobilimbia microcarpa</i> (Th.Fr.) Hafellner	
96	Paraphyses <2 µm thick. Apothecial margin distinct, disc flat	<i>Mycobilimbia tetramera</i> (De Not.) Hafellner & Türk	

97	Spores 1-celled		98
97	Spores not 1-celled		103
98	Spores subglobose, 12-16 per ascus	<i>Steinia geophana</i> (Nyl.) Stein	
98	Spores not subglobose, 8 or more than 32 per ascus		99
99	Spores more than 32 per ascus	<i>Sarcosagium campestre</i> (Fr.) Poetsch & Schied.	
99	Spores 8 per ascus		100
100	Apothecial margin (section!) deep black, not transparent in thick sections		
		<i>Farnoldia muscigena</i> (Vězda) Treliach & Hafellner	
100	Apothecial margin (section!) not deep black, transparent		101
101	Epithecium K+ green	<i>Helocarpon pulverulum</i> (Th.Fr.) Türk & Hafellner	
101	Epithecium K-		102
102	Thallus thick, verrucose. Paraphyses distinctly thickened above. Hypothecium without scattered bluish granules reacting K+ green. Spores 1-celled		
		<i>Mycobilimbia berengeriana</i> (A.Massal.) Hafellner & V.Wirth	
102	Thallus thin, not verrucose. Paraphyses only slightly thickened above. Hypothecium with scattered bluish granules reacting K+ green. Spores 1(-4)-celled		
		<i>Mycobilimbia hypnorum</i> (Lib.) Kalb & Hafellner	
103	Spores 2-celled		104
103	Spores more than 4-celled		106
104	Apothecial margin indistinct	<i>Myxobilimbia microcarpa</i> (Th.Fr.) Hafellner	
104	Apothecial margin distinct		105
105	Paraphyses 2-3 µm thick. Spores ellipsoid, 1(-4)-celled. Hypothecium with scattered bluish granules reacting K+ green		
		<i>Mycobilimbia hypnorum</i> (Lib.) Kalb & Hafellner	
105	Paraphyses <2 µm thick. Spores ellipsoid-cylindrical, 2-4-celled. Hypothecium without scattered bluish granules reacting K+ green		
		<i>Mycobilimbia tetramera</i> (De Not.) Hafellner & Türk	
106	Parasitic on <i>Baeomyces</i>	<i>Arthrorhaphis grisea</i> Th.Fr.	
106	Non parasitic		107
107	Spores more than 4 µm large	<i>Myxobilimbia sabuletorum</i> (Schreb.) Hafellner	
107	Spores less than 4 µm large		108
108	Apothecia brownish	<i>Bacidia herbarum</i> (Stizenb.) Arnold	
108	Apothecia black (sometimes bluish-pruinose)		109
109	Thallus whitish. Apothecia non pruinose. Epithecium bright green. Most spores < 2.5 µm broad	<i>Bacidia bagliettoana</i> (A.Massal. & De Not.) Jatta	
109	Thallus greyish brown. Apothecia often bluish-pruinose. Epithecium dark olivaceous green. Most spores >2.5 µm broad	<i>Toninia coelestina</i> (Anzi) Vězda	

Key C: mediterranean to montane, on acid to subacid substrata

You can use this key if your lichen was collected in any part of Italy located below the subalpine-alpine belts (from the mediterranean region to the beech belt, i.e. from sea level to ca. 1800 m), on acid siliceous substrata such as granite, quartzite, acid sandstone, etc., or on rotting wood.

Fruticose lichens: subkey C1, p. 283

Foliose lichens: subkey C2, p. 287

Squamulose lichens: subkey C3, p. 289

Crustose lichens: subkey C4, p. 290

Leprose lichens: see general key, p. 143

Subkey C1 - Fruticose lichens

- | | | | |
|----|--|--|----|
| 1 | Thallus orange, K+ red | <i>Teloschistes flavicans</i> (Sw.) Norman | |
| 1 | Thallus of other colours, K- or K+ yellow | | 2 |
| 2 | Thallus dark-coloured, black to dark brown | | 3 |
| 2 | Thallus not dark-coloured | | 7 |
| 3 | Thallus filamentous (thread-like) | | 4 |
| 3 | Thallus non filamentous, without a central cavity (if with a central cavity, go to option 21) | | 5 |
| 4 | With cyanobacteria; branches <0.2 mm thick | | |
| | | <i>Polychidium muscicola</i> (Sw.) Gray | |
| 4 | With green algae; branches >0.2 mm thick | | |
| | | <i>Bryoria bicolor</i> (Ehrh.) Brodo & D.Hawksw. | |
| 5 | Lobes >3 mm broad. Medulla P+ yellow to orange, with fumarprotocetraric acid | | |
| | | <i>Cetraria islandica</i> (L.) Ach. | |
| 5 | Lobes <3 mm broad. Medulla P-, without fumarprotocetraric acid | | 6 |
| 6 | Branches flattened, uneven, to ca. 1 mm diam., branching open and coarse; pseudocyphellae concave, elongate | <i>Cetraria aculeata</i> (Schreb.) Fr. | |
| 6 | Branches rounded, even, delicate, to ca. 0.5 mm diam., branching dense and spinulose; pseudocyphellae flat, circular | <i>Cetraria muricata</i> (Ach.) Eckfeldt | |
| 7 | Thallus thin, flat in section | <i>Anaptychia ciliaris</i> (L.) Körb. | |
| 7 | Thallus thick, inflated to round in section | | 8 |
| 8 | Thallus without a central cavity (section!) | | 9 |
| 8 | Thallus with a central cavity | | 14 |
| 9 | Thallus (fruticose thallus parts) prostrate, densely covered by greenish soredia-like granules or by grey small scale-like structures (phyllocladia) | | 10 |
| 9 | Thallus (fruticose thallus parts) erect, naked | | 12 |
| 10 | Thallus covered by greenish, soredia-like, leprose, ecorticate granules; branches <0.3 mm diam. | <i>Leprocaulon microscopicum</i> (Vill.) Gams | |
| 10 | Thallus without soredia-like granules but densely covered by coarse, whitish and pale grey, corticate scale-like structures (phyllocladia); branches >0.5 mm diam. | | 11 |
| 11 | Thallus P+ orange, with stictic acid. Podetia tomentose, on soil (if podetia naked, firmly attached to the rock: <i>Stereocaulon vesuvianum</i> Pers.) | | |
| | | <i>Stereocaulon tomentosum</i> Fr. | |
| 11 | Thallus P- or P+ yellow, without stictic acid | | |
| | | <i>Stereocaulon condensatum</i> Hoffm. | |
| 12 | Crustose primary thallus with evident (to 6 mm broad) radiating marginal lobes | | |
| | | <i>Baeomyces placophyllus</i> Ach. | |

12	Crustose primary thallus without marginal lobes	13
13	Apothecia brownish, concave to flat and marginate at first, later swollen and with reflexed margin. Thallus and medulla UV-. Asci I-. With stictic acid, and variable amounts of norstictic and constictic acids	
	<i>Baeomyces placophyllus</i> Ach.	
13	Apothecia pink-coloured, soon swollen and emarginate. Thallus and medulla UV+ orange. Asci I+ blue. With baeomycesic acid, and variable amounts of squamatic acid and atranorin	
	<i>Dibaeis baeomyces</i> (L. fil.) Rambold & Hertel	
14	Thallus densely ramified, shrub-like	15
14	Thallus not or scarcely ramified, never shrub-like	53
15	Podetia without cortex (surface arachnoid under a strong lens) and without squamules. Primary thallus crustose, ephemeral and rarely seen	16
15	Podetia with cortex, with or without squamules. Primary thallus mostly evident, squamulose	20
16	Thallus K+ yellow	
	<i>Cladonia rangiferina</i> (L.) F.H. Wigg.	
16	Thallus K-	17
17	Thallus P+ yellow	
	<i>Cladonia arbuscula</i> (Wallr.) Flot. subsp. <i>arbuscula</i>	
17	Thallus P+ red, or P-	18
18	Thallus P+ red, with fumarprotocetraric acid	
	<i>Cladonia ciliata</i> Stirt.	
18	Thallus P-, without fumarprotocetraric acid	19
19	Ramifications mainly dichotomous. Thallus yellowish. Restricted to humid, undisturbed, mediterranean stands. Without perlatolic acid	
	<i>Cladonia mediterranea</i> P.A. Duvign. & Abbayes	
19	Ramifications mainly trichotomous. Thallus grey. Mainly submediterranean. With perlatolic acid	
	<i>Cladonia portentosa</i> (Dufour) Coem.	
20	Cortex disrupted into soredia-like structures (a very rare species of very humid areas)	
	<i>Cladonia scabriuscula</i> (Delise) Leight.	
20	Cortex continuous to cracked, not disrupted into soredia-like structures (common species)	21
21	Thallus K+ brownish	
	<i>Cladonia furcata</i> (Huds.) Schrad.	
21	Thallus K+ yellow, or K-	22
22	Thallus K+ yellow, with atranorin	23
22	Thallus K-, without atranorin	25
23	Thallus P-, without fumarprotocetraric acid	
	<i>Cladonia rangiformis</i> Hoffm.	
23	Thallus P+ red, with fumarprotocetraric acid	24
24	Podetia greenish to whitish grey, slender, densely ramified, usually squamulose, without convex, white medullary outbursts at the base	
	<i>Cladonia rangiformis</i> Hoffm.	
24	Podetia brown, stout, non- or scarcely squamulose, with evident, convex, white medullary outbursts at the base	
	<i>Cladonia subrangiformis</i> Sandst.	
25	Thallus P+ red	26
25	Thallus P-	27
26	Podetia greenish grey, slender, squamulose, without evident, convex, white medullary outbursts at the base	
	<i>Cladonia furcata</i> (Huds.) Schrad.	
26	Podetia brown, stout, with evident, convex, white medullary outbursts at the base	
	<i>Cladonia subrangiformis</i> Sandst.	
27	With cups	28
27	Without cups	54
28	With soredia (do not confuse schizidia-like, corticate structures with true soredia!)	29
28	Without soredia	44
29	Apothecia and pycnidia scarlet red, K+ blood red (if apothecia are absent, look at the margins of cups for pycnidia !)	30
29	Apothecia and pycnidia pale to dark brown, K-	33
30	Primary squamules large (>0.5 cm diam.). Thallus K+ yellow, KC- or KC+	

	yellowish, P+ orange, with thamnolic acid, without usnic acid	
	<i>Cladonia digitata</i> (L.) Hoffm.	
30	Primary squamules small to middle-sized (<0.5 cm diam.). Thallus K-, KC+ yellow, P-, with usnic acid, without thamnolic acid	31
31	Podetia with broad cups and short stalks (like <i>C. pyxidata</i>)	
	<i>Cladonia pleurota</i> (Flörke) Schaer.	
31	Podetia slender, with long stalks and narrow cups	32
32	Podetia mostly without cups, and then with pointed ends, but sometimes with narrow, lacerated cups. With usnic and sometimes squamatic acids, without zeorin. Thallus UV+ white or UV-	
	<i>Cladonia sulphurina</i> (Michx.) Fr.	
32	Podetia with narrow, more or less regular cups, more rarely pointed, squamulose esp. toward the base. With usnic acid and zeorin. Thallus always UV-	
	<i>Cladonia deformis</i> (L.) Hoffm.	
33	Thallus K+ yellow turning to red, C+ red, KC+ red, with cryptochlorophaeic acid	
	<i>Cladonia cryptochlorophaea</i> Asahina	
33	Thallus K+ yellow or K-, without cryptochlorophaeic acid	34
34	Thallus K+ yellow	35
34	Thallus K-	36
35	Primary squamules large, with distinct brownish to pinkish veins below. Without atranorin. Extremely rare in Italy, restricted to humid-warm mediterranean stands	
	<i>Cladonia cyathomorpha</i> Walt. Watson	
35	Primary squamules without veins below. With atranorin. More common	
	<i>Cladonia humilis</i> (With.) J.R. Laundon	
36	Soredia granular (here we include also some species with schizidia). Cups broad, with short stalks (like those of <i>C. pyxidata</i>)	37
36	Soredia farinose. Cups narrow, with long stalks.	39
37	Thallus KC+ red, with merochlorophaeic acid (warning! the reaction is visible in extracts only!)	
	<i>Cladonia merochlorophaea</i> Asahina	
37	Thallus KC-, without merochlorophaeic acid	38
38	Thallus UV-. With fumarprotocetraric acid only	
	<i>Cladonia chlorophaea</i> (Flörke ex Sommerf.) Spreng.	
38	Thallus UV+ bluish white. With grayanic and fumarprotocetraric acids	
	<i>Cladonia grayi</i> Sandst.	
39	Cups regular	
	<i>Cladonia fimbriata</i> (L.) Fr.	
39	Cups, when present, irregular	40
40	Thallus P+ yellow changing to orange-red	
	<i>Cladonia rei</i> Schaer.	
40	Thallus P-, or P+ red	41
41	Thallus P-	42
41	Thallus P+ red	43
42	Cups open at the bottom (i.e. with a hole). With squamatic acid	
	<i>Cladonia cenotea</i> (Ach.) Schaer.	
42	Cups closed at the bottom. With homosekikaic acid	
	<i>Cladonia rei</i> Schaer.	
43	Podetia >4 cm tall, corticate only at base, non squamulose. Thallus pale grey to whitish, sometimes with a greenish or brownish tinge	
	<i>Cladonia subulata</i> (L.) F.H. Wigg.	
43	Podetia <4 cm tall, squamulose-granular to partly decorticate. Thallus greenish brown	
	<i>Cladonia ramulosa</i> (With.) J.R. Laundon	
44	Apothecia and pycnidia scarlet red	45
44	Apothecia and pycnidia brown	47
45	With squamatic acid (UV+ white). Podetia >3 cm tall, densely squamulose, with long stalks and narrow cups	
	<i>Cladonia bellidiflora</i> (Ach.) Schaer.	
45	Without squamatic acid (UV-). Podetia <3 cm tall, scarcely or non-squamulose, with short stalks and broad cups, similar to those of <i>C. pyxidata</i> (if you cannot assess chemical differences among the following taxa, your samples could be	46

	called " <i>Cladonia coccifera</i> (L.) Willd. s.lat.")	
46	With usnic and barbatic acids	<i>Cladonia borealis</i> S. Stenroos
46	With usnic acid and zeorin	<i>Cladonia coccifera</i> (L.) Willd.
47	Thallus K+ yellow	48
47	Thallus K-	50
48	Thallus P+ orange, with thamnolic and barbatic acids	
	<i>Cladonia squamosa</i> Hoffm. var. <i>subsquamosa</i> (Leight.) Vain.	
48	Thallus P+ red, with fumarprotocetraric acid	49
49	Squamules pinkish grey below	<i>Cladonia firma</i> (Nyl.) Nyl.
49	Squamules grey below, without a pinkish hue	
	<i>Cladonia subcervicornis</i> (Vain.) Kernst.	
50	Thallus P-, with squamatic acid, without fumarprotocetraric acid	
	<i>Cladonia squamosa</i> Hoffm. var. <i>squamosa</i>	
50	Thallus P+ red, with fumarprotocetraric acid	51
51	Podetia <4 cm tall	52
51	Podetia >4 cm tall	53
52	Squamules bluish-grey below. Podetia proliferating from the centre	
	<i>Cladonia cervicornis</i> (Ach.) Flot. subsp. <i>cervicornis</i>	
52	Squamules white below. Podetia non proliferating or proliferating from the margin	<i>Cladonia pyxidata</i> (L.) Hoffm.
53	Podetia proliferating from the centre (forming several stocks of superimposed cups); squamules bluish grey below	
	<i>Cladonia cervicornis</i> (Ach.) Flot. subsp. <i>verticillata</i> (Hoffm.) Ahti	
53	Podetia non proliferating, or proliferating from the margin; squamules white below	<i>Cladonia phyllophora</i> Hoffm.
54	With soredia	55
54	Without soredia	63
55	Apothecia and pycnidia scarlet red	56
55	Apothecia and pycnidia brown	58
56	Thallus K+ yellow, with thamnolic acid	
	<i>Cladonia macilenta</i> Hoffm. subsp. <i>macilenta</i>	
56	Thallus K-, without thamnolic acid	57
57	Podetia small and inconspicuous, <0.5 cm tall, yellowish grey. Primary squamules to 4 mm long. Extremely rare in Italy	<i>Cladonia incrassata</i> Flörke
57	Podetia stout, >1 cm tall, yellowish green. Primary squamules 2-8 mm long. More common species	go back to option 32
58	Thallus P+ yellow, slowly changing to orange-red	<i>Cladonia rei</i> Schaer.
58	Thallus P+ rapidly red, or P-	59
59	Thallus P-, without fumarprotocetraric acid	<i>Cladonia rei</i> Schaer.
59	Thallus P+ red, with fumarprotocetraric acid	60
60	Podetia >4 cm tall	<i>Cladonia cornuta</i> (L.) Hoffm.
60	Podetia <4 cm tall	61
61	Podetia phyllopodiate, i.e. arising from inflated primary squamules, densely squamulose, pycnidia generally on the squamules. Very, rare, restricted to lowland areas	<i>Cladonia pseudopityrea</i> Vain.
61	Podetia not phyllopodiate, squamulose or not, pycnidia mostly on the podetia. Not very rare, found both in lowland and upland areas	62
62	Soredia farinose, podetia non-squamulose, or squamulose only at the base	<i>Cladonia coniocraea</i> (Flörke) Spreng.
62	Soredia granulose, podetia densely and minutely squamulose	<i>Cladonia ramulosa</i> (With.) J.R.Laundon
63	Thallus K+ red, with norstictic acid	<i>Cladonia polycarpoides</i> Nyl.
63	Thallus K+ yellow or K-, without norstictic acid	64
64	Thallus K+ yellow	65
64	Thallus K-	69

65	Thallus P+ orange, with thamnolic acid <i>Cladonia squamosa Hoffm. var. subsquamosa (Leight.) Vain.</i>	
65	Thallus P+ red or P-, without thamnolic acid	66
66	Thallus P+ red, with fumarprotocetraric acid <i>Cladonia cariosa (Ach.) Spreng.</i>	
66	Thallus P-, without fumarprotocetraric acid	67
67	Thallus KC+ yellowish, with usnic acid. Apothecia and pycnidia pale yellowish brown <i>Cladonia botrytes (K.G.Hagen) Willd.</i>	
67	Thallus KC-, without usnic acid. Apothecia and pycnidia dark brown	68
68	Primary thallus squamulose. Podetia >0.5 mm diam., very thick-walled, with medullary hyphae running parallel to the surface <i>Cladonia cariosa (Ach.) Spreng.</i>	
68	Primary thallus crustose. Podetia <0.5 mm diam., thin-walled <i>Pycnothelia papillaria (Ehrh.) L.M.Doufur</i>	
69	Apothecia and pycnidia scarlet red	70
69	Apothecia and pycnidia brown	71
70	Thallus KC+ yellow, with usnic and squamatic acids, yellowish green. Podetia densely squamulose, 3-5 cm tall <i>Cladonia bellidiflora (Ach.) Schaer.</i>	
70	Thallus KC-, with barbatic and (rarely) thamnolic acids, greenish grey. Podetia non-squamulose, or squamulose only at the base, 1-3 cm tall <i>Cladonia macilenta Hoffm. subsp. floerkeana (Fr.) V.Wirth</i>	
71	Thallus C+ bright emerald green, with baeomycesic and squamatic acids, and strepsilin. Extremely rare, presence in Italy dubious <i>Cladonia strepsilis (Ach.) Grognot</i>	
71	Thallus C-, with a different chemistry	72
72	Thallus P-, without fumarprotocetraric acid	73
72	Thallus P+ red, with fumarprotocetraric acid	74
73	Podetia thin, non squamulose, greenish-yellowish, to 5 mm tall. Apothecia and pycnidia very pale yellowish brown. With usnic acid, without squamatic acid. Medulla UV- <i>Cladonia botrytes (K.G.Hagen) Willd.</i>	
73	Podetia thick, densely squamulose, whitish grey, to 5 cm tall. Apothecia and pycnidia medium to dark brown. Without usnic acid, with squamatic acid. Medulla UV+ white <i>Cladonia squamosa Hoffm. var. squamosa</i>	
74	Primary squamules large, cream-coloured below <i>Cladonia foliacea (Huds.) Willd.</i>	
74	Squamules small to middle-sized, pure white below	75
75	Podetia, when present, <3 mm tall. With fumarprotocetraric acid. Primary squamules middle-sized, to 7 mm long <i>Cladonia caespiticia (Pers.) Flörke</i>	
75	Podetia >10 mm tall. With fumarprotocetraric acid and variable amounts of ursolic acid. Primary squamules very small (<1 mm long) <i>Cladonia peziziformis (With.) J.R.Laundon</i>	

Subkey C2 - Foliose lichens

1	Thallus bright yellow to orange	<i>Xanthoria calcicola Oksner</i>	
1	Thallus of other colours		2
2	Thallus dark, from black to dark brown		3
2	Thallus not dark		12
3	With soredia or isidia		4
3	Without soredia or isidia		7
4	With soredia. Thallus heteromerous, not gelatinous when wet <i>Nephroma parile (Ach.) Ach.</i>		
4	With isidia. Thallus homeomerous, gelatinous when wet (if thallus heteromerous, with isidia-like marginal structures, see opt. 7: <i>Massalongia cariosa</i>)		5
5	Isidia granulose, not flattened <i>Collema tenax (Sw.) Ach.</i>		

5	Isidia flattened, spathulate		6
6	Lobes brown, ascending, ear-like, not very thick when wet. Spores 4-7-celled, sometimes submuriform, >10 µm broad	<i>Collema crispum</i> (Huds.) F.H.Wigg.	
6	Lobes blackish brown to black, not ascending and ear-like, very thick when wet. Spores 5-6-celled, never submuriform, <10 µm broad	<i>Collema flaccidum</i> (Ach.) Ach.	
7	Thallus stratified, not gelatinous when wet. Upper cortex composed by 3-8 layers of cells	<i>Massalongia carnosa</i> (Dicks.) Körb.	
7	Thallus not stratified, gelatinous when wet. Upper cortex absent, or composed by 1(-3) layers of cells		8
8	Thallus with thin transparent hairs, esp. at the margin	<i>Leptochidium albociliatum</i> (Desm.) M.Choisy	
8	Thallus without hairs		9
9	Thallus thick, without cortex	<i>Collema tenax</i> (Sw.) Ach.	
9	Thallus thin, with an evident cortex composed by a single layer of angular cells (observe a lobe under the microscope from above)		10
10	Lobes suberect, cucullate, with revolute, entire margin, appearing tube-like esp. above, with antler-like tips	<i>Leptogium corniculatum</i> (Hoffm.) Minks	
10	Margin of lobes not revolute-cucullate, tips never antler-like		11
11	Edge of lobes more or less entire	<i>Leptogium gelatinosum</i> (With.) J.R.Laundon	
11	Edge of lobes deeply dilacerate-fringed	<i>Leptogium lichenoides</i> (L.) Zahlbr.	
12	Photobiont cyanobacterial (<i>Nostoc</i>) (photobiont layer bluish green in section)		13
12	Photobiont chlorococcoid (photobiont layer bright green in section)		24
13	With soredia or isidia		14
13	Without soredia or isidia		15
14	With soredia	<i>Peltigera didactyla</i> (With.) J.R.Laundon	
14	With isidia	<i>Peltigera praetextata</i> (Sommerf.) Zopf	25
15	Veins on lower surface absent (either lower surface uniformly pale at the margin and dark in the centre, or lower surface black, with scattered white spots)	<i>Peltigera elisabethae</i> Gyeln.	
15	Veins on lower surface present (to observe the veins, carefully clean the entire lower surface!)		16
16	Thallus non tomentose		17
16	Thallus tomentose at least at the margin of lobes (lens!)		22
17	Veins and rhizines whitish to pale ochraceous brown		18
17	Veins and rhizines dark brown to black, at least at thallus centre		19
18	Veins distinctly raised, whitish, sometimes pale brown in the centre	<i>Peltigera degenii</i> Gyeln.	
18	Veins flattened, pale ochraceous brown	<i>Peltigera hymenina</i> (Ach.) Delise	
19	Lobes >3 cm broad, rhizines mostly slender >5 mm long	<i>Peltigera neopolydactyla</i> (Gyeln.) Gyeln.	
19	Lobes <3 cm broad, rhizines <5 mm long		20
20	Lower surface pale at margin, dark in the centre, with indistinct venation. Lobes often faintly pruinose at margin	<i>Peltigera neckeri</i> Müll.Arg.	
20	Lower surface with a very distinct pattern of reticulated, dark veins. Lobes not pruinose at margin		21
21	Apothecia horizontal, rounded. Rhizines fasciculate, separate, arranged in concentric lines (clean carefully the lower face!)	<i>Peltigera horizontalis</i> (Huds.) Baumg.	
21	Apothecia erect, saddle-shaped. Rhizines becoming confluent, not arranged in concentric lines	<i>Peltigera polydactyla</i> (Neck.) Hoffm.	
22	Lobes 6-10 mm broad	<i>Peltigera rufescens</i> (Weiss) Humb.	
22	Lobes >10 mm broad		23
23	Rhizines slender, more or less simple	<i>Peltigera praetextata</i> (Sommerf.) Zopf	
23	Rhizines squarrose	<i>Peltigera membranacea</i> (Ach.) Nyl.	

24	With soredia or isidia	25
24	Without soredia or isidia	28
25	Without pseudocyphellae	26
25	With linear pseudocyphellae	27
26	With isidia. Thallus K+ yellow, with atranorin	<i>Parmelina tiliacea</i> (Hoffm.) Hale
26	With soredia. Thallus K-, without atranorin	<i>Phaeophyscia hispidula</i> (Ach.) Essl.
27	With isidia	<i>Parmelia saxatilis</i> (L.) Ach.
27	With soredia	<i>Parmelia sulcata</i> Taylor
28	With conspicuous marginal cilia	<i>Anaptychia ciliaris</i> (L.) Körb.
28	Without marginal cilia	29
29	Veins on lower surface present	<i>Peltigera aphthosa</i> (L.) Willd.
29	Veins on lower surface absent	30
30	Thallus brown- Lobes <1 mm broad)	<i>Anaptychia bryorum</i> Poelt
30	Thallus greenish. Lobes >1 mm broad	<i>Xanthoparmelia somloënsis</i> (Gyeln.) Hale

Subkey C3 - Squamulose lichens

1	Photobiont cyanobacterial (photobiont layer bluish green in section)	2
1	Photobiont chlorococcoid (photobiont layer bright green in section)	6
2	Thallus dark, from black to dark brown	3
2	Thallus not dark	<i>Protopannaria pezizoides</i> (Weber) M.Jörg. & S.Ekman
3	Thallus not gelatinous when wet. Photobionts restricted to a well-delimited layer (section!).	<i>Massalongia carnososa</i> (Dicks.) Körb.
3	Thallus more or less gelatinous when wet. Photobionts homogeneously spread throughout the thallus (section!)	4
4	Thallus with thin transparent hairs (lens!)	<i>Leptochidium albociliatum</i> (Desm.) M.Choisy
4	Thallus without thin transparent hairs	5
5	Edge of lobes deeply dilacerate	<i>Leptogium lichenoides</i> (L.) Zahlbr.
5	Edge of lobes more or less entire	<i>Leptogium gelatinosum</i> (With.) J.R.Laundon
6	Squamules subfoliose, ascending, bifacial (<i>Cladonia</i>)	7
6	Squamules of different forms, but not subfoliose, ascending, and bifacial	18
7	Squamules with soredia	8
7	Squamules without soredia	9
8	Squamules whitish grey, <3 mm long, deeply incised, granulose-“sorediose”. With thamnolic acid and variable amounts of barbatic acid. Apothecia and pycnidia (when present) brown	<i>Cladonia parasitica</i> (Hoffm.) Hoffm.
8	Squamules greenish, >5 mm long, rounded, with marginal soredia. With thamnolic acid only. Apothecia and pycnidia (when present) bright red	<i>Cladonia digitata</i> (L.) Hoffm.
9	Thallus K+ red	<i>Cladonia polycarpoides</i> Nyl.
9	Thallus K+, or K+ yellow	10
10	Thallus K+ yellow	11
10	Thallus K-	13
11	Thallus P+ orange, with thamnolic acid, without fumarprotocetraric acid	<i>Cladonia squamosa</i> Hoffm. var. <i>subsquamosa</i> (Leight.) Vain.
11	Thallus P+ red, without thamnolic acid, with fumarprotocetraric acid	12
12	Lower surface of squamules reddish grey	<i>Cladonia firma</i> (Nyl.) Nyl.
12	Lower surface of squamules lead grey	<i>Cladonia subcervicornis</i> (Vain.) Kernst.
13	Thallus C+ bright emerald green, with baeomycesic and squamatic acids and strepsilin	<i>Cladonia strepsilis</i> (Ach.) Grognot
13	Thallus C-, with a different chemistry	14
14	Thallus P-, without fumarprotocetraric acid	<i>Cladonia squamosa</i> Hoffm. var. <i>squamosa</i>

14	Thallus P+ red, with fumarprotocetraric acid	15
15	Squamules white below	16
15	Squamules grey to pale yellowish below	17
16	Squamules greenish grey, less than 0.4 mm thick, ascending	
	<i>Cladonia caespiticia</i> (Pers.) Flörke	
16	Squamules more or less brownish, 1-2 mm thick, forming a subrosulate crust	
	<i>Cladonia pocillum</i> (Ach.) O.J. Rich.	
17	Squamules bluish grey below. Without usnic acid	
	<i>Cladonia cervicornis</i> (Ach.) Flot. subsp. <i>cervicornis</i>	
17	Squamules pale yellowish below. With usnic acid	
	<i>Cladonia foliacea</i> (Huds.) Willd.	
18	With isidia	<i>Trapeliopsis wallrothii</i> (Spreng.) Hertel & Gotth.Schneid.
18	Without isidia	19
19	With punctiform pseudocyphellae	<i>Toninia toepfferi</i> (Stein) Navàs
19	Without pseudocyphellae	20
20	With apothecia (thallus positive or negative to K, C, KC and P)	21
20	With perithecia (thallus always K-, C-, KC-, P-)	27
21	Thallus bright-coloured, yellowish-green, orange or red	22
21	Thallus not bright-coloured, of other colours	23
22	With radiating marginal lobes	go to subkey D4, option 10
22	Without radiating marginal lobes	go to subkey D4, option 12
23	Apothecia lecanorine, with a thalline margin containing algal cells	
	<i>Solenopsora holophaea</i> (Mont.) Samp.	
23	Apothecia non lecanorine, without a thalline margin containing algal cells	24
24	Most spores more than 5-celled, needle-shaped	
	<i>Toninia squalida</i> (Ach.) A.Massal.	
24	Most spores less than 5-celled, not needle-shaped	25
25	Spores 1-celled	<i>Toninia tristis</i> (Th.Fr.) Th.Fr. subsp. <i>pseudotabacina</i> Tindal
25	Spores 2-celled	26
26	Hypothecium without orange and yellow pigments. Epithecium brown. Spores 13.5-20.5 x 3.5-5 µm	<i>Toninia tristis</i> (Th.Fr.) Th.Fr. subsp. <i>tristis</i>
26	Hypothecium with orange (K+red) and yellow (K-) pigments. Epithecium brownish to greenish brown. Spores 12.5-19 x 3.5-5.5 µm	
	<i>Toninia tristis</i> (Th.Fr.) Th.Fr. subsp. <i>asiae-centralis</i> (H.Magn.) Tindal	
27	Thallus without hairs. Cells of lower cortex arranged in vertical rows (section!). Conidia 5-7 µm long	<i>Placidium adami-borosi</i> Szatala
27	Thallus with fine hairs. Cells of lower cortex not arranged in vertical rows, Conidia 3-5 µm long	<i>Placidium pilosellum</i> (Breuss) Breuss

Subkey C4 - Crustose lichens

1	With cyanobacteria (photobiont layer bluish-green in section)	2
1	Without cyanobacteria (photobiont layer bright green to orange-green in section)	3
2	Spores 1-celled. Thallus subleprose	<i>Moelleropsis nebulosa</i> (Hoffm.) Gyeln.
2	Spores submuriform. Thallus not subleprose	<i>Epiphloea terrena</i> (Nyl.) Trevis.
3	Thallus dark, from black to very dark brown	4
3	Thallus not dark	8
4	With soredia	<i>Trapeliopsis gelatinosa</i> (Flörke) Coppins & P.James
4	Without soredia	5
5	Thallus KC+ red, with gyrophoric acid	
	<i>Placynthiella icmalea</i> (Ach.) Coppins & P.James	
5	Thallus KC-, without gyrophoric acid	6
6	Thallus smooth. Spores subglobose, >16 µm long	
	<i>Japewia tornoënsis</i> (Nyl.) Tønsberg	

6	Thallus granulose. Spores ellipsoid, <16 µm long. Epithecium brown (if epithecium green see opt. 4: <i>Trapeliopsis gelatinosa</i>)	7
7	Granules wart-like (100-300 µm), becoming yellowish green when wet <i>Placynthiella oligotropa (J.R.Laundon) Coppins & P.James</i>	
7	Granules small, less than 100 µm, not becoming yellowish green when wet <i>Placynthiella uliginosa (Schrad.) Coppins & P.James</i>	
8	Thallus bright (greenish-) yellow to orange	9
8	Thallus not bright yellow to orange	14
9	Thallus composed by very small (<0.4 mm diam.), rounded, scattered, bright yellow-green granules. Apothecia perithecioid to urceolate, small (<0.5 mm diam.), immersed in the granules	10
9	Thallus and apothecia different	13
10	Disc of the apothecia not exposed (apothecia perithecioid, the warts opening through a narrow pore)	11
10	Disc of the apothecia at least partly exposed	12
11	Spores oblong-obtuse, 3-4(-5) x 1-1.5 µm. Paraphyses absent, substituted by periphyses. <i>Thelocarpon intermediellum Nyl.</i>	
11	Spores subglobose to broadly ellipsoid, 1.5-4(-6) x 1.5-2 µm. Paraphyses present. <i>Thelocarpon laureri (Flot.) Nyl.</i>	
12	Periphyses absent. Paraphyses branched (carefully observe many paraphyses under the microscope!). Asci I+ pale blue, on <i>Baeomyces</i> <i>Thelocarpon lichenicola (Fuckel) Poelt & Hafellner</i>	
12	Periphyses present. Paraphyses not branched. On bare soil, or, if on <i>Baeomyces</i> , asci I- <i>Thelocarpon epibolum Nyl.</i>	
13	Mostly on wood, very rarely on soil. Thallus of closely packed, granular elements. Apothecia rare <i>Candelariella kuusamoënsis Räsänen</i>	
13	Mostly on siliceous rocks, but not unfrequent on mosses and mineral soil over siliceous substrata. Thallus from granulose to small-lobulate, with flat lobules, not forming convex pillows of densely packed coralloid elements. Apothecia frequent <i>Candelariella vitellina (Hoffm.) Müll.Arg.</i>	
14	With soredia or isidia	15
14	Without soredia or isidia	20
15	Thallus with isidia <i>Trapeliopsis wallrothii (Spreng.) Hertel & Gotth.Schneid.</i>	
15	Thallus with soredia	16
16	Thallus K+ yellow <i>Baeomyces rufus (Huds.) Rebent.</i>	
16	Thallus K-	17
17	Thallus greenish, entirely leprose-sorediate, KC-, with pulvinic acid derivatives <i>Chaenotheca furfuracea (L.) Tibell</i>	
17	Thallus not greenish, not entirely leprose-sorediate, KC+ red to orange, without pulvinic acid derivatives	18
18	Thallus with orange-red, K+ red patches (anthraquinones) <i>Trapeliopsis pseudogranulosa Coppins & P.James</i>	
18	Thallus without orange-red, K+ red patches (no anthraquinones)	19
19	Thallus C+, KC+ orange-red. Soredia grouped into maculiform soralia. Apothecia lecanorine, >2 mm diam. Spores >30 µm long <i>Ochrolechia androgyna (Hoffm.) Arnold</i>	
19	Tallus C+, KC+ red. Soredia diffuse. Apothecia non-lecanorine, < 2 mm diam. Spores <15 µm long <i>Trapeliopsis granulosa (Hoffm.) Lumbsch</i>	
20	Thallus with radiating marginal lobes <i>Baeomyces placophyllus Ach.</i>	
20	Thallus without marginal lobes	21
21	With perithecia	22
21	With apothecia	24
22	Spores 2-celled <i>Epigloea grumannii Döbbeler</i>	
22	Spores not 2-celled	23
23	Spores 4-celled <i>Thelidium zwackii (Hepp) A.Massal.</i>	

23	Spores not 4-celled		
		<i>Protothelenella sphinctrinoidella</i> (Nyl.) H.Mayrhofer & Poelt	
24	Apothecia lecanorine, with a thalline margin containing algal cells		25
24	Apothecia non lecanorine, without a thalline margin		27
25	Spores more than 4-celled	<i>Rinodina intermedia</i> Bagl.	
25	Spores 1- to 2-celled		26
26	Spores 1-celled	<i>Trapelia coarctata</i> (Sm.) M.Choisy	
26	Spores 2-celled		
		<i>Caloplaca cerina</i> (Hedw.) Th.Fr. var. <i>muscorum</i> (A.Massal.) Jatta	
27	Thallus KC+ yellow. Apothecia stipitate		28
27	Thallus KC-, KC+ orange, or KC+ red. Apothecia usually not stipitate		29
28	Thallus and medulla UV-. Apothecia reddish brown. With stictic acid, and variable amounts of norstictic and constictic acids		
		<i>Baeomyces rufus</i> (Huds.) Rebent.	
28	Thallus and medulla UV+ orange. Apothecia pale pink-coloured. With baeomycesic acid, and variable amounts of squamatic acid and atranorin		
		<i>Dibaeis baeomyces</i> (L. fil.) Rambold & Hertel	
29	Thallus KC+ orange		30
29	Thallus KC+ red or KC-		31
30	Apothecia pink to pale orange-pink	<i>Icmadophila ericetorum</i> (L.) Zahlbr.	
30	Apothecia dark-coloured	<i>Buellia insignis</i> (Hepp) Th.Fr.	
31	Thallus KC+ red		32
31	Thallus KC-		34
32	Spores 1-celled	<i>Trapeliopsis granulosa</i> (Hoffm.) Lumbsch	
32	Spores 2- to 4-celled		33
33	Macroconidia less than 50 µm long. Apothecia frequent. Spores (11-)15-23(-24) x 3-5(-6) µm	<i>Micarea peliocarpa</i> (Anzi) Coppins & R.Sant.	
33	Macroconidia flexuous, filiform, 50-110 x 1 µm. Apothecia rare. Spores (19-)23-34(-38) x 4.5-6 µm	<i>Micarea cinerea</i> (Schaer.) Hedl.	
34	Apothecia pale-coloured		35
34	Apothecia dark-coloured		38
35	Spores 2-celled	<i>Micarea prasina</i> Fr.	
35	Spores 1- or 4-celled		36
36	Spores 4-celled	<i>Mycobilimbia pilularis</i> (Körb.) Hafellner & Türk	
36	Spores 1-celled		37
37	Apothecial margin (section!) colourless outside, pale brown inside. Thallus continuous, whitish grey	<i>Biatora subduplex</i> (Nyl.) Printzen	
37	Apothecial margin (section!) more or less pale brown, uniformly coloured. Thallus granulose, greyish-green	<i>Biatora vernalis</i> (L.) Fr.	
38	Thallus K+ yellow	<i>Buellia insignis</i> (Hepp) Th.Fr.	
38	Thallus K-		39
39	Thallus P+ red	<i>Micarea lignaria</i> (Ach.) Hedl. var. <i>lignaria</i>	
39	Thallus P-		40
40	Spores 4-celled		41
40	Spores not 4-celled		42
41	Thallus thick, composed of small lobulate areolae (lens!)		
		<i>Myxobilimbia lobulata</i> (Sommerf.) Hafellner	
41	Thallus thin, continuous, not composed of lobulate areolae		
		<i>Micarea botryoides</i> (Nyl.) Coppins	
42	Spores 1-celled		43
42	Spores not 1-celled		45
43	Spores subglobose, 12-16 per ascus	<i>Steinia geophana</i> (Nyl.) Stein	
43	Spores not subglobose, 8 or more than 32 per ascus		44
44	Thallus gelatinous when wet, granulose. Spores >25 µm long, broadly ellipsoid. Paraphyses simple, not anastomosing. Asci cylindrical		

		<i>Aphanopsis coenosa</i> (Ach.) Coppins & P.James	
44	Thallus not gelatinous when wet, more or less continuous. Spores <25 µm long. Paraphyses ramified, anastomosing. Asci clavate		
		<i>Micarea bauschiana</i> (Körb.) V.Wirth & Vězda	
45	Spores more than 4-celled	<i>Gyalideopsis athalloides</i> (Nyl.) Vězda	46
45	Spores 2-celled		
46	Spores pigmented	<i>Amandinea punctata</i> (Hoffm.) Coppins & Scheid.	47
46	Spores hyaline		
47	Epithecium K+ violet	<i>Micarea prasina</i> Fr.	48
47	Epithecium K-		
48	Hypothecium pale to colourless	<i>Catillaria contristans</i> (Nyl.) Zahlbr.	49
48	Hypothecium dark		
49	Epithecium N-. Spores oval, 1-4-celled	<i>Micarea botryoides</i> (Nyl.) Coppins	
49	Epithecium N+ red. Spores ellipsoid-cylindrical, (1)-2-celled	<i>Micarea melaenida</i> (Nyl.) Coppins	

Key D: mediterranean to montane, on subneutral to basic (calcareous) substrata

You can use this key if your lichen was collected in any part of Italy located below the subalpine-alpine belts (from the mediterranean region to the beech belt, i.e. from sea level to ca. 1800 m), on calcareous or dolomitic substrata, on in areas with base-rich siliceous rocks such as calciferous schist, calciferous sandstone, basalt, etc. If your species was collected on rotting wood, you better go to key C.

Fruticose lichens: subkey D1, p. 295

Foliose lichens: subkey D2, p. 297

Squamulose lichens: subkey D3, p. 299

Crustose lichens: subkey D4, p. 304

Leprose lichens: see general key, p. 243

Subkey D1 - Fruticose lichens

- | | | |
|----|--|----|
| 1 | Thallus orange, K+ red. Restricted to humid mediterranean stands, extremely rare | |
| | <i>Teloschistes flavicans</i> (Sw.) Norman | |
| 1 | Thallus of other colours, K- or K+ yellow | 2 |
| 2 | Thallus dark-coloured, black to dark brown | 3 |
| 2 | Thallus not dark-coloured | 5 |
| 3 | Thallus small-filamentous (thread-like), with cyanobacteria | |
| | <i>Polychidium muscicola</i> (Sw.) Gray | |
| 3 | Thallus non filamentous (flattened), with green algae | 4 |
| 4 | Lobes >3 mm broad. Medulla P+ yellow to orange, with fumarprotocetraric acid | |
| | <i>Cetraria islandica</i> (L.) Ach. | |
| 4 | Lobes <3 mm broad. Medulla P-, without fumarprotocetraric acid | |
| | go to subkey C1, option 6 | |
| 5 | Thallus without a central cavity (section!) | 6 |
| 5 | Thallus with a central cavity | 7 |
| 6 | Thallus (fruticose thallus parts) densely covered by greenish soredia-like granules | |
| | <i>Leprocaulon microscopicum</i> (Vill.) Gams | |
| 6 | Thallus (fruticose thallus parts) erect, naked | 9 |
| | go to key C1, option 12 | |
| 7 | Thallus densely ramified, shrub-like | 8 |
| 7 | Thallus not, or scarcely ramified, never shrub-like | 16 |
| 8 | Podetia without cortex (surface arachnoid under a strong lens), without squamules. Primary thallus crustose, ephemeral and rarely seen | 9 |
| 8 | Podetia with cortex, with or without squamules. Primary thallus mostly evident, squamulose | 10 |
| 9 | Thallus P+ red, with fumarprotocetraric acid | |
| | <i>Cladonia ciliata</i> Stirt. | |
| 9 | Thallus P-, without fumarprotocetraric acid | |
| | <i>Cladonia mediterranea</i> P.A.Duvign. & Abbayes | |
| 10 | Cortex disrupted into soredia-like structures (a very rare species of very humid areas) | |
| | <i>Cladonia scabriuscula</i> (Delise) Leight. | |
| 10 | Cortex continuous to cracked, not disrupted into soredia-like structures (common species) | 11 |
| 11 | Thallus K+ brownish | |
| | <i>Cladonia furcata</i> (Huds.) Schrad. | |
| 11 | Thallus K+ yellow, or K- | 12 |

12	Thallus K+ yellow, with atranorin	13
12	Thallus K-, without atranorin	15
13	Thallus P-, without fumarprotocetraric acid	<i>Cladonia rangiformis Hoffm.</i>
13	Thallus P+ red, with fumarprotocetraric acid	14
14	Podetia greenish to whitish grey, slender, densely ramified, usually squamulose, without convex, white medullary outbursts at the base	<i>Cladonia rangiformis Hoffm.</i>
14	Podetia brown, stout, non- or scarcely squamulose, with evident, convex, white medullary outbursts at the base	<i>Cladonia subrangiformis Sandst.</i>
15	Podetia greenish grey, slender, squamulose, without evident, convex, white medullary outbursts at the base	<i>Cladonia furcata (Huds.) Schrad.</i>
15	Podetia brown, stout, with evident, convex, white medullary outbursts at the base	<i>Cladonia subrangiformis Sandst.</i>
16	With cups	17
16	Without cups	32
17	With soredia (do not confuse schizidia-like, corticate structures with true soredia!)	18
17	Without soredia	26
18	Thallus K+ yellow turning to red, C+ red, KC+ red, with cryptochlorophaeic acid	<i>Cladonia cryptochlorophaea Asahina</i>
18	Thallus K+ yellow or K-, without cryptochlorophaeic acid	19
19	Thallus K+ yellow	<i>Cladonia humilis (With.) J.R.Laundon</i>
19	Thallus K-	20
20	Soredia granular. Podetia with broad cups and short stalks (like those of <i>C. pyxidata</i>)	21
20	Soredia farinose. Podetia elongate, with narrow cups on long stalks	22
21	Thallus KC+ red, with merochlorophaeic acid (warning! the reaction is visible in extracts only!)	<i>Cladonia merochlorophaea Asahina</i>
21	Thallus KC-, without merochlorophaeic acid	<i>Cladonia chlorophaea</i>
22	Cups regular (round in outline)	<i>Cladonia fimbriata (L.) Fr.</i>
22	Cups, when present, irregular	23
23	Thallus P+ yellow changing to orange-red	<i>Cladonia rei Schaer.</i>
23	Thallus P-, or P+ red	24
24	Thallus P+ red	<i>Cladonia ramulosa (With.) J.R.Laundon</i>
24	Thallus P-	25
25	Cups open at the bottom (i.e. with a hole). With squamatic acid	<i>Cladonia cenotea (Ach.) Schaer.</i>
25	Cups closed at the bottom. With homosekikaic acid	<i>Cladonia rei Schaer.</i>
26	Thallus K+ yellow	27
26	Thallus K-	29
27	Thallus P+ orange, with thamnolic and barbatic acids	<i>Cladonia squamosa Hoffm. var. subsquamosa (Leight.) Vain.</i>
27	Thallus P+ red, with fumarprotocetraric acid	28
28	Squamules pinkish grey below	<i>Cladonia firma (Nyl.) Nyl.</i>
28	Squamules lead-grey below, without a pinkish hue	<i>Cladonia subcervicornis (Vain.) Kernst.</i>
29	Thallus P-, with squamatic acid, without fumarprotocetraric acid	<i>Cladonia squamosa Hoffm. var. squamosa</i>
29	Thallus P+ red, with fumarprotocetraric acid	30
30	Podetia >4 cm tall	<i>Cladonia dimorpha S. Hammer</i>
30	Podetia <4 cm tall	31
31	Thallus more or less brownish. Primary squamules 0.5-2 mm thick, flat, forming a thick subrosulate crust	<i>Cladonia pocillum (Ach.) O.J. Rich.</i>
31	Thallus greyish-green. Primary squamules <0.5 mm thick, more or less ascending, never forming a thick subrosulate crust	

		<i>Cladonia pyxidata (L.) Hoffm.</i>	
32	With soredia		33
32	Without soredia		37
33	Thallus P+ yellow, slowly changing to orange-red	<i>Cladonia rei Schaer.</i>	
33	Thallus P+ rapidly red, or P-		34
34	Thallus P-, without fumarprotocetraric acid	<i>Cladonia rei Schaer.</i>	
34	Thallus P+ red, with fumarprotocetraric acid		35
35	Podetia phyllopodiate, i.e. arising from inflated primary squamules, densely squamulose, pycnidia generally on the squamules. Very, rare, restricted to lowland areas	<i>Cladonia pseudopityrea Vain.</i>	
35	Podetia not phyllopodiate, squamulose or not, pycnidia mostly on the podetia. Not very rare, found both in lowland and upland areas		36
36	Soredia farinose, podetia non-squamulose, or squamulose only at the base	<i>Cladonia coniocraea (Flörke) Spreng.</i>	
36	Soredia granulose, podetia densely and minutely squamulose	<i>Cladonia ramulosa (With.) J.R.Laundon</i>	
37	Thallus K+ red, with norstictic acid		38
37	Thallus K+ yellow or K-, without norstictic acid		39
38	Thallus K+ rapidly red, P+ red, without atranorin	<i>Cladonia polycarpoides Nyl.</i>	
38	Thallus K+ yellow, then slowly red, P+ orange-yellow, with atranorin	<i>Cladonia symphycarpa (Flörke) Fr.</i>	
39	Thallus K+ yellow		40
39	Thallus K-		41
40	Thallus P+ orange, with thamnolic acid	<i>Cladonia squamosa Hoffm. var. subsquamosa (Leight.) Vain.</i>	
40	Thallus P+ red or P-, without thamnolic acid	<i>Cladonia cariosa (Ach.) Spreng.</i>	
41	Thallus P-, without fumarprotocetraric acid	<i>Cladonia squamosa Hoffm. var. squamosa</i>	
41	Thallus P+ red, with fumarprotocetraric acid		42
42	Squamules small, white below	<i>Cladonia caespiticia (Pers.) Flörke</i>	
42	Squamules large, cream-coloured below	<i>Cladonia foliacea (Huds.) Willd</i>	

Subkey D2 - Foliose lichens

1	Thallus bright yellow to orange	<i>Xanthoria calcicola Oksner</i>	
1	Thallus of other colours		3
3	Thallus dark, from black to dark brown		4
3	Thallus not dark		17
4	With soredia or isidia		5
4	Without soredia or isidia		8
5	With soredia. Thallus heteromerous, not gelatinous when wet	<i>Nephroma parile (Ach.) Ach.</i>	
5	With isidia. Thallus homeomerous, gelatinous when wet		6
6	Isidia granulose, not flattened	<i>Collema tenax (Sw.) Ach.</i>	
6	Isidia flattened, spathulate		7
7	Lobes brown, ascending, ear-like, not very thick when wet. Spores 4-7-celled, sometimes submuriform, >10 µm broad	<i>Collema crispum (Huds.) F.H.Wigg.</i>	
7	Lobes blackish brown to black, not ascending and ear-like, very thick when wet. Spores 5-6-celled, never submuriform, <10 µm broad	<i>Collema flaccidum (Ach.) Ach.</i>	
8	Thallus with thin transparent hairs, esp. at the margin	<i>Leptochidium albociliatum (Desm.) M.Choisy</i>	
8	Thallus without hairs		9
9	Thallus thin, with an evident cortex composed by a single layer of angular cells (observe a lobe under the microscope from above)		10

9	Thallus thick, without cortex	12
10	Lobes suberect, cucullate, with revolute, entire margin, appearing tube-like esp. above, with antler-like tips	<i>Leptogium corniculatum</i> (Hoffm.) Minks
10	Margin of lobes not revolute-cucullate, tips never antler-like	11
11	Edge of lobes more or less entire	<i>Leptogium gelatinosum</i> (With.) J.R.Laundon
11	Edge of lobes deeply dilacerate-fringed	<i>Leptogium lichenoides</i> (L.) Zahlbr.
12	Spores 2-celled	<i>Collema coccophorum</i> Tuck.
12	Spores not 2-celled	13
13	Spores 4-celled	<i>Collema tenax</i> (Sw.) Ach.
13	Spores not 4-celled	14
14	Spores 1-celled	15
14	Spores more than 4-celled	16
15	Spores ellipsoid, 20-33 x 10-13 µm	<i>Lempholemma chalazanum</i> (Ach.) de Lesd.
15	Spores globose, 9-14 x 9-14 µm	<i>Lempholemma polyanthes</i> (Bernh.) Malme
16	Spores 8 per ascus	<i>Collema tenax</i> (Sw.) Ach.
16	Spores (2-)4 per ascus	<i>Collema limosum</i> (Ach.) Ach.
17	Photobiont cyanobacterial (<i>Nostoc</i>) (photobiont layer bluish green in section)	18
17	Photobiont chlorococcoid (photobiont layer bright green in section)	35
18	With soredia or isidia	19
18	Without soredia or isidia	21
19	With soredia	<i>Peltigera didactyla</i> (With.) J.R.Laundon
19	With isidia	20
20	Isidia peltate (attached by a single point in the centre), scattered on the upper surface. Thallus usually <1 cm broad. Veins flattened	<i>Peltigera lepidophora</i> (Vain.) Bitter
20	Isidia spathulate (flattened, and erect, attached by the basis), mostly located along cracks. Thallus usually >5 cm broad. Veins raised	<i>Peltigera praetextata</i> (Sommerf.) Zopf
21	Veins on lower surface absent (either lower surface uniformly pale at the margin and dark in the centre, or lower surface black, with scattered white spots)	<i>Peltigera elisabethae</i> Gyeln.
21	Veins on lower surface present (to observe the veins, carefully clean the entire lower surface!)	22
22	Thallus non tomentose	23
22	Thallus tomentose at least at the margin of lobes (lens!)	28
23	Veins and rhizines whitish to pale ochraceous brown	24
23	Veins and rhizines dark brown to black, at least at thallus centre	25
24	Veins distinctly raised, whitish, sometimes pale brown in the centre	<i>Peltigera degenii</i> Gyeln.
24	Veins flattened, pale ochraceous brown	<i>Peltigera hymenina</i> (Ach.) Delise
25	Lobes >3 cm broad, rhizines mostly slender >5 mm long	<i>Peltigera neopolydactyla</i> (Gyeln.) Gyeln.
25	Lobes <3 cm broad, rhizines <5 mm long	26
26	Lower surface pale at margin, dark in the centre, with indistinct venation. Lobes often faintly pruinose at margin	<i>Peltigera neckeri</i> Müll.Arg.
26	Lower surface with a very distinct pattern of reticulated, dark veins. Lobes not pruinose at margin	27
27	Apothecia horizontal, rounded. Rhizines fasciculate, separate, arranged in concentric lines (clean carefully the lower face!)	<i>Peltigera horizontalis</i> (Huds.) Baumg.
27	Apothecia erect, saddle-shaped. Rhizines becoming confluent, not arranged in concentric lines	<i>Peltigera polydactyla</i> (Neck.) Hoffm.
28	Lobes 6-10 mm broad	29
28	Lobes >10 mm broad	32
29	Rhizines and veins long remaining pale	<i>Peltigera ponojensis</i> Gyeln.

29	Rhizines and veins soon darkening	30
31	Rhizines near the margin slender, simple, or with a few branches only. Veins flat <i>Peltigera monticola</i> Vítik.	
31	Rhizines conspicuously and richly branched also at margin. Tomentum appressed (if tomentum erect see opt. 33 <i>P. kristinssonii</i>) <i>Peltigera rufescens</i> (Weiss) Humb.	
32	Rhizines slender, more or less simple <i>Peltigera praetextata</i> (Sommerf.) Zopf	33
32	Rhizines squarrose	
33	Upper surface with sparse erect tomentum at the margin, glossy towards centre. Veins flat <i>Peltigera kristinssonii</i> Vítik.	
33	Tomentum not erect. Veins raised	34
34	Rhizines confluent, penicillated (brush-like). Veins soon darkened towards centre <i>Peltigera canina</i> (L.) Willd.	
34	Rhizines separate, with numerous branches perpendicular to the main axis (bottle-brush-like). Veins conspicuously erect-tomentose and pale, also in thallus centre <i>Peltigera membranacea</i> (Ach.) Nyl.	
35	With soredia <i>Parmelia sulcata</i> Taylor	
35	Without soredia	36
36	With conspicuous marginal cilia <i>Anaptychia ciliaris</i> (L.) Körb.	
36	Without marginal cilia	37
37	Lower surface dark, from black to dark brown, esp. in the centre <i>Physconia muscigena</i> (Ach.) Poelt var. <i>muscigena</i>	
37	Lower surface pale throughout	38
38	Veins on lower surface present	39
38	Veins on lower surface absent	40
39	Without warty cephalodia on upper surface. Apothecia laminal, rounded, semi-immersed in the upper surface <i>Solorina saccata</i> (L.) Ach.	
39	With warty cephalodia on upper surface. Apothecia absent, or if present not semi-immersed in the thallus <i>Peltigera leucophlebia</i> (Nyl.) Gyeln.	
40	Lobes long and narrow (<1 mm broad); thallus brownish <i>Phaeophyscia constipata</i> (Norrl. & Nyl.) Moberg	
40	Lobes not long and narrow, generally >1 mm broad; if less, reduced to a broad collar around the apothecia; thallus usually greenish	41
41	Thallus K+ yellow. Medulla K+ yellow changing to red, with salazinic acid. Apothecia lecanorine, sessile, strongly constricted <i>Xanthoparmelia somloënsis</i> (Gyeln.) Hale	
41	Thallus and medulla K-, without salazinic acid. Apothecia non lecanorine, semi-immersed in the thallus	42
42	Spores 2 per ascus <i>Solorina bispora</i> Nyl. subsp. <i>bispora</i>	
42	Spores 4 per ascus <i>Solorina saccata</i> (L.) Ach.	

Subkey D3 - Squamulose lichens

1	Photobiont cyanobacterial (photobiont layer bluish green in section)	2
1	Photobiont chlorococcoid (photobiont layer bright green in section)	14
2	Thallus dark, from black to dark brown	3
2	Thallus not dark	9
3	Thallus thick, subfruticulose, inflated to terete in section <i>Leptogium schraderi</i> (Bernh.) Nyl.	
3	Thallus thin, flat in section, not subfruticulose	4
4	Thallus not gelatinous when wet. Photobionts restricted to a well-delimited layer (section!). Apothecia restricted to the base, never immersed to semi-immersed in the thallus (if so, see option 9: <i>Peltula patellata</i>) <i>Fuscopannaria praetermissa</i> (Nyl.) M.Jørg.	
4	Thallus more or less gelatinous when wet. Photobionts homogeneously spread throughout the thallus (section!)	5

5	Thallus with thin transparent hairs (lens!) <i>Leptochidium albociliatum (Desm.) M.Choisy</i>	
5	Thallus without thin transparent hairs	6
6	Most squamules <1 mm broad (measure the squamules in the central part!)	7
6	Most squamules >1 mm broad	8
7	Thallus not entirely paraplectenchymatous, i.e. the cortex not extending throughout its thickness (section!). Photobionts in long chains <i>Leptogium intermedium (Arnold) Arnold</i>	
7	Thallus entirely paraplectenchymatous, i.e. the cortex extending throughout its thickness (section!). Photobionts in short chains (section!) <i>Leptogium tenuissimum (Dicks.) Körb.</i>	
8	Edge of lobes deeply dilacerate <i>Leptogium lichenoides (L.) Zahlbr.</i>	
8	Edge of lobes more or less entire <i>Leptogium gelatinosum (With.) J.R.Laundon</i>	
9	Apothecia lecanorine, with a thalline margin containing algal cells <i>Peltula patellata (Bagl.) Swinscow & Krog</i>	
9	Apothecia non lecanorine, without a thalline margin	10
10	Apothecia perithecioid, opening by a small pore. Most spores < 15 µm long <i>Gloeoheppia turgida (Ach.) Gyeln.</i>	
10	Apothecia non perithecioid, with exposed disc. Most spores >15 µm long	11
11	Without upper and lower cortex (section!). Thallus never pruinose <i>Heppia lutosa (Ach.) Nyl.</i>	
11	With upper and/or lower cortex (section!). Thallus pruinose or not	12
12	Thallus heavily pruinose, with a white thick layer of clustered crystals <i>Heppia solorinoides (Nyl.) Nyl.</i>	
12	Thallus non-pruinose	13
13	Restricted to upland areas. Hymenium I+ red. Lower cortex well-developed, formed by periclinally arranged hyphae <i>Heppia adglutinata (Kremp.) A.Massal.</i>	
13	Restricted to lowland areas. Hymenium I+ blue. Lower cortex absent or restricted to the margins <i>Heppia despreauxii (Mont.) Tuck.</i>	
14	Squamules subfoliose, ascending, bifacial (<i>Cladonia</i>)	15
14	Squamules of different forms, but not subfoliose, ascending, and bifacial	24
15	Thallus K+ red	16
15	Thallus K+, or K+ yellow	17
16	Squamules K+ rapidly deep red. With norstictic acid, without atranorin <i>Cladonia polycarpoides Nyl.</i>	
16	Squamules K+ yellow, then slowly red. With norstictic acid and atranorin <i>Cladonia symphycarpa (Flörke) Fr.</i>	
17	Thallus K+ yellow	18
17	Thallus K-	20
18	Thallus P+ orange, with thamnolic acid, without fumarprotocetraric acid <i>Cladonia squamosa Hoffm. var. subsquamosa (Leight.) Vain.</i>	
18	Thallus P+ red, without thamnolic acid, with fumarprotocetraric acid	19
19	Lower surface of squamules reddish grey <i>Cladonia firma (Nyl.) Nyl.</i>	
19	Lower surface of squamules lead grey <i>Cladonia subcervicornis (Vain.) Kernst.</i>	
20	Thallus P-, without fumarprotocetraric acid <i>Cladonia squamosa Hoffm. var. squamosa</i>	
20	Thallus P+ red, with fumarprotocetraric acid	21
21	Squamules white below	22
21	Squamules grey to pale yellowish below	23
22	Squamules greenish grey, less than 0.4 mm thick, ascending <i>Cladonia caespiticia (Pers.) Flörke</i>	
22	Squamules more or less brownish, 1-2 mm thick, forming a subrosulate crust <i>Cladonia pocillum (Ach.) O.J. Rich.</i>	
23	On calcareous substrata. Squamules 15-40 x 2-10 mm, sometimes with black or white hairs at the margins, forming straggling clusters	

- Cladonia convoluta* (Lam.) Anders
- 23 On subneutral siliceous substrata. Squamules 4-15 x 1-3 mm, forming compact mats, sometimes with black hairs at the margins
- Cladonia foliacea* (Huds.) Willd. 25
- 24 With soredia or isidia. Thallus with or without hairs 25
- 24 Without soredia or isidia. Thallus always without hairs 27
- 25 Squamules < 0.5 mm broad, with thin transparent hairs
- Agonimia opuntiella* (Poelt & Buschardt) Vězda 26
- 25 Squamules much larger, without hairs 26
- 26 Thallus C-, KC+ yellowish, with usnic acid, without gyrophoric acid. Isidia knotty-granulose, marginal. Apothecia lecanorine, with a thalline margin containing algal cells
- Squamarina conrescens* (Müll.Arg.) Poelt
- 26 Thallus C+ red, KC+ red, without usnic acid, with gyrophoric acid. Isidia flattened, spathulate, clustered in laminal rounded spots. Apothecia non lecanorine
- Trapeliopsis wallrothii* (Spreng.) Hertel & Gotth.Schneid.
- 27 With punctiform pseudocyphellae 28
- 27 Without pseudocyphellae 29
- 28 Thallus grey, weakly pruinose to epruinose, matt. Squamules elongate, columnar. Spores 11.5-18.5 x 3.5-5 µm
- Toninia physaroides* (Opiz) Zahlbr.
- 28 Thallus brown, epruinose, somehow shiny. Squamules more or less spherical, bullate. Spores 15-23 x 3-3.5 µm
- Toninia toepfferi* (Stein) Navàs
- 29 With apothecia (thallus positive or negative to K, C, KC and P) 30
- 29 With perithecia (thallus always K-, C-, KC-, P-) 57
- 30 Thallus bright-coloured, yellowish-green, yellow or orange 31
- 30 Thallus not bright-coloured, of other colours 33
- 31 Thallus K-, reddish-coloured
- Psora decipiens* (Hedw.) Hoffm.
- 31 Thallus K+ red, yellow to orange-coloured 32
- 32 With radiating marginal lobes go to subkey D4, option 10
- 32 Without radiating marginal lobes go to subkey D4, option 12
- 33 Apothecia lecanorine, with a thalline margin containing algal cells 34
- 33 Apothecia non lecanorine, without a thalline margin containing algal cells 39
- 34 Spores 2-celled
- Solenopsora holophaea* (Mont.) Samp.
- 34 Spores 1-celled 35
- 35 Thallus forming very regular rosettes, with radiating marginal lobes. Medulla always P-
- Squamarina lentigera* (Weber) Poelt
- 35 Thallus not forming regular rosettes, of irregular, more or less imbricate lobes. Medulla P- or P+ 36
- 36 Medulla P+ red
- Squamarina cartilaginea* (With.) P.James f. *iberica* Mattick
- 36 Medulla P- or P+ yellow 37
- 37 Medulla P-, without psoromic acid
- Squamarina cartilaginea* (With.) P.James f. *pseudocrassa* Mattick
- 37 Medulla P+ yellow, with psoromic acid 38
- 38 Squamules yellowish green to greenish grey, non-pruinose or white-pruinose at the margin. Apothecial disc greenish-brown to (rarely) reddish brown. Spores oblong-obtuse, (10-)12-14(-15) x (4-)4.5-6 µm.
- Squamarina cartilaginea* (With.) P.James f. *cartilaginea*
- 38 Squamules densely white-pruinose throughout. Apothecial disc reddish brown. Spores ellipsoid, 9-13(-16) x (3-)4-7 µm
- Squamarina stella-petraea* Poelt
- 39 Most spores more than 5-celled, needle-shaped
- Toninia squalida* (Ach.) A.Massal.
- 39 Most spores less than 5-celled, not needle-shaped 40
- 40 Spores (2-)4-celled 41
- 40 Spores 1-2-celled 43
- 41 Epithecium K+ red
- Toninia lutosa* (Ach.) Timdal

41	Epithecium K-		42
42	Squamules flattened, crenate-lobulate, forming a compact crust. Spores fusiform, 14-20(-26) x 3-5(-6) µm	<i>Myxobilimbia lobulata</i> (Sommerf.) Hafellner	
42	Squamules not crenate-lobulate, scattered to contiguous, not forming a compact crust. Spores ellipsoid-cylindrical, 11-22.5 x 4-5.5 µm	<i>Toninia aromatica</i> (Sm.) A.Massal.	
43	Spores 1-celled		44
43	Spores 2-celled		49
44	Thallus pale pink-coloured	<i>Psora saviczii</i> (Tomin) Follmann & A. Crespo	
44	Thallus not pale pink-coloured		45
45	Epithecium K-		46
45	Epithecium K+ red		47
46	Squamules flat, clearly and densely imbricate. Epithecium brownish, N-. Spores 6-8 µm broad	<i>Mycobilimbia lurida</i> (Ach.) Hafellner & Türk	
46	Squamules convex, bullate, scattered to contiguous, not imbricate. Epithecium greenish brown to bright green, N+ violet. Spores 4.5-6.5 µm broad	<i>Toninia tristis</i> (Th.Fr.) Th.Fr. subsp. <i>pseudotabacina</i> Tindal	
47	Squamules with a conspicuous white margin	<i>Psora vallesiaca</i> (Schaer.) Tindal	
47	Squamules without a conspicuous white margin		48
48	Squamules chestnut brown, rarely faintly white-pruinose, greyish to brownish below. Spores 10-13 x 5-7 µm	<i>Psora globifera</i> (Ach.) A.Massal.	
48	Squamules greenish brown above, whitish below. Spores 12-15 x 6-8 µm	<i>Psora gresinonis de Lesd.</i>	
49	Thallus chestnut brown, often with punctiform depressions. Epithecium K-.		50
49	Thallus rarely chestnut brown, without depressions. Epithecium K+ violet		51
50	Hypothecium without orange and yellow pigments. Epithecium brown. Spores 13.5-20.5 x 3.5-5 µm	<i>Toninia tristis</i> (Th.Fr.) Th.Fr. subsp. <i>tristis</i>	
50	Hypothecium with orange (K+red) and yellow (K-) pigments. Epithecium brownish to greenish brown. Spores 12.5-19 x 3.5-5.5 µm	<i>Toninia tristis</i> (Th.Fr.) Th.Fr. subsp. <i>asiae-centralis</i> (H.Magn.) Tindal	
51	Hypothecium pale brown to colourless		52
51	Hypothecium dark		53
52	Thallus densely covered by a white, granular pruina, with shallow fissures in the cortex	<i>Toninia rosulata</i> (Anzi) H.Olivier	
52	Thallus olivaceous brown, epruinose, with regular, evident fissures in the cortex	<i>Toninia taurica</i> (Szatala) Oksner	
53	Thallus entirely pruinose; pruina granular	<i>Toninia diffracta</i> (A.Massal.) Zahlbr.	
53	Thallus non-pruinose, or only partly pruinose, the pruina composed of very small crystals, not granular		54
54	Squamules more or less flat, with a white-pruinose rim	<i>Toninia albilabra</i> (Dufour) H.Olivier	
54	Squamules bullate, or - if flat - without white-pruinose rim		55
55	Squamules (2-)3-6 mm broad, bullate, vertically flattened when old, more or less imbricate	<i>Toninia opuntoides</i> (Vill.) Tindal	
55	Squamules weakly convex to bullate, 1-2(-3) mm broad, not vertically flattened and not imbricate		56
56	Thallus generally without pruina, rarely faintly pruinose, often shiny and with regular fissures. Apothecia generally epruinose. Spores 10-16.5 x 3.5-4.5 µm	<i>Toninia massata</i> (Tuck.) Herre	
56	Thallus often white-pruinose at least in part, dull, smooth or with very shallow fissures in the cortex. Apothecia often pruinose. Spores 12-24 x 3-5 µm	<i>Toninia sedifolia</i> (Scop.) Tindal	
57	Spores submuriform to muriform		58
57	Spores 1-2-celled		60
58	Squamules small, <0.5 mm long. Perithecia without hymenial algae		

	<i>Agonimia tristicula</i> (Nyl.) Zahlbr.	
58	Squamules >0.5 mm long. Perithecia with hymenial algae	59
59	Squamules densely imbricate, ascending. Lower surface black with a white margin, without rhizohyphae. Spores 1 per ascus	
	<i>Endocarpon adscendens</i> (Anzi) Müll.Arg.	
59	Squamules scattered to contiguous, not overlapping. Lower surface either uniformly black or uniformly pale, with rhizohyphae. Spores usually 2 per ascus (some asci may contain a single spore)	
	<i>Endocarpon pusillum</i> Hedw.	
60	Spores 2-celled	61
60	Spores 1-celled	63
61	Thallus attached by a central holdfast looking like a rhizine	
	<i>Placidiopsis custnani</i> (A.Massal.) Körb.	
61	Thallus attached only by rhizohyphae, central holdfast absent	62
62	Perithecia with involucrellum (section!) <i>Placidiopsis tenella</i> (Nyl.) Zahlbr.	
62	Perithecia without involucrellum <i>Placidiopsis cinerascens</i> (Nyl.) Breuss	
63	Rhizohyphae dark (make a section of the squamule, and carefully observe the rhizohyphae under the microscope). Mostly in upland areas.	61
63	Rhizohyphae pale. Mostly in lowland areas	66
64	Perithecia developing on the dark hypothallus between the squamules, with involucrellum (section!) <i>Involucropyrenium waltheri</i> (Kremp.) Breuss	
64	Perithecia immersed in the squamules, without involucrellum	65
65	Lower cortex present, dark, paraplectenchymatous (section!). Thallus brownish grey, often faintly pruinose especially toward the centre, and darker toward the margin. Old perithecia with a dark wall. Asci 65-70 x 16-22 µm. Spores (15-)17-23(-25) x (6-)6.5-8.5(-9.5) µm <i>Catapyrenium cinereum</i> (Pers.) Körb.	
65	Lower cortex absent. Thallus brownish grey, often faintly pruinose especially towards the centre, never darker at margin. Most perithecia with a pale to colourless wall. Asci 75-85 x 17-20 µm Spores (15-)17-22(-24) x (5-)6-8(-9) µm <i>Catapyrenium daedaleum</i> (Kremp.) Stein	
66	Perithecia with involucrellum, developing on the dark hypothallus between the squamules	67
66	Perithecia without involucrellum, developing inside the squamules	68
67	Involucrellum all around the perithecium. Perithecia pyriform. A very rare, mediterranean species <i>Involucropyrenium sbarbaronis</i> (Servit) Breuss	
67	Involucrellum apical. Perithecia globose also at maturity. More common, mediterranean to submediterranean <i>Involucropyrenium tremniacense</i> (A.Massal.) Breuss	
68	Squamules small, densely imbricate, forming cushions <i>Heteroplacidium imbricatum</i> (Nyl.) Breuss	
68	Squamules small to large, not densely imbricate, never forming cushions	69
69	Rhizines present (do not confuse true rhizines, which are formed by bundles of hyphae, with rhizohyphae, which consist of individual hyphae - if you are not certain, observe a section under the microscope!)	70
69	Rhizines absent	72
70	Perithecial wall dark throughout <i>Anthracocarpon virescens</i> (Zahlbr.) Breuss	
70	Perithecial wall pale throughout	71
71	Squamules flattened to weakly convex, not pruinose. Pycnidia laminal. Spores ellipsoid, 12-15(-17) x 6-7.5 µm <i>Placidium lacinulatum</i> (Ach.) Breuss	
71	Squamules mostly subconcave, with up-turned margins, at least in part grey-pruinose. Pycnidia marginal. Spores broadly ellipsoid, (12-)14-19 x 7-10 µm <i>Placidium semaforonense</i> Breuss	
72	Perithecial wall <25 µm thick (section!) <i>Placidium michelii</i> A.Massal.	
72	Perithecial wall >25 µm thick	73
73	Pycnidia laminal, fully immersed in the squamules, or absent (observe carefully several squamules!)	74

73	Pycnidia marginal, prominent	75
74	Squamules 2-7 mm broad. Rhizohyphae 4.5-6.5 µm thick	
	<i>Placidium squamulosum (Ach.) Breuss</i>	
74	Squamules 0.7-2(-3) mm broad. Rhizohyphae 3.5-5 µm thick	
	<i>Placidium tenellum (Breuss) Breuss</i>	
75	Cells of lower cortex arranged in vertical rows (section!). Conidia 5-7 µm long	76
75	Cells of lower cortex not arranged in vertical rows, Conidia 3-5 µm long	77
76	Below treeline. Most squamules >6 mm broad, with a thin margin	
	<i>Placidium adami-borosi Szatala</i>	
76	Mostly above or near treeline. Most squamules <6 mm broad, with a distinctly thickened margin	
	<i>Placidium lachneum (Ach.) de Lesd.</i>	
77	Squamules with very thin hairs, at least at the periphery (this character is difficult to observe: carefully examine several squamules under the binocular!). Mostly on soil	
	<i>Placidium pilosellum (Breuss) Breuss</i>	
77	Squamules without hairs. Mostly on rock	
	<i>Placidium rufescens (Ach.) A.Massal.</i>	

Subkey D4 - Crustose lichens

1	With cyanobacteria (photobiont layer bluish-green in section)	2
1	Without cyanobacteria (photobiont layer bright green to orange-green in section)	7
2	Apothecia non lecanorine, without a thalline margin containing algal cells	
	<i>Heppia lutosa (Ach.) Nyl.</i>	
2	Apothecia lecanorine, with a thalline margin containing algal cells	3
3	Spores 1-celled. Thallus subleprose	<i>Moelleropsis nebulosa (Hoffm.) Gyeln.</i>
3	Spores many-celled, submuriform. Thallus not subleprose	4
4	Spores 4 per ascus. Most apothecia > 1 mm diam	<i>Collema limosum (Ach.) Ach.</i>
4	Spores 8 per ascus. Most apothecia <1 mm diam	5
5	Photobiont <i>Scytonema</i> -like (cells 6-12 x 3-10 µm, isolated or in small groups)	
	<i>Epiphloea terrena (Nyl.) Trevis.</i>	
5	Photobiont <i>Nostoc</i> (cells spherical, 3-6 µm in diam., mostly in short chains)	6
6	Thallus crustose-granulose, apothecia mostly flat, semi-immersed, with a thin margin. Most spores with 1 transversal septum, 16-28 x 7-15 µm	
	<i>Leptogium byssinum (Hoffm.) Nyl.</i>	
6	Thallus small-subsquamulose, apothecia concave, sessile, with a rather thick margin. Most spores with 2 transversal septa, 24-32 x 13-16 µm	
	<i>Leptogium biatorinum (Nyl.) Leight.</i>	
7	Thallus bright (greenish-) yellow to orange	8
7	Thallus not bright yellow to orange	18
8	With soredia	<i>Caloplaca limonia Nimis & Poelt</i>
8	Without soredia	9
9	Thallus with radiating marginal lobes	10
9	Thallus without radiating marginal lobes	12
10	With schizidia (central parts of thallus covered by numerous flattened to convex, scale-like areoles), often without apothecia	<i>Fulgensia subbracteata (Nyl.) Poelt</i>
10	Without schizidia, most often with apothecia	11
11	Thallus monophyllous (lobes fused together, esp. at the centre). Spores from ovoid to slightly pyriform, 7-16 x 3.5-5 µm	<i>Fulgensia fulgens (Sw.) Elenkin</i>
11	Thallus non monophyllous (lobes contiguous, but separated). Spores with one end much larger than the other, 12-20 x 5-6 µm	<i>Fulgensia fulgida (Nyl.) Szatala</i>
12	Thallus composed by very small (<0.4 mm diam.), rounded, scattered, bright yellow-green granules. Apothecia perithecioid to urceolate, small (<0.4 mm diam.), immersed in the granules	13
12	Thallus and apothecia different	14
13	Spores 12-16 per ascus. Restricted to the mediterranean belt	

	<i>Thelocarpon macchiaie Nimis, Poelt & Puntillo</i>	
13	Spores more than 50 per ascus. Occurring also outside the mediterranean belt	
	<i>Thelocarpon laureri (Flot.) Nyl.</i>	
14	Thallus K-	<i>Acarospora schleicheri (Ach.) A.Massal.</i>
14	Thallus K+ deep red	
15	Spores 1-celled	<i>Fulgensia poeltii Llimona</i>
15	Spores 2-celled	
16	Spores pyriform, with one end much larger than the other (extremely rare, known from a single locality in the Gennargentu Massif, Sardegna)	
	<i>Caloplaca canariensis (Follmann & Poelt) Breuss</i>	
16	Spores ellipsoid	
17	On mineral soil, mostly in lowland areas. Spores 11-17 x 5-8 µm	
	<i>Fulgensia desertorum (Tomlin) Poelt</i>	
17	On epilithic mosses, esp. <i>Schistidium</i> , mostly in upland areas. Spores 15-23 x 5-8 µm	
	<i>Fulgensia schistidii (Anzi) Poelt</i>	
18	Photobiont trentepohlioid	
18	Photobiont chlorococcoid	
19	With perithecia	
19	With apothecia	
20	Spores 2-celled	<i>Thelopsis isiaca Stizenb.</i>
20	Spores not 2-celled	
21	Mainly mediterranean. Spores muriform	<i>Topelia rosea (Servít) M.Jørg. & Vězda</i>
21	Restricted to upland areas. Spores not muriform	<i>Belonia russula Nyl.</i>
22	Apothecial margin densely white-pruinose. Apothecial disc red to bright reddish brown. Apothecia not perithecioid, > 0.5 mm diam.	<i>Gyalecta ulmi (Sw.) Zahlbr.</i>
22	Apothecial margin not white-pruinose. Apothecial disc not red to reddish-brown, or, if so, apothecia perithecioid, < 0.5 mm diam.	<i>Gyalecta geoica (Ach.) Ach.</i>
23	With soredia or isidia	
23	Without soredia or isidia	
24	With isidia, KC+red	<i>Trapeliopsis wallrothii (Spreng.) Hertel & Gotth.Schneid.</i>
24	With soredia	
25	Thallus K+ yellow	<i>Baeomyces rufus (Huds.) Rebenl.</i>
25	Thallus K-	<i>Chaenotheca furfuracea (L.) Tibell</i>
26	Thallus with radiating marginal lobes	
26	Thallus without marginal lobes	
27	Apothecia lecanorine, with a thalline margin containing algal cells. Spores hyaline	
27	Apothecia non lecanorine, without a thalline margin. Spores pigmented	
28	Apothecial disc dark. Thallus KC-. Spores 50-100 per ascus	
	<i>Acarospora placodiiformis H.Magn.</i>	
28	Apothecial disc not dark. Thallus KC+ yellow. Spores 8 per ascus	
	<i>Squamarina lentigera (Weber) Poelt</i>	
29	In dry alpine valleys. Spores with rugulate ornamentation, (12-)13-20(-23) x (5.5-)6-10(-10.5) µm	<i>Buellia elegans Poelt</i>
29	Strictly mediterranean. Spores with microfoveate ornamentation, 10-17 x 5.5-8.5 µm	<i>Buellia zoharyi Galun</i>
30	With perithecia	
30	With apothecia	
31	Spores 2-celled	<i>Epigloea grumannii Döbbeler</i>
31	Spores not 2-celled	
32	Spores 4-celled	<i>Thelidium zwackii (Hepp) A.Massal.</i>
32	Spores not 4-celled	
33	Perithecia pale-coloured	<i>Leucocarpia biatorella (Arnold) Vězda</i>
33	Perithecia dark-coloured	
34	Spores 1-celled	
34	Spores more than 4-celled	

35	Spores >12 µm broad	<i>Verrucaria geophila</i> Zahlbr.	
35	Spores <12 µm broad		36
36	Paraphyses present. Perithecia covered by a thalline layer. Spores often clavate	<i>Thrombium epigaeum</i> (Pers.) Wallr.	
36	Paraphyses absent, substituted by periphyses. Perithecia not covered by a thalline layer. Spores narrowly ellipsoid, never clavate	<i>Verrucaria xyloxena</i> Norman	
37	Spores pigmented, brown	<i>Polyblastia rouxiana</i> Vězda & Vivant	
37	Spores hyaline (sometimes yellowish brown when old)		38
38	Spores 2-4 per ascus	<i>Chromatochlamys muscorum</i> (Fr.) H.Mayrhofer & Poelt var. <i>muscorum</i>	
38	Spores more than 4 per ascus		39
39	Spores 6-8 per ascus	<i>Chromatochlamys muscorum</i> (Fr.) H.Mayrhofer & Poelt var. <i>octospora</i> (Nyl.) H.Mayrhofer & Poelt	
39	Spores 8 per ascus	<i>Staurothele terricola</i> (Bagl.) Poelt & Nimis	
40	Apothecia lecanorine, with a thalline margin containing algal cells		41
40	Apothecia non lecanorine, without a thalline margin		56
41	Spores strongly muriform		42
41	Spores not muriform (or at most with a only a few longitudinal septa)		44
42	Apothecia up to 7 mm diam. Thallus C-, KC-, with norstictic and connorstictic acids	<i>Diploschistes ocellatus</i> (Vill.) Norman	
42	Apothecia up to 3 mm diam. Thallus C+ and KC+ red, with lecanoric and diploschistesic acids		43
43	Spores (4-)8 per ascus, 20-38 x 9-17 µm. Non parasitic. Thallus pruinose	<i>Diploschistes diacapsis</i> (Ach.) Lumbsch	
43	Spores always 4 per ascus, 18-32 x 6-15 µm. Starting the life-cycle on other lichens. Thallus non- or weakly pruinose	<i>Diploschistes muscorum</i> (Scop.) R.Sant.	
44	Thallus K+ rapidly red, with norstictic acid	<i>Acarospora nodulosa</i> (Dufour) Hue var. <i>reagens</i> (Zahlbr.) Clauzade & Cl.Roux	
44	Thallus K+ yellow or K-, without norstictic acid		45
45	Spores 4-celled	<i>Rinodina conradii</i> Körb.	
45	Spores not 4-celled		46
46	Spores more than 4-celled	<i>Rinodina intermedia</i> Bagl.	
46	Spores 1- to 2-celled		47
47	Spores 1-celled		48
47	Spores 2-celled		50
48	Thallus C+, KC+ red, with gyrophoric acid	<i>Trapelia coarctata</i> (Sm.) M.Choisy	
48	Thallus C-, KC-, without gyrophoric acid		49
49	Spores many per ascus	<i>Acarospora nodulosa</i> (Dufour) Hue var. <i>nodulosa</i>	
49	Spores 8 per ascus	<i>Megaspora verrucosa</i> (Ach.) Hafellner & V.Wirth var. <i>verrucosa</i>	
50	Apothecia densely white-pruinose, <0.3 mm diam.	<i>Lecania pusilla</i> Tretiach	
50	Apothecia not densely white-pruinose and < 0.3 mm diam at the same time		51
51	Apothecia dark-coloured	<i>Solorinella asteriscus</i> Anzi	
51	Apothecia bright yellow to orange		52
52	Thallus thick, areolate to subsquamulose, never film-like		53
52	Thallus thin, film-like		54
53	In lowland areas, on mineral soil. Thallus white. Apothecial disc bright rusty red. Spores 12-18 x 7-10 µm	<i>Caloplaca aetnensis</i> de Lesd.	
53	In upland areas, on mosses. Thallus brownish to brownish grey. Apothecial disc orange. Spores 12-15 x 4-8 µm	<i>Caloplaca congregiens</i> (Nyl.) Zahlbr.	
54	Apothecial margin yellow to olive-yellow	<i>Caloplaca tirolensis</i> Zahlbr.	
54	Apothecial margin grey		55
55	Apothecial disc pale greenish-yellow, sometimes becoming darker olive-yellow		

	with age	<i>Caloplaca cerina</i> (Hedw.) var. <i>chloroleuca</i> (Sm.) Th.Fr.	
55	Apothecial disc deep orange		
		<i>Caloplaca cerina</i> (Hedw.) Th.Fr. var. <i>muscorum</i> (A.Massal.) Jatta	
56	Thallus KC+ yellow. Apothecia stipitate		57
56	Thallus KC-, KC+ orange, or KC+ red. Apothecia usually not stipitate		58
57	Thallus and medulla UV-. Apothecia reddish brown. With stictic acid, and variable amounts of norstictic and constictic acids		
		<i>Baeomyces rufus</i> (Huds.) Rebent.	
57	Thallus and medulla UV+ orange. Apothecia pale pink-coloured. With baeomycesic acid, and variable amounts of squamatic acid and atranorin		
		<i>Dibaeis baeomyces</i> (L. fil.) Rambold & Hertel	
58	Thallus KC+ orange	<i>Buellia insignis</i> (Hepp) Th.Fr.	
58	Thallus KC+ red or KC-		59
59	Apothecia orange, K+ red	<i>Protoblastenia terricola</i> (Anzi) Lyngé	
59	Apothecia not orange, K-		60
60	Apothecia pale-coloured		61
60	Apothecia dark-coloured		67
61	Spores more than 4-celled	<i>Myxobilimbia sabuletorum</i> (Schreb.) Hafellner	
61	Spores no more than 4-celled		62
62	Spores 4-celled		63
62	Spores 1-celled		65
63	Paraphyses contorted, entwining the asci. Thallus composed by gonocysts with short conical outgrowths, usually semi-immersed in the substratum		
		<i>Veizdaea aestivalis</i> (Ohlert) Tscherm.-Woess & Poelt	
63	Paraphyses straight, not entwining the asci. Thallus not composed of gonocysts, without conical outgrowths, not immersed in the substratum		64
64	Apothecia whitish to pale yellowish white. Spores broadly ellipsoid to fusiform, (12-)13-22 x 4-7 µm	<i>Mycobilimbia pilularis</i> (Körb.) Hafellner & Türk	
64	Apothecia reddish to blackish brown. Spores ellipsoid-cylindrical, 16-30 x 5-6 µm		
		<i>Myxobilimbia microcarpa</i> (Th.Fr.) Hafellner	
65	Spores 8 per ascus	<i>Veizdaea aestivalis</i> (Ohlert) Tscherm.-Woess & Poelt	
65	Spores many more than 8 per ascus		66
66	Spores cylindrical, 8-13 µm long. Apothecia up to 1 mm diam.		
		<i>Biatorella fossarum</i> (Fr.) Th.Fr.	
66	Spores narrowly ellipsoid, 5-8 µm long. Apothecia mostly >1 mm diam.		
		<i>Biatorella hemisphaerica</i> Anzi	
67	Thallus K+ yellow	<i>Buellia insignis</i> (Hepp) Th.Fr.	
67	Thallus K-		68
68	Spores 4-celled		69
68	Spores not 4-celled		71
69	Thallus thick, composed of small lobulate areolae forming a compact crust (lens!)		
		<i>Myxobilimbia lobulata</i> (Sommerf.) Hafellner	
69	Thallus thin, continuous, not composed of lobulate areolae		70
70	Paraphyses 2-3 µm thick. Apothecial margin indistinct, disc convex		
		<i>Myxobilimbia microcarpa</i> (Th.Fr.) Hafellner	
70	Paraphyses <2 µm thick. Apothecial margin distinct, disc flat		
		<i>Mycobilimbia tetramera</i> (De Not.) Hafellner & Türk	
71	Spores 1-celled		72
71	Spores not 1-celled		77
72	Spores subglobose, 12-16 per ascus	<i>Steinia geophana</i> (Nyl.) Stein	
72	Spores not subglobose, 8 or more than 32 per ascus		73
73	Spores more than 32 per ascus	<i>Sarcosagium campestre</i> (Fr.) Poetsch & Schied.	
73	Spores 8 per ascus		74
74	Hypothecium pale to colourless		75
74	Hypothecium dark		76

- 75 Thallus gelatinous when wet, granulose. Spores >25 µm long, broadly ellipsoid. Paraphyses simple, not anastomosing. Asci cylindrical
Aphanopsis coenosa (Ach.) Coppins & P.James
- 75 Thallus not gelatinous when wet, more or less continuous. Spores <25 µm long. Paraphyses ramified, anastomosing. Asci clavate
Micarea bauschiana (Körb.) V.Wirth & Vězda
- 76 Thallus thick, verrucose. Paraphyses distinctly thickened above. Hypothecium without scattered bluish granules reacting K+ green. Spores 1-celled
Mycobilimbia berengeriana (A.Massal.) Hafellner & V.Wirth
- 76 Thallus thin, not verrucose. Paraphyses only slightly thickened above. Hypothecium with scattered bluish granules reacting K+ green. Spores 1(-4)-celled
Mycobilimbia hypnorum (Lib.) Kalb & Hafellner
- 77 Spores 2-celled 78
- 77 Spores more than 4-celled 83
- 78 Spores pigmented 79
- 78 Spores hyaline 80
- 79 Spores >15 µm long, with ornamented wall *Buellia epigaea* (Pers.) Tuck.
- 79 Spores <15 µm long, with a smooth wall
Amandinea punctata (Hoffm.) Coppins & Scheid.
- 80 Apothecial margin distinct 81
- 80 Apothecial margin indistinct 82
- 81 Paraphyses 2-3 µm thick. Spores ellipsoid, 1-(4)-celled. Hypothecium with scattered bluish granules reacting K+ green
Mycobilimbia hypnorum (Lib.) Kalb & Hafellner
- 81 Paraphyses <2 µm thick. Spores ellipsoid-cylindrical, 2-4-celled. Hypothecium without scattered bluish granules reacting K+ green
Mycobilimbia tetramera (De Not.) Hafellner & Türk
- 82 Hypothecium dark *Micarea melaenida* (Nyl.) Coppins
- 82 Hypothecium pale to colourless *Myxobilimbia microcarpa* (Th.Fr.) Hafellner
- 83 Spores more than 4 µm large 84
- 83 Spores less than 4 µm large 85
- 84 Hypothecium red-brown. Epithecium bright green
Myxobilimbia accedens (Arnold) Hafellner
- 84 Hypothecium pale to colourless. Epithecium brownish
Myxobilimbia sabuletorum (Schreb.) Hafellner
- 85 Apothecia brownish *Bacidia herbarum* (Stizenb.) Arnold
- 85 Apothecia black (sometimes bluish-pruinose) 86
- 86 Thallus whitish. Apothecia non pruinose. Epithecium bright green. Most spores < 2.5 µm broad
Bacidia bagliettoana (A.Massal. & De Not.) Jatta
- 86 Thallus greyish brown. Apothecia often bluish-pruinose. Epithecium dark olivaceous green. Most spores >2.5 µm broad *Toninia coelestina* (Anzi) Vězda

GLOSSARY

As for all languages, botanical language has deep roots in the past. Modern authors tend to adopt the same terms they learnt as students from their professors, just as the latter did when they were students. Old-inherited terminology, however, can degenerate into jargon. A term like *leprose* dates back to times when *lepra* was a common skin disease in Europe. Today, it evokes something only to people which have other things to do than appreciating a leprose thallus.

Botanical jargon largely derives from Greek and Latin (e.g. *acicular*, *anisotomic*, *apothecium*, *paraplechtenchymatous*). Coined at a time where most scholars were fluent in these languages, those terms are often mute to modern users.

Technical jargon is indispensable in any scientific discipline. We wonder, however, whether at least some of the old-inherited terms could be made more understandable in broader circles.

Most programs of automatic identification, including FRIDA, can adapt terminology to the user's needs. If a teacher has explained to child that a lichen can bear "*flying discs*", that term can appear in the keys instead of the Ostrogothic "*apothecia*".

We refrained from such an endeavour, in this book, with some exceptions (e.g. see *biatorine*, *lecideine* and *zeorine* in the glossary).

Acicular (of spores): needle-like, narrow and long, e.g. those of *Arthrorhaphis*.

Acuminate (of spores): pointed, with acute ends.

Adglutinate (of paraphyses): not easily detachable from each other, almost glued together.

Adnate (of apothecia): not restricted at the base.

Adpressed (of thallus): closely adhering to the substrate.

Alpine (of distribution): occurring above treeline in the Alps and in the highest peaks of the Central Apennines. More details in the introduction.

Amyloid (of asci, or thallus parts): reacting **I+** blue.

Anastomosing (of paraphyses): branched, the branches joining irregularly, forming a net; e.g. those of *Micarea*.

Angiocarp (of ascocarps): the *hymenium* is not exposed until the asci are mature. This term was not used in this book. See also *hemiangiocarp*.

Anisotomic (of thallus parts): dividing in unequal parts, with a division which is thicker or/and longer than the others; e.g. the branching of

Alectoria nigricans. See also *dichotomic*, *iso-*, *isotomic*, *tetractomous*, *trichotomous*.

Anti (general Greek suffix): something against something else.

Anticlinally (of hyphae): the *hyphae* are arranged perpendicularly to the surface of the *thallus*.

Anular (Latin: *annulus* = ring): ring-like, like the structure found in the apical apparatus of some *asci*.

Apical (Latin: *apex*: the top of something): located at the top. See also *tholus*.

Apo- (general Greek suffix): lying above something else.

Apothecia (singular: apothecium): the fruiting bodies of *discocarpous* Ascomycetes, *ascocarps* where the *hymenium* is fully exposed to the air, usually forming a *disc*, surrounded or not by a *margin*. Depending on the type of margin, they may be *lecanorine* or non-lecanorine. Most apothecia have a more or less rounded form, with several exceptions: some (e.g. those of some *Pertusaria*) are *perithecioid*, the disc being completely surrounded by the thalline margin, the spores being discharged by a narrow pore, others (e.g. in *Graphis*, *Opegrapha*, etc.) are elongated and ramified (*lirelliform*), etc.

Arachnoid (of thallus): a tissue of lax *hyphae*, cottony in appearance, like the web of some spiders (*Arachnida*).

Areolae (singular: areola, Latin: *area*): portions of crustose thalli divided by cracks. They may be contiguous or dispersed, rounded, angular, or elongate, flat or convex, etc.

Areolate (of thallus, or of cortex): disrupted into *areolae*. This term is often used also for the *schizidia*-like structures present on the podetia of some *Cladonias* (e.g. in *Cladonia pyxidata*).

Asci (singular: ascus): sac-like structures within which the *spores* are formed. Important taxonomic characters at supraspecific level are the layers of the ascus wall (see *bitunicate*, *unitunicate*), and the structure of the ascus tip, which facilitates the dispersal of spores (see *tholus*). These features - best observed under the microscope by applying *I* to a thin section - are rarely used in the dichotomies, being rather difficult to appreciate, but they are often mentioned in the descriptions.

Ascocarp: the fruiting body of any Ascomycete, i.e. the structure in which the fungal partner produces the *spores*. See *apothecia* and *perithecia*.

Ascoma (plural: ascomata): see *ascocarp*.

Ascospores: see *spores*.

Aspicilioid (of apothecia): *lecanorine apothecia* half-immersed in the thallus, the thalline *margin* not prominent, but containing algae in section; e.g. those of *Aspicilia calcarea*. See also *cryptolecanorine*.

Axil (of podetia): the point where two *branches* diverge. In some species of *Cladonia* the *axils* are occupied by a hole (perforated axils).

- Axis** (plural: axils) the term mostly refers to the compact, thread-like *medulla* of *Usnea*-species (central axis, or central *chord*).
- Bacilliform** (of spores and conidia, from Latin): stick-shaped, narrowly cylindrical, the ends not acute.
- Biatorine** (of apothecia): *apothecia* “lacking a true *exciple* when mature, and which are pale or more or less coloured, soft in consistency, and generally strongly convex” (from Purvis et al. 1992). In other terms, a *lecideine apothecium* with a non-black *margin*. This difficult term is not used here, being subsumed under the expression “non-*lecanorine*”.
- Biseriate** (of spores): arranged more or less in two rows inside the *asci*.
- Bitunicate** (of ascus walls): the *ascus* wall is composed of two layers (endo- and esoascus), which tend to separate at the time of dispersal of *spores*: the more rigid outer *wall* breaks, the inner wall rapidly collapses. See also: *fissitunicate*, *unitunicate*.
- Blastidia**: propagules for the asexual reproduction of the lichen symbiosis, produced by the budding of thalli in a yeast-like manner, with each new blastidium produced from the tip of the previous one; they are easily confused with *soredia*, more rarely with *isidia*; in these keys, they are mostly subsumed under “*soredia*”.
- Branches**: parts of ramified fruticose lichens with a more or less circular section.
- Bullate** (of thallus parts): bubble-like, restricted at the base. Used esp. for squamulose lichens, e.g. the squamules of some *Toninia*, e.g. *T. toepfferi*.
- C** (reagents): bleaching water solution (sodium hypochlorite) or undiluted commercial bleach. This reagent is short-lasting, it should be renovated after ca. 10-20 days (more often in summer or in heated spaces). Reactions with C are sometimes ephemeral. Attention! Pure sodium hypochlorite - due to its odour - is becoming rare in supermarkets, being substituted by other products, some of which may give odd reactions.
- Ca.** (abbreviation): more or less, almost (from the Latin *circa*).
- Canaliculate** (of thallus parts): channelled (e.g. the lobes of *Flavocetraria cucullata*).
- Capitate** (of soralia): *soredia* grouped into more or less convex knots, located at the end of *lobes* or *branches* (e.g. those of *Hypogymnia tubulosa*); the term is sometimes used also for *paraphyses* with distinctly swollen apical cells.
- Capitulum**: the spore-bearing, enlarged part of the pin-like *apothecia* of some Caliciales.
- Carbonaceous** (of parts of the ascocarps): coal-like, black, non-transparent, and friable (section!), such as the apothecial *margins* of *Opegrapha*.
- Cephalodia** (singular: cephalodium, from the Greek *Kephalon* = head, brain): lichenised structures containing *cyanobacteria*, found in thalli with a *chlorococcoid photobiont*. They may appear as warts (e.g. *Peltigera aphthosa*), or *coralloid* outgrowths (e.g. *Lobaria amplissima*)

on the upper surface of *foliose* lichens, or as small warts on the *pseudopodetia* of *fruticose* lichens such as *Stereocaulon*. In some species they are scarcely visible, being immersed in the thallus (e.g. the internal cephalodia of some *Solorina*-species).

Cerebriform (from the Latin *cerebrum*= *brain*): folded, like the human brain.

Chlorococcoid (of photobiont): one-celled green algae, excluding *Trentepohlia*: the *photobiont* layer has a bright green colour. See also *trentepohliod*.

Chord: see *axis*.

Cilia: human hair-like, stout outgrowths composed by several *hyphae*, usually arising from the edge of *foliose* thalli. (e.g. in *Parmotrema*), not to be confused with *hairs*.

Clavate (of spores, or of asci): club-like, with one end thicker than the other.

Coccoid (of photobiont cells): more or less spherical.

Concolourous: of the same colour.

Concrescent (e.g. of apothecia, of lobes, etc.): becoming jointed.

Confluent: becoming merged (e.g. of soralia).

Conglutinate (of apothecial parts, esp. paraphyses): not easily detachable, almost glued together.

Conidia (singular: conidium): fragments of fungal hyphae produced in great number within *pycnidia*. They may serve for *vegetative* reproduction, but their most probable role is that of acting as male cells for the sexual reproduction of the *mycobiont* of *ascomyces*. Their dubious role is the reason of a confusing terminology: they are often called *pyncoconidia*, *pyncospores*, *spermatia*, *spermogonia*. They may be one- or more-celled, and of very different forms and sizes. They are important in systematics (see Vobis 1980), but they rarely appear in the dichotomies of these keys, because they are not always easy to observe. In some groups (e.g. *Micarea*) there are different types of conidia, whose different functions still await elucidation: see *macroconidia*, *microconidia*.

Conidiophorous (of cells): fungal cells, usually located inside *pycnidia*, which in various ways give rise to *conidia*.

Consoredia: a term used only for some species of *Lepraria* and *Leproloma*, which have a thallus consisting of a mass of *soredia*-like granules. It refers to the case in which the granules are fused into larger clusters.

Constricted (of apothecia): becoming narrow towards the attachment point, e.g. the apothecia of *Lecanora epibryon* as opposed to those of *Micarea adnata*.

Constricted (of spores): the width of the *spore* is shorter at the level of the *septum* than between septa.

Coralloid (of isidia, or thallus parts): coral-like, densely ramified, sometimes almost shrubby, e.g. the *isidia* of *Lasallia pustulata*.

- Cortex:** the outer layer of *thalli*, when it consists of densely compacted and ordinally arranged *hyphae*. Several *foliose* lichens may have both an upper and a lower cortex. See also *paraplectenchymatous*, *prosoplectenchymatous*.
- Corticate** (of thallus parts): provided with a *cortex*.
- Crenate-crenulate** (of thallus and thallus parts): with rounded marginal teeth.
- Crustose** (of thallus): crust-like, without lower *cortex* and *rhizinae*, attached to the substratum by a dense hyphal net, hence gas exchanges only possible through the upper surface. Crustose lichens can be only collected together with their substratum.
- Cryptolecanorine** (of apothecia): *lecanorine apothecia* more or less immersed in the thallus, the thalline *margin* not prominent (see also *aspicilioid*).
- Crystals** (of anatomical sections): usually of oxalates. The presence and size of crystals in anatomical sections (esp. of *apothecia*) is important for identification in some groups (e.g. in some *Lecanora*). They are best observed in thin sections under polarised light. The *pruina* as well is mostly composed of small to coarse crystals.
- Cups** (in *Cladonia*): cup-like endings of *podetia*. They generally bear *apothecia* and *pycnidia* at the margin; sometimes they are *proliferating*, either from the margin or from the centre, giving rise to several stocks of superimposed cups (e.g. in *Cladonia cervicornis* subsp. *verticillata*).
- Cyanobacterial** (of photobiont): the *photobiont* is a Cyanobacterium. In section, it has a characteristic blue-green colour. Cyanobacteria belong to two main different groups: filamentous (thread-like, e.g. *Nostoc*, *Scytonema*) and coccaceous (several cells joined into a spherical structure, e.g. *Gloeocapsa*). *Nostoc*, however, can occur in the typical form, with a thread-like, *moniliform* series of globular cells (e.g. in *Collema*), or in very short-chained forms, sometimes reduced to a series of a few cells only (e.g. in some small *Leptogium*-species).
- Cyphellae** (singular: cyphella): like *pseudocyphellae*, these are structures for facilitating gas-exchange, but have a more complex structure, with a layer of globular, thin-walled cells delimiting a gaping hole. The only Italian lichens with cyphellae (more or less round openings in the lower surface) belong to *Sticta*, which is not included in these keys.
- Diaspore:** a rather confusing term of the lichenological jargon, designating anything which can reproduce the lichen, including things like *spores* (sexual reproduction) and *isidia* (vegetative reproduction), both protected by the large umbrella of the term “*spores*”. This term, in our opinion, must be abandoned. See also *propagule*.
- Dichotomous** (of thallus parts): branching into equal *branches*, as in the letter Y (see also: *anisotomic*, *isotomic tetractomous*, *trichotomous*).

- Diffuse** (of soralia): evenly spread through the thallus (e.g. those of *Phlyctis argena*).
- Disc** (of apothecia): the exposed upper surface of the *hymenium* in lichens with *apothecia*.
- Discocarpous** (of mycobionts): lichenised fungi with *apothecia*.
- Dorsiventral** (of thallus): with clearly different upper and lower surfaces (e.g. the thallus of *Evernia prunastri*).
- E-** (general suffix): without (e.g. *epruinose*, *ecorticate*, etc.).
- Ecorticate** (of thallus): without cortex.
- Effigurate** (of crustose thalli): with radiating marginal lobes, e.g. *Squamarina lentigera*; see also *placodioid*.
- E.g.** (abbreviation): for example (from the Latin *exempli gratia*).
- Endo-** (general Greek suffix): lying inside something else (e.g. *endolithic*, *endoascus*).
- Endoascus** (of asci): see *bitunicate*.
- Endolithic** (of thallus): completely embedded in the rock, incl. the *photobiont* layer (e.g. in most species of *Bagliettoa*, or in *Clauzadea immersa*). There are at least two types of endolithic lichens: some are typical of dry areas (deserts and semi-deserts, dry valleys in Antarctica, etc.), mostly on siliceous rocks, others - the most widespread in Italy - occur on compact limestone. These two types differ considerably in morphology and ecology (Tretiach 1995). See also *endosubstratic*, *hemiendosubtratic*.
- Endosubstratic** (of thallus): completely embedded in the substratum, incl. the *photobiont layer*, e.g. the thallus of *Bagliettoa parmigera*). See also *endolithic*, *hemiendosubtratic*.
- Ephemeral** (of thalli): of short duration.
- Epi-** (general Greek suffix): lying above something else (e.g. *epithecium*, *epiphytic*).
- Epicortex** (of thallus): a term used only for *Parmelia* s.latiss., which designates a more or less amorphous layer lying above the upper *cortex*. Never used in this book.
- Epigaic** (of lichens): growing on the ground; see Introduction.
- Epihymenium** (of apothecia): see *epithecium*.
- Epilithic** (of thallus): growing above a rock surface (see also: *endolithic*).
- Epinecral** (of thallus): a superficial layer consisting of the residues of dead fungal and algal cells covering the upper surface, with an amorphous appearance in microscopic sections, commonly present in several crustose lichens, both with and without a true *cortex*.
- Epiphytic** (of thallus): growing on the bark of higher plants (sometimes used also for lichens growing on the leaflets of bryophytes).
- Epipsamma** (of apothecia): a term used for the *epihymenium*, when this is granular, or rich in *crystals*. Never used in this book.

- Epispore:** the outer part of the *spore* wall, when this is thick and often *ornamented* (e.g. with ridges, warts, etc.). See also **perispore**.
- Epithecium** (of apothecia): the uppermost part of the *hymenium*, formed by the usually pigmented upper cells of *paraphyses*: it often has a distinct colour, sometimes characteristic reactions useful for identification. It must be observed under thin microscopic sections.
- Epruinose** (of thallus and apothecia): without *pruina*.
- Eso-** (general Greek suffix): lying outside something else (e.g. *esoascus*).
- Esoascus** (of asci): see *bitunicate*.
- Excipulum** (sometimes deformed into “exciple”, of ascocarps): the tissue(s) forming the *margin* of an *apothecium*, or the walls of a *perithecium*. For apothecia, lichenologists often distinguish between an “*excipulum proprium*” (proper, or true margin, formed only by the fungus) and an “*excipulum thallinum*” (thalline margin, containing also the *photobiont*). In this book the term “excipulum” may appear in the descriptions - in which case it is always used for anatomical features of the *proper margin*. It is not used in the dichotomies, being subsumed under *margin* for all lichens with non-*lecanorine* apothecia. See also *pyrenium*.
- Farinose** (of soredia, pruina): small and powdery, looking like meal. See also *granulose*.
- Fasciculate** (of rhizines, from the Latin *fascium* = bundle, e.g. Fascist, Fascism): with several, more or less parallel branches originating from the same point.. See also *squarrose*.
- Fibrillae** (singular: fibrilla): in *Usnea* these are short, simple branches perpendicular to the main ones; in foliose lichens this term is used for pale *cilia*-like structures found on the margin of the lobes (e.g. in *Physcia adscendens*, *Anaptychia ciliaris*, etc.).
- Filamentous** (of thallus, or of cyanobacterial photobionts): thread-like (e.g. the thalli of *Alectoria*, *Bryoria*, *Ramalina thrausta*, *Usnea*, and those of *Nostoc* among *photobionts*).
- Fissitunicate** (of asci): *bitunicate*.
- Foliose** (of thallus, from the Latin *folia* = leaf): leaf-like, flattened, with an upper and lower surface, gas exchange occurring from both faces, usually with *rhizinae*. Some lichens (e.g. *Anaptychia ciliaris* and *Pseudevernia furfuracea*) have a basically foliose, flattened thallus, which, however, tends to develop into three dimensions, and is not attached to the substratum by rhizinae; in these keys, they are treated both among the foliose and the fruticose lichens.
- Foveolate** (of thallus, from the Latin *fovea* = depression): with small, shallow depressions.
- Fruticose** (of thallus): developing in three dimensions, often shrub-like, and round to inflated in section, gas exchange occurring throughout the surface. See also *foliose*, and *squamulose*.

- Fusiform** (of spores): spindle-like, broader in the centre and narrowing towards the ends.
- Gelatinous** (of thallus - cyanobacterial lichens): becoming jellyish when wet (e.g. *Collema*). The cyanobacterial cells are surrounded by coats which tend to absorb liquid water, becoming jelly-like when wet. This character is easy to appreciate in some genera (e.g. *Collema*) in which the photobiont is predominant, less easy in other genera, like *Leptogium*. See also *homeomerous*, *heteromerous*.
- Glabrous**: without *hairs* or *tomentum*.
- Glaucous** (of colours): bluish-greenish grey.
- Globose**: spherical.
- Gloeocapsa**: a genus of *cyanobacteria* characterised, together with other similar genera, by more or less spherical masses containing clusters of cells with a distinct, multi-layered, sometimes pigmented gelatinous coat. Most frequent in the Lichinaceae.
- Goniocyst**: more or less spherical groups of green algal cells surrounded by short *hyphae*, but without a true *cortex* (section!), forming a minutely-*granulose* thallus (e.g. in *Micarea*).
- Granules** (of thallus parts): small, coarse, more or less spherical, mostly *corticate* elements making up most of the thallus.
- Granulose** (of soredia): coarse, resembling *granules*, but without *cortex*. See also *farinose*.
- Hairs**: short, erect, transparent, *hair*-like structures, generally present on the upper *cortex*, and formed by a single *hypha* (e.g. in *Agonimia opuntiella*, *Phaeophyscia hirsuta*). See also *cilia*, *fibrillae*, and *tomentum*.
- Halonate** (of spores): with a thick, transparent, gelatinous outer coat. See also *perispore*.
- Hamathecium** (of ascocarps): a rather difficult, “neutral” term, which was never used in this book, referring to all types of sterile *hyphae* (*paraphyses*, *paraphysoids*, *periphyses*, etc.) which occur in the *hymenium*.
- Haustorium** (plural: haustoria): *hyphae* of the *mycobiont* which apparently penetrate inside the cells of the *photobiont*.
- Hemi-** (general Greek suffix): almost, partially.
- Hemiangiocarp** (of ascocarps): the *hymenium* is initially protected by a covering layer, which disrupts when the *asci* are ripe. Not used in this book. See also *angiocarp*.
- Hemiendolithic** (of thallus): see *hemiendosubtratic*.
- Hemiendosubstratic** (of thallus): embedded in the substratum, except the *photobiont* layer (e.g. *Caloplaca ochracea* as opposed to *Bagliettoa*-species). This character, being difficult to appreciate, was not used in these keys.
- Hetero-** (general Greek suffix): looking different from something else.

- Heterocyst** (of photobionts): a cell of filamentous *cyanobacteria* which differs from the others in the chain by its paler cytoplasm and its thicker wall, devoted to nitrogen fixation. Never used in these keys.
- Heteromerous** (of thallus): having the *mycobiont* and the *photobiont* separated into well-distinct layers. See also *homeomerous*, *gelatinous when wet*.
- Homeo-** (general Greek suffix): looking similar to something else.
- Homeomerous** (of thallus): having the *mycobiont* and the *photobiont* evenly intermixed throughout the *thallus* (e.g. in *Collema*). See also *gelatinous when wet*, *heteromerous*.
- Hyaline** (of spores): transparent, colourless.
- Hymenial algae** (of lichens with perithecia): green algal cells contained inside the *hymenium* of some groups of *pyrenocarpous* lichens (e.g. *Endocarpon*, *Staurothele*). They are often visible under a binocular, the sections of *perithecia* having a bright green core. These algae are often different in shape and size from those of the thallus.
- Hymenium** (of ascocarps, in section): the layer where *asci* arise and *spores* are produced. Its thickness, colour, and the reactions, esp., with *I*, may be important in some groups. The thickness should be measured starting from the roots of the *asci*, including the *epihymenium*. See also *thecium*.
- Hypha** (plural: hyphae): one of the filaments constituting the fungal *mycelium*.
- Hypo-** (general Greek suffix): lying below something else (e.g. *hypothallus*, *hypothecium*). See also *sub-*.
- Hypothallus**: marginal part of the *thallus* of *foliose* or *squamulose* lichens, composed only by the fungus, normally with a different colour and texture. In these keys, this term is often merged with *prothallus*.
- Hypothecium** (of apothecia): in these keys this term refers indiscriminately for all tissues located below the *hymenium*. Its thickness, reactions and esp. pigmentation may be important for identification. See also *subhymenium*.
- I** (reactions): the typical *Lugol's* solution, which can be purchased by specialised furnishers: a solution with 2 g of Iodine stock solution and 20 g distilled water. To prepare the stock solution: (3% IKI) dissolve 1 g iodine crystals and 2 g potassium iodide in 30 ml distilled water.
- I.e.** (abbreviation): equal to something else (from the Latin *id est*).
- Imbricate** (of thallus parts): overlapping, shingle-like, as the tiles of a roof, e.g. the squamules of *Mycobilimbia lurida*.
- Immersed** (of ascocarps and pycnidia): embedded in the substratum (e.g. the *apothecia* of *Clauzadea immersa*), or in the thallus (e.g. the *perithecia* of *Catapyrenium cinereum*).
- Inflated** (of thallus parts, from the Latin *inflatus*): swollen.
- Inspersed** (of the hymenium, in sections): full of oil droplets which render it somehow milky, not transparent in a microscopic section.

- Involucellum** (of perithecia): a usually black, lid-like structure originating from the upper part of the *perithecium*, protecting the *ostiole*. It can be best observed under a binocular, by vertically sectioning the perithecium. It is mostly limited to the upper part of the perithecium, but sometimes it extends until its base. Its presence may be important for identification (e.g. in *Catapyrenium s. lat.*, *Verrucaria*).
- Isidia** (singular: isidium): structures for the vegetative reproduction of the lichen, which derive from swellings of the upper *cortex*, and contain *photobionts*. True isidia are always *corticate*, as opposed to *soredia*. They may have different forms: erect and more or less round in section (simple or ramified-*coralloid*), or flattened (*spathulate*, *peltate*), etc. See also *blastidia*, *phyllidia*, and *schizidia*.
- Isidiate** (of thalli): with *isidia*.
- Iso-** (general Greek suffix): equal, e.g. *isodiametric*, *isotomic*.
- Isodiametric** (of thallus parts): having more or less the same diameter, mostly rounded in shape.
- Isotomic** (of thallus parts): dividing in regular dichotomies into equal branches. See also *anisotomic*, *dichotomic*, *tetractomous*, *trichotomous*.
- K** (reactions): a ca. 10% water solution of potassium hydroxide (KOH). It can be substituted with household lye (sodium hydroxide, NaOH).
- KC** (reactions): the test is performed by wetting the tested area first with **K**, then with **C**. These reactions are often ephemeral. In most cases, the KC test enhances the results obtained with **C** only.
- Labriform** (of soralia, from the Latin *labrum* = lip): *soredia* originating from the lower face of *lobes* which tend to bent upwards, the *soralia* assuming a lip-like form (e.g. *Hypogymnia physodes*, *Phaeophyscia chloantha*).
- Laciniae** (singular: lacinia, from Latin): flattened parts of ramified *fruticose* lichens (e.g. *Ramalina fraxinea*). Sometimes called *lobes*.
- Laminal** (from Latin: *lamina*, something thin and flattened): located on the upper surface of the thallus, e.g. the *soralia* of *Parmelia sulcata*.
- Lax** (of medulla): loose, not compact.
- Lecanorine** (of apothecia): with a thalline *margin* containing *photobionts*. In most cases, the colour of the margin is very different from that of the *disc*. In some genera, however the colour is similar (e.g. in several species of *Caloplaca*), and one has to look for *photobionts* in microscopic sections. See also *aspicilioid*, *biatorine*, *lecidine*, *zeorine*.
- Lecideine** (of apothecia): having a *margin* exclusively consisting of dark-coloured fungal *hyphae*. In these keys, this term is subsumed under the expression *non-lecanorine*. See also *biatorine*, *excipulum*, *lecanorine*, *zeorine*.
- Leprose** (of thallus, from Latin *Lepra*: a skin disease): a powdery mass of hydrophobic, *soredia*-like granules. Some experience is needed to

distinguish truly leprose thalli from *crustose* thalli with abundant, diffuse *soredia*.

Lichenised (of mycobionts): always growing in symbiosis with a *photobiont*. In certain groups, e.g. *Arthonia*, some species are clearly lichenised, others are clearly non-lichenised (no true lichens), still others are of uncertain attribution.

Lignicolous: growing on wood.

Linear (of pseudocyphellae, from Latin: *linea*): when well-developed, narrow and elongated.

Lirelliform (of apothecia): a *non-lecanorine apothecium* with a long, narrow, elongated form (e.g. of *Graphis*, *Opegrapha*).

Lobes (of thalli): flattened, elongated, lichenised structures developed at the margin of the *thalli* (e.g. in *Squamarina lentigera*), or around the *apothecia* (e.g. in *Physconia venusta*). Their width should be measured in the central part. See also *effigurate*, *placodiomorph*.

Lobulate: with small *lobes*.

Lugol (of reactions): see *I*.

Macroconidia (singular: macroconidium): the larger *conidium* of a species that has more than one type of conidium (e.g. in some species of *Micarea*, or *Porina*).

Maculiform (of soralia, from the Latin *macula*: spot, patch): *laminal soralia* grouped into more or less round patches. See also *punctiform*.

Maezedium: a mass of *spores* liberated continuously by the *asci* of *Caliciales*. It appears as a powdery mass covering the *apothecium*. See also *capitulum*.

Margin (of apothecia, Latin *margo*: margin): *apothecia* have two main types of margin: a) a *proper* margin consisting of fungal *hyphae* only; usually, the proper margin is similar in colour to the disc, different from the thallus. b) a *thalline* margin, which includes *photobionts*; usually similar in colour to the thallus, different from the disc (with several exceptions., e.g. in *Caloplaca*). In these keys, unless otherwise specified, the term “margin” always refers to the thalline margin for *lecanorine* apothecia, to the proper margin for *non-lecanorine* apothecia.

Marginal (of soralia): *soredia* limited to the marginal parts of thallus parts (usually *lobes* of *foliose* lichens).

Mediterranean (of distribution): occurring in the belt dominated by evergreen broad-leaved trees, mainly *Quercus ilex*.

Medulla: the “central” part of the *thallus*, located under the *photobiont* layer. It is composed exclusively by loosely arranged fungal *hyphae*, the spaces between them facilitating gas exchange for the photosynthetic partner. It can be compact, loose or almost hollow, *pigmented* or not, and it often contains lichens substances which are absent in the *cortex* (hence, it can have peculiar reactions, or a characteristic colour under a *UV*-lamp).

Micareoid (of photobionts): green algae with a diameter of 4-7 mm, thin-walled, often occurring in pairs (e.g. those of *Micareia*).

Micro- (general Greek suffix): very small.

Microconidia (singular: microconidium): the smaller *conidium* of a species that has more than one type of conidium (e.g. in some species of *Micareia*).

Moniliform (of hyphae): arranged in a thread consisting in a series of globose cells, looking like a rosary, or the chains of *Nostoc*.

Montane (of distribution): occurring in the belt dominated by beech (*Fagus sylvatica*). More details in the introduction.

Morphic (-*morphous*, a Greek suffix): the form of something.

Muriform (of spores): looking like a brick-wall, many-celled, with many longitudinal *septa* and crosswalls. See also *submuriform*.

Mycelium: the tissue composed by the fungal partner of the lichen, consisting of *hyphae*.

Myco- (general Greek suffix): related to a fungus (Latin: *fungus*).

Mycobiont: the fungal symbiotic partner in a lichen, to which the scientific name of the lichen refers.

N (reactions): concentrated nitric acid (HNO₃). Warning: this is a strong acid, and can easily damage microscopic gears.

Non-lecanorine (of apothecia): without a thalline *margin*. See also *apothecium*, *biatorine*, *lecanorine*, *margin*, *zeorine*.

Nostoc: a genus of *cyanobacteria* with more or less long chains of rounded cells. In some genera (e.g. some *Leptogium* species) the chains are very short, consisting of a few cells only.

Ocular chamber (of asci): the ascus is *bitunicate*, the two layers separate at the tip leaving an empty space (see *tholus*), this space is concave with respect to the inner part of the *ascus*.

Orbicular (of thallus): more or less circular in shape.

Ornamented (of spores): spore *wall* not smooth. Ornamentation is important in some groups, e.g. in *Buellia*.

Oro- (Greek suffix): having to do with mountains.

Oromediterranean (of distribution): occurring above treeline in the highest mountains of the Mediterranean, excluding the Alps and the Central Apennines. More details in the Introduction.

Ostiole (from the Latin *ostium*: door): pore-like opening situated at the top of a *perithecium* or of *pycnidia*, through which the *propagules* escape.

Oval (of spores): egg-like, the convex part lying more or less in the centre, symmetrical with respect to the two axes.

Ovoid (of spores): see *oval*.

P (reagents): A saturated solution of para-phenylenediamine in ethylic alcohol (of short duration!). It is also possible to prepare **P** in water solution: e.g. 1 g of para-phenylenediamine, 10 g of Natrium sulphate in 100 ml water. This substance, although still utilised e.g. for hair dyeing,

might be carcinogenic. It should be used with great care (especially avoid to breath it when using the microscope!). Teachers should not endorse its use by students, unless if coupled with a lesson on the use of potentially dangerous substances, and with the corresponding measures.

Para- (general Greek suffix): located near, beside something else.

Paraphyses (singular: paraphysis): sterile *hyphae* in the *hymenium*, forming a palisade within which the *asci* are interspersed. They may be simple or ramified, in some case they are *anastomosing*; the upper cells, sometimes inflated and most often pigmented, form the *epihymenium*. The true paraphyses always start from the base of the *hymenium*. See also *paraphysoids* and *periphyses*.

Paraphysoids: structures resembling paraphyses, but originating from the hymenial tissue between the *asci* as pre-ascal elements stretching with the growth of the *hymenium*. They are usually thin, abundantly branched and *anastomosing*, e.g. in *Arthonia*. In this book, this term is sometimes used in the descriptions, being substituted by the term *paraphyses* in the dichotomies.

Paraplectenchymatous (of sections): a fungal tissue (section!) consisting of more or less *isodiametric*, rounded to angular cells. See also: *plectenchyma*, *prosoplectenchymatous*.

Parasitic: this term is used here in a very broad, often incorrect sense: it refers both to truly parasitic fungi growing on lichens, and to the so-called “*parasymbiotic*” lichens, i.e. those which regularly start their life-cycle on other lichens, without being true parasites; in fact, having a photobiont layer, they are autotrophic. Their “parasitism” probably consisting in “stealing” photobionts from the host lichen. More research is necessary to clarify the complex relations between “parasymbiotic” lichens and their hosts.

Parasymbiotic: see *parasitic*.

Parathecium (of apothecia): proper *margin*, formed only by fungal *hyphae*.
Not used in this book, because not necessary.

Peltate: plate-like, with a single attachment point from the centre of the lower surface (e.g. the *isidia* of *Peltigera lepidophora*).

Peri - (Greek suffix): lying around something else.

Periclinal (of hyphae): parallel to something else (e.g. the apothecial margin).

Periphyses (singular: periphysis): *hyphae* resembling *paraphyses*, produced near the *ostioles* of *perithecia*. They are mostly short and thin, hair-like.

Periphysoids: this term is used by some authors for *paraphyses*-like structures of *pyrenocarpous* lichens, developing from the upper part of the *pyrenium*, near the *ostiole*, and growing downwards. In these keys the term was not used consistently.

Perispore (of spores): a colourless gelatinous layer around a *spore*, visible in microscopic sections. See also *episporium*, *halonate*.

- Perithecia** (singular: perithecium): globose to flask-like *ascomata* where the *hymenium* is enclosed within a “box” opening through a narrow apical pore at the summit, called *ostiole*. See also: *involucrellum*, *pyrenocarpous*.
- Perithecioid** (of apothecia): opening through a pore, hence *disc* not evident and the whole structure resembling a *perithecium* (e.g. *Pertusaria pertusa*). In a few cases, it might be difficult to distinguish between a true perithecium and a perithecioid apothecium (e.g. in *Belonia russula*).
- Photo** - (Greek suffix): related to light.
- Photobiont** (from the Greek *photos* = light and *bios* = life): the photosynthetic partner of a lichen. In our keys three main types of photobionts are used for identification: *cyanobacterial*, *chlorococcoid*, and *trentepohlioid*.
- Phyllos** (Greek suffix): similar to a leaf.
- Phyllidia** (singular: phyllidium, from the Greek *phyllos* = leaf): flattened structures resembling small lobes, formed by abstriction of a leaf-like part of the thallus, and serving for the vegetative reproduction of the lichen; they are sometimes difficult to distinguish from flattened *isidia*; this term is used very seldom in these keys.
- Phyllocladia** (singular: phyllocladium, from the Greek *cladon* = branch): minute, granular, verrucose to coralloid, peltate to digitate parts of the thallus of *Stereocaulon*, bearing the *photobiont*.
- Pigmented** (mostly of spores): coloured, not transparent in section (e.g. the *spores* of *Buellia* and *Rinodina*).
- Placodioid** (of crustose thalli): *orbicular*, with radiating marginal *lobes*. A difficult, not indispensable term of the lichenological jargon. See also *effigurate*.
- Placodiomorph** (of crustose thalli): see *placodioid*.
- Plectenchyma** (of thallus sections): a general term for all false tissues formed by the *mycobiont* only. See also *paraplectenchymatous*, *prosoplectenchymatous*.
- Pluricellular** (of spores): many-celled.
- Podetia** (singular: podetium): lichenised, fruticose structures of *Cladonia* and a few related genera, ontogenetically developing from a vertical extension of the lower apothecial tissues. Most of the *Cladonia* have two types of thallus: a *primary*, crustose to squamulose thallus, and the "podetia". A beginner might wonder whether the thalli of e.g. *Dactylina ramulosa* or *Thamnolia vermicularis* are "podetia" or not. As far as possible, we have tried to use this term only within *Cladonia*. See also *primary*, *pseudopodetia*.
- Polar-diblastic** (of spores): two-celled, the cells being connected by a narrow canal (most *Teloschistaceae*), whose length may be important for identification.
- Poly** - (general Greek suffix):

Polymorphic: of different forms.

Polysporous (of asci): with many (more than 8) spores.

Primary (of thallus parts): some fruticose lichens (especially *Cladonia*) have two types of *thallus*: the primary one, *crustose* or *squamulose*, gives origin to *fruticose* structures (*podetia* and *pseudopodetia*). In this book the term “primary squamules” exclusively refers to those of *Cladonia*, while the term “primary thallus” also refers to other genera in which *podetia* or *pseudopodetia* originate from a crust-like thallus (e.g. *Baeomyces*, *Stereocaulon*). The term “primary” has to do with the ontogeny of thallus parts, non-primary structures (like *podetia*) developing from the generative tissue of the *apothecia*, a character which is of no use for identification.

Proliferating (of *podetia*): formed in the centre (e.g. in *Cladonia cervicornis* subsp. *verticillata*) or along the margins (e.g. sometimes in *Cladonia pyxidata*) of *cups*, giving rise to one or several stocks of *podetia*.

Propagule: any structure serving to reproduce the lichen. Mostly used for those related to *vegetative* reproduction (*soredia*, *isidia*, *thalloconidia*, etc.). See also *diaspore*.

Proper (of apothecial margin): see *margin*.

Prosoplectenchymatous (of thallus sections): fungal tissue consisting of coalesced, more or less elongated hyphal cells; see also *paraplectenchymatous*.

Prothallus: marginal part of the *thallus* of crustose lichens, composed only by the fungus, normally with a different colour and texture. In some cases (e.g. *Placynthium nigrum*) it is rather thick and felt-like, in other cases (e.g. *Rhizocarpon* species growing on quartz) it appears in the form of thin, branched bundles of *hyphae* exploring the substratum. See also *hypothallus*.

Pruina: powdery, frost-like deposits of *crystals* (often calcium oxalates), present on the *cortex*, or on the *ascocarps*; they may be very small and powdery, or aggregated into larger clumps; they are usually white, rarely of other colours (e.g. yellow in some *Caliciales*).

Pruinose: covered by *pruina*.

Pseudo - (general Latin suffix): resembling something without being it (e.g. *pseudopodetia*).

Pseudocyphellae (singular: pseudocyphella): small interruptions of the *cortex* where the *medulla* is exposed to facilitate gas exchange. They may be linear-elongate (e.g. in *Parmelia sulcata*), reticulate (e.g. in *Parmotrema reticulatum*), punctiform (e.g. in *Punctelia subrudecta*). This character is important, esp. for foliose lichens, but is often difficult to appreciate for beginners (cracks in the cortex are often mistaken for pseudocyphellae).

Pseudopodetia (singular: pseudopodetium): in the dictionary of Fungi by Hawksworth et al. (1995) this term is defined as follows “a lichenised,

podetium-like structure of vegetative origin, ascogonia arising on this not on the pre-formed granular or squamulose thallus initials". The difference between podetia and pseudopodetia has to do with their ontogeny (see *primary*), and lies outside the scope of identification keys. In the dichotomies, pseudopodetia are mostly subsumed under *podetia*.

Pubescent (of thallus parts): covered by thin, short *hairs*.

Pustula (plural: *pustulae*): bubble-like swellings present on the thalli of some species (e.g. *Collema nigrescens*, *Lasallia*).

Pustulate (of thallus): covered by *pustulae*.

Pycnidia (singular: pycnidium): flask-like structures, resembling *perithecia*, in which *conidia* are produced. They are mostly, but not always, dark-coloured, immersed in the thallus, appearing as small dots. Sometimes, however, they become prominent (e.g. in some *Micarea* species), and may have very different colours (from white to yellow-orange).

Pycnidiospores: see *conidia*. This term was never used in these keys.

Pyrenium (of perithecia): the *wall* of *perithecia*. A term which was never used in these keys. See also *excipulum*.

Pyrenocarpous (of mycobionts): lichenised fungi with *perithecia*.

Pyrenolichen: a lichen with *perithecia*.

Pyriform (of spores, perithecia, from the Latin *Pyrus*: the pear tree and its fruits): pear-shaped.

Reniform (of spores): kidney-like, curved.

Reticulate: net-like and interconnected (e.g. like the *pseudocyphellae* of *Parmotrema reticulatum*).

Revolute (of thallus parts): bent downward.

Rhiz - (general suffix, from Greek): a root, or something anchoring somewhat else into the ground.

Rhizines: bundles of hyphae mostly originating from the lower *cortex*, which anchor *foliose* or *squamulose* lichens to the substratum. Their shape and length may be important in some genera (e.g. *Peltigera*). See also *rhizohyphae*.

Rhizinomorphs: *rhizine*-like structures, usually found on the lower surface of *umbilicate* thalli belonging to *Umbilicaria* and *Dermatocarpon*, which do not function as attachment organs.

Rhizohyphae: individual hyphae, pigmented or colourless, which anchor the squamules of some lichens (e.g. *Catapyrenium* s.lat.) to the substratum. They should not be confused with *rhizines*, which originate from a lower *cortex*, and are stouter, being composed of thick bundles of *hyphae*.

Rimose (of thallus): irregularly and minutely cracked, without distinct *areolae*. A rather odd term, seldom used in these keys.

Rosette-shaped (of thallus): rounded in shape, symmetrical, mostly with radiating marginal *lobes* (e.g. *Squamarina lentigera*).

S. lat. (of taxa): in the broad sense (from the Latin *sensu lato*).

S. str. (of taxa): in the strict sense (from the Latin *sensu stricto*).

Saddle-shaped (of apothecia): used only for some *Peltigera*-species, those whose *apothecia* are elongated and curved, like the saddle of a horse (e.g. *P. polydactyla*), as opposed to those with flattened, horizontal apothecia (e.g. *P. horizontalis*).

Scabrose (of thallus surface): having a minutely roughened surface, generally caused by an accumulation of dead cortical material (e.g. *Peltigera scabrosa*).

Schizo (Greek suffix): abruptly separating from something else.

Schizidia (singular: schizidium): structures for the vegetative reproduction of the lichen, deriving from the scale-like flaking of the upper *cortex* into flattened to convex *areolae* which are detached from the thallus. They have the same function as *isidia* and *phylidia*, but they are *corticate* only above (e.g. *Cladonia pyxidata*, *Fulgensia subbracteata*).

Scytonema (of photobionts): a genus of filamentous *cyanobacteria* with “false” branching, by breaking through its gelatinous sheath.

Secondary (of thallus): see *primary*.

Semi- (suffix): half, almost.

Semi-immersed (of apothecia): half immersed in the thallus.

Septa (of spores, singular: septum): cross-walls separating the individual cells of more than 1-celled *spores*; their thickness is an important character in some groups (e.g. in *Caloplaca*).

Sessile (of apothecia): not immersed, sitting on the surface, but without a stalk of any kind. See also *stipitate*.

Soralia (singular: soralium): well-delimited parts of thallus where *soredia* are produced breaking the upper *cortex*. They may be of different forms: *punctiform*, *maculiform*, *labriform*, *linear*, *capitate*, *helmet-shaped*, etc.

Soredia (singular: soredium): bundles of hyphae entwining a few *photobiont* cells, which serve to the vegetative reproduction of the lichen. They mostly originate from the *medulla*, and appear as powdery or granular masses. See also *blastidia*, *soralia*.

Spathulate (of thallus parts, from the Latin *spatula*): flattened, in the form of a spatula, or of a spoon.

Spermatia: see *conidia*.

Spermogonia (singular: spermogonium): see *conidia*.

Spores: this term is the origin of much confusion in Mycology; in these keys it is exclusively used for the sexual *propagules* of the *mycobionts*, which, produced inside the *asci*. Spore characters (size, shape, number of cells, pigmentation, etc.) are important for identification.

Squamulose (of thallus): composed by small, scale-like lobes lifting from the surface. Among the traditionally recognised growth-forms, this is the most ambiguous. Typically squamulose is the *primary* thallus of most *Cladonia*-species, which consists of small, leaf-like units attached to the substratum only laterally, without *rhizines*.. However, the term *squamulose* is often used also for small-fruticose thalli (e.g. *Toninia*

opuntioides). In our opinion, squamulose thalli should have both an upper and lower surface for gas exchange, but should be attached to the substratum only laterally or centrally. In this book, we still stick to the old-fashioned definition of the term.

Squarrose (of rhizinae): densely ramified, brush-like, with short, stiff perpendicular branches, having the appearance of a bottlebrush (e.g. in *Peltigera canina*).

Stigonema (of photobionts): a genus of filamentous *cyanobacteria* having “true branching”, resulting from perpendicular divisions of cells within the filament, found only in few cyanobacterial lichens (e.g. in *Ephebe*).

Stipitate (of apothecia): brought on a peduncle (e.g. the apothecia of *Baeomyces*).

Sub- (general Latin suffix): partially, incompletely, approaching (e.g. *submuriform*), or “lying under something else” (e.g. *subhymenium*).

Subalpine (of distribution): occurring in the belt dominated by *Larix*, *Pinus cembra* and *Rhododendron*, near treeline in the Alps. More details in the introduction.

Subhymenium (of apothecia): in the strict sense, this is the part of the *apothecium* (visible in microscopic sections) which corresponds to the generative tissue below the *hymenium*. In these keys, it is most often used as a synonym of *hypothecium*.

Submediterranean (of distribution): occurring in the belt dominated by deciduous broad-leaved trees, mainly *Quercus*, *Carpinus* and *Ostrya*, excluding the beech belt. See also *montane*. More details in the introduction.

Submuriform (of spores): weakly *muriform*, with only a few longitudinal *septa*.

Sulcate (of thallus parts): furrowed, e.g. the surface of *Parmelia sulcata*.

Taxon (plural: taxa, a Greek term): any unit in a classification scheme (family, genus, species, subspecies, etc.).

Terete (of thallus, or thallus parts): round in cross-section (e.g. the *branches* of many *Usnea*-species).

Terricolous (of lichens): see Introduction.

Tetrachotomous (of thallus parts, from the Greek tetra = 4): 4-branched (e.g. in some species of *Cladonia*). (see also: *anisotomic*, *dichotomic*, *isotomic*, *trichotomous*).

Thalline (of apothecial margins): the *margin* of *lecanorine apothecia*, produced by the thallus and hence containing the *photobionts*. Usually, the thalline margin has the same colour of the thallus, and differs in colour from the *disc* (e.g. in *Lecanora chlorotera*). Sometimes, however, especially when the thallus is similar in colour to the disc (e.g. in some species of *Candelariella* and *Caloplaca*), a section is needed to reveal the photobiont in the margin.

- Thalloconidia** (singular: thalloconidium): small *propagules* serving to the vegetative reproduction of the *mycobiont*, consisting of clumps of *hyphae*, which are produced on the thallus, or even on the prothallus. They may be confused with *soredia*, which, however, contain some cells of the *photobiont*, while the thalloconidia are formed only by the mycobiont. Rare, and limited to genera such as *Umbilicaria* (from the lower cortex), and *Protoparmelia* (e.g. *P. leproloma*, from the margin of areolae).
- Thallus** (plural: thalli): the “body” of the lichen, formed by the *mycobiont* and the *photobiont*. See also *hypothallus*, *prothallus*.
- Thecium** (of ascocarps, a Greek term for something like a “layer”): a synonym of *hymenium*. The parts lying above and under the hymenium are often called *epihymenium* and *subhymenium*. The term *thecium* was never used in this book, but we consistently call its upper and lower parts *epithecium* and *hypothecium*.
- Tholus** (of asci): the apex of *bitunicate asci*, when the two *walls* become distant from each other, giving the impression of an apical thickening. Its features, best observed after application of *I*, are important for distinguishing among supraspecific ranks.
- Tomentose** (of thallus, from Latin): having a cover of soft, matted *hairs*, best seen under a binocular microscope or a strong lens (e.g. the lobes of *Peltigera rufescens*).
- Torulose** (of branches): cylindrical, but with regular swellings at intervals.
- Torus** (of spores): a thickening occurring near the *septum* of pluricellular *spores*, e.g. in most species of *Rinodina*.
- Trentepohliial** (of photobiont): a green alga related to *Trentepohlia*. The algal layer has a characteristic orange to greenish orange colour, due to the presence of pigments which enhance photosynthesis in condition of weak light. Most common in tropical lichens, *Trentepohlia* occurs in ca. 9% of Italian lichens, esp. those which live in shaded-humid situations.
- Trichotomous** (of thallus parts): 3-branched, e.g. the thallus of *Cladonia portentosa*.
- Truncate** (of thallus parts): ending abruptly, e.g. the *lobes* of *Parmelia sulcata*.
- Umbilicate** (of foliose thalli): attached by a single, more or less central point (e.g. *Dermatocarpon*, *Rhizoplaca*, *Umbilicaria*).
- Umbonate** (of apothecia): provided with a column of sterile *hyphae* which protrude from the *hymenium* in the form of a small, central wart (e.g. in *Lecidea umbonata*).
- Uni** - (Latin suffix): referring to one single object.
- Uniseriate** (of spores): in a single row within the *ascus*.
- Unitunicate** (of ascus walls): the wall is composed of one layer only (a primitive character). See also: *bitunicate*.

- Urceolate** (of apothecia): deeply concave, pitcher-like in form (e.g. in *Diploschistes diacapsis*). When young, urceolate *apothecia* may be confused with *perithecia* (see also *perithecioid*).
- UV**: the colour of thallus or (mostly) of the *medulla*, as it appears under a UV lamp (in darkness). Protect your eyes with adequate spectacles, and be sure that the material on which you place your sample is not in itself reactive to UV (in principle, avoid white paper). Several UV-lamps permit the observation both under short- and long-wave radiation. Short-wave is the best for lichens.
- Vegetative** (of reproduction): non-sexual. In lichens vegetative reproduction can involve both partners of the symbiosis (e.g. with *soredia*, *isidia*, *blastidia*), or the *mycobiont* only (e.g. with *thalloconidia*). See also *conidia*.
- Veins** (of thallus): vein-like thickenings or flattened structures differing in colour or shape from the rest of the lower surface of some foliose lichens, esp. in *Peltigera*. They are mostly very evident, and should not be confused with small foldings of the lower surface.
- Verrucose** (of thallus): wart-like.
- Zeorine** (of apothecia): A *lecanorine apothecium* with a proper *margin* completely surrounded by a layer of *photobionts* reaching the lower part of the *hymenium*. This difficult term was never used in this book.
- Zonate** (of thallus): with concentric areas of different colour (e.g. in some forms of *Pertusaria amara*).

REFERENCES

- AHTI T. & OKSANEN J., 1990 - Epigeic lichen communities of taiga and tundra regions. *Vegetatio*, 86: 39-70.
- AHTI T., JØRGENSEN P.M., KRISTINSSON H., MOBERG R., SØCHTING U. & THOR G. (eds.). 1999 - *Nordic Lichen Flora. Vol. 1. Introductory parts. Calicioid lichens and fungi*. Nordic Lichen Society, Uddevalla, 94 pp.
- ARRIGONI P.V., 1968 - Fitoclimatologia della Sardegna. *Webbia*, 23: 1-100.
- BARKMAN J.J., 1958 - *Phytosociology and Ecology of Cryptogamic Epiphytes*. Van Gorcum, Assen. 628 pp.
- BARRENO E., 1991 - Phytogeography of terricolous lichens in the Iberian Peninsula and the Canary Islands. *Botanika Chronika*, 10: 199-210.
- BARRENO E., 1998 - Lichens: a special case in biogeographical analysis. In: Nimis P.L. (ed.). *International Lichenological Newsletter*, 31,1: 18-20.
- BOLOGNINI G. & NIMIS P.L., 1993 - Phytogeography of Italian deciduous oak woods based on numerical classification of plant distribution ranges. *Journal of Vegetation Science*, 4: 847-860.
- BREUSS O., 1990 - Die Flechtengattung *Catapyrenium* (Verrucariaceae) in Europa. - *Stapfia*, 23:1 -153.
- BREUSS O., 1996 - Revision der Flechtengattung *Placidiopsis* (Verrucariaceae). *Oesterr. Z. Pilzk.*, 5: 65 -94.
- BRIDGMAN P.W., 1927 - *The Logic of Modern Physics*. Freeman. S. Francisco. CA.
- BURGAZ A.R. & VENTUREIRA M., 1990 - A new vagrant terricolous lichen community (*Parmelietum rysssoleae* ass. nova). *Herzogia*, 8: 357-361.
- CLAUZADE G. & ROUX C., 1985 - *Likenoj de Okcidenta Europo. Ilustrita Determinlibro*. Bulletin de la Societè Botanique du Centre-Ouest, Nouvelle Série, Num. Spec. 7. Royan, France. 893 pp.
- CRESPO A. & BARRENO E., 1978 - Sobre las comunidades terricolas de liquenes vagantes (*Sphaerothallio-Xanthoparmelion vagantis* al. nov.). *Acta Botanica Malacitana* 4: 55-62.
- DANIËLS F.J.A., 1982 - Vegetation of the Angmagssalik District, Southeast Greenland, IV. Shrub, dwarf shrub and terricolous lichens. *Meddelelser om Grønland, Bioscience*, 10: 1-78.
- DÜLL R., 1991 - Zeigerwerte von Laub- und Lebermoose. In: Ellenberg, H. et al. (eds.): Zeigerwerte von Pflanzen in Mitteleuropa. *Scripta Geobotanica*, 18: 175-214.
- EGEA J.M., 1985 - Liqueenes calcícolas y terrícolas de las Sierras de Pedro Ponce y Quipar (NW de Murcia, Espana). *Anales de Biología (Biología Vegetal, 1)*, 6: 19-27.
- ELLENBERG H., 1974 - Zeigerwerte der Gefäßpflanzen Mitteleuropa. *Scripta Geobotanica*, 9: 1-97.
- ELLENBERG H., 1991 - Zeigerwerte der Gefäßpflanzen. In: Ellenberg, H. et al. (eds.): Zeigerwerte von Pflanzen in Mitteleuropa. *Scripta Geobotanica*, 18: 9-166.
- FRYDAY A., 2001 - Phytosociology of terricolous lichen vegetation in the Cairngorm Mountains, Scotland. *Lichenologist*, 33(4): 331-351.

- GANIS P., MARTINI F., BORGIA E. & ROMANELLI G., 2000 - *Chiave computerizzata dei generi delle Graminacee del Friuli-Venezia Giulia*. GEAD-EQ n. 12. Università degli Studi di Trieste. pp.90.
- GILBERT O.L., 1980 - Effect of land-use on terricolous lichens. *Lichenologist* 12: 117-124.
- HAFELLNER J. & TÜRK R., 2001 - Die lichenisierten Pilze Österreichs - eine Checkliste der bisher nachgewiesenen Arten mit Verbreitungsangaben. *Stappia*, 76: 1-167.
- HALE M.E. JR, 1969: *How to Know the Lichens*. Wm. C. Brown Company Publishers, Dubuque, Iowa. vii + 226 pp.
- HALE M.E. JR, 1979: *How to Know the Lichens. 2nd. Edition*. Wm. C. Brown Co., Dubuque, Iowa. 246 pp.
- HAWKSWORTH D.L., KIRK P.M., SUTTON B.C. & PEGLER D.N., 1995 - *Dictionary of the Fungi. 8th edition*. CAB International, Wallingford. 616 pp.
- JAMES P.W., HAWKSWORTH D.L. & ROSE F., 1977 - Lichen communities in the British Isles: a preliminary conspectus. - In: M. R. D. Seaward (ed.): *Lichen Ecology*. Academic Press, London, pp. 295-413.
- KALB K., 1970 - Flechtengesellschaften der vorderen Oetztaler Alpen. *Dissertationes Bot.*, 9: 1-124.
- KLEMENT O., 1955 - Prodrromus der mitteleuropäischen Flechtengesellschaften. *Feddes Repert. Beih.* 135 (Beiträge zur Vegetationskunde): 5-194.
- LANDOLT E., 1977 - *Ökologische Zeigerwerte zur Schweizer Flora*. Veröff. Geobot. Inst. ETH Rübel, Zürich, 64, 206 pp.
- NIMIS P.L., 1981 - The thorny cushions vegetation in Mediterranean Italy. Phytogeographical Problems. *Anales Jardin Botanico de Madrid*, 37, 2: 339-351.
- NIMIS P.L., 1987 - I Macrolicheni d' Italia. Chiavi analitiche per la determinazione. *Gortania*, 8: 101-220.
- NIMIS P.L., 1991 - Developments in lichen community studies. *Lichenologist*, 23, 3: 215-225.
- NIMIS P.L., 1993 - *The Lichens of Italy. An annotated catalogue*. Mus. Reg. Sci. Nat. Torino. Monogr. 12. 897 pp.
- NIMIS P.L., 1999 - The Arctic-alpine element in the lichen flora of the Alps. *Revue Valdôtaine d'Histoire Naturelle*, 51, suppl.: 361-369.
- NIMIS P.L., 1999b - *Lichen Database of Italy 1.0*. Univ. of Trieste, Dept. of Biology, IN1.0/99 (<http://biobase.kfunigraz.ac.at/flechte/owa/askitalflo>).
- NIMIS P.L., 2003 - *Checklist of Italian Lichens 3.0*. Univ. of Trieste, Dept. of Biology, IN3.0/2 (<http://dbiodbs.univ.trieste.it>).
- NIMIS P.L. & BOLOGNINI G., 1993 - Quantitative phytogeography of the Italian beech forests. *Vegetatio*, 109: 125-143.
- NIMIS P.L. & MARTELLOS S., 2001 - Testing the predictivity of ecological indicator values. A comparison of real and virtual relevés of lichen vegetation. *Plant Ecology*, 157: 165-172.
- NIMIS P.L. & MARTELLOS S., 2002 - ITALIC - the information system on Italian lichens. In: X.Llimona, H.T. Lumbsch, S. Ott (eds.): Progress and problems in

- lichenology at the Turn of the Millennium. *Bibliotheca Lichenologica*, 82: 271-283.
- NIMIS P.L. & MARTELLOS S., 2003 - *A second checklist of the lichens of Italy with a thesaurus of synonyms*. Museo Regionale di Scienze Naturali, Monogr. 4, Saint-Pierre, Aosta. 192 pp.
- NIMIS P.L., MARTELLOS S. & MORO A., 2003 - Il progetto Dryades: come identificare una pianta, da Gutenberg a Internet. *Biologi Italiani* 7: 9-15.
- NIMIS P.L. & POELT J., 1987 - The lichens and Lichenicolous Fungi of Sardinia (Italy). *Studia Geobotanica*, 7, suppl. 1., 269 pp.
- NIMIS P.L. & TRETACH M., 1995 - The lichens of Italy. A phytoclimatic outline. *Cryptogamic Botany*, 5: 199-208.
- NIMIS P.L. & TRETACH M., 2004 - Delimiting Tyrrhenian Italy: A lichen foray in the SW part of the Italian peninsula. *Bibl. Lichenol.*, 88: 465-478.
- OZENDA P. & CLAUZADE G., 1970 - *Les Lichens. Etude Biologique et Flore Illustrée*. Masson & Cie, Editeurs, Paris. 801 pp.
- PAUS S., 1997 - *Die Erdflechtenvegetation Nordwestdeutschlands und einiger Randgebiete. Vegetationsökologische Untersuchungen unter besonderer Berücksichtigung des Chemismus ausgewählter Arten*. Bibliotheca Lichenologica, Band 66. 222 Seiten, 28 Abbildungen, 10 Tabellen, 15 Vegetationstab.
- PIGNATTI E., PIGNATTI S., NIMIS P.L. & AVANZINI A., 1980 - *La vegetazione ad arbusti spinosi emisferici: Contributo alla interpretazione delle fasce di vegetazione delle alte montagne dell'Italia mediterranea*. C.N.R. AQ/1/79, Roma. 130 pp.
- PIGNATTI E., PIGNATTI S., AVANZINI A. & NIMIS P.L., 1997 - Die klimatisch bedingte Dornpolster-Vegetation der Gebirge Südtaliens, Siziliens und Sardinien. In H. Dierschke (ed.) *Vegetation und Klima*. Cramer Vaduz: 373-390.
- POELT J., 1969 - *Bestimmungsschlüssel europäischer Flechten*. Verlag von J. Cramer, Lehre. 757 pp.
- POELT J. & VEZDA A., 1977 - *Bestimmungsschlüssel europäischer Flechten. Ergänzungsheft I*. Bibliotheca Lichenologica 9. J. Cramer, Vaduz. 258 pp.
- POELT J. & VEZDA A., 1981 - *Bestimmungsschlüssel europäischer Flechten. Ergänzungsheft II*. Bibliotheca Lichenologica 16, J. Cramer, Vaduz. 390 pp.
- PURVIS O.W., COPPINS B.J., HAWKSWORTH D.L., JAMES P.W. & MOORE D.M. (EDS.), 1992: *The Lichen Flora of Great Britain and Ireland*. Natural History Museum Publications & British Lichen Society, London. 710 pp.
- RAMBOLD G. (ED.), 1996-2000 - *LIAS: Global Information System for Lichenized and Non-Lichenized Ascomycetes*. Botanische Staatssammlung München: <http://www.botanik.biologie.uni-muenchen.de/botsamml/lias/lias.html>
- ROSENTRER R. & ELDRIDGE D.J., 2002 - Monitoring biodiversity and ecosystem function: grasslands, deserts, and steppe. - In: Nimis, P.L., Scheidegger, C., Wolseley, P.A. (eds.): *Monitoring with Lichens - Monitoring Lichens*. NATO Science Series. IV. Earth and Environmental Sciences, Kluwer Academic Publishers, Dordrecht, The Netherlands, pp. 223-237.
- TEHLER A., 1983 - The genera *Dirina* and *Roccellina*. *Opera Botanica*, 70: 1-86.

- TIMDAL E., 1991 - A monograph of the genus *Toninia*. *Opera Botanica*, 110: 1 -137.
- TOMASELLI R., BALDUZZI A., FILIPELLO S., 1973 - Carta bioclimatica d'Italia. In: Tommaselli R.: *La vegetazione forestale d'Italia*. Collana Verde, 33, 1973: 1-64, 3 tav.
- TRETIACH M., 1995 - Ecophysiology of calcicolous endolithic lichens, progress and problems. *Giornale Botanico Italiano*, 129: 159-184
- VAN DAM H., MERTENS A. & SINKELDAM J., 1994 - A coded checklist and ecological indicator values of freshwater diatoms from the Netherlands. *Netherlands Journal of Aquatic Ecology*, 28: 117-133.
- VITIKAINEN O., 1994 - Taxonomic revision of *Peltigera* (lichenized Ascomycotina) in Europe. *Acta Botanica Fennica*, 152: 1 -96.
- VOBIS G., 1980 - *Bau und Entwicklung der Flechten-Pycnidien und ihrer Conidien*. Bibliotheca Lichenologica, 14, 141 pp.
- WIRTH V., 1991 - Zeigerwerte von Flechten. In: Ellenberg, H. et al. (eds.): *Zeigerwerte von Pflanzen in Mitteleuropa*. *Scripta Geobotanica*, 18: 215-237.
- WIRTH V., 1995 - *Die Flechten Baden-Württembergs*. 2 voll. Ulmer. Stuttgart.

INDEX TO TAXA
(leading to their descriptions only)

Absconditella annexa (Arnold) Vězda	
Absconditella delutula (Nyl.) Coppins & H. Kilius	
Absconditella sphagnum Vězda & Poelt	
Acarospora nodulosa (Dufour) Hue var. nodulosa	
Acarospora nodulosa (Dufour) Hue var. reagens (Zahlbr.) Clauzade & Cl.Roux	
Acarospora placodiiformis H.Magn.	
Acarospora schleicheri (Ach.) A.Massal.	
Agonimia opuntiella (Poelt & Buschardt) Vězda	129
Agonimia tristicula (Nyl.) Zahlbr.	147
Alectoria nigricans (Ach.) Nyl.	39
Alectoria ochroleuca (Hoffm.) A.Massal.	41
Allocetraria madreporiformis (Ach.) Kärnefelt & Thell	47
Amandinea punctata (Hoffm.) Coppins & Scheid.	
Anaptychia bryorum Poelt	110
Anaptychia ciliaris (L.) Körb.	42
Anthracoarpon virescens (Zahlbr.) Breuss	157
Anzina carneonivea (Anzi) Scheid. var. carneonivea	
Aphanopsis coenosa (Ach.) Coppins & P.James	
Arthrorhaphis alpina (Schaer.) R.Sant.	
Arthrorhaphis citrinella (Ach.) Poelt	
Arthrorhaphis grisea Th.Fr.	
Arthrorhaphis vacillans Th.Fr.	
Aspicilia hispida Mereschk.	47
Bacidia bagliettoana (A.Massal. & De Not.) Jatta	
Bacidia herbarum (Stizenb.) Arnold	
Baeomyces carneus Flörke	48
Baeomyces placophyllus Ach.	48
Baeomyces rufus (Huds.) Rebert.	49
Belonia incarnata Th.Fr.	
Belonia russula Nyl.	
Biatora subduplex (Nyl.) Printzen	
Biatora vernalis (L.) Fr.	
Biatorella fossarum (Fr.) Th.Fr.	
Biatorella hemisphaerica Anzi	
Bryodina rhypariza (Nyl.) Hafellner & Türk	
Bryonora castanea (Hepp) Poelt	
Bryonora curvescens (Mudd) Poelt	
Bryoria bicolor (Ehrh.) Brodo & D.Hawksw.	38
Bryoria chalybeiformis (L.) Brodo & D.Hawksw.	38
Buellia asterella Poelt & Sulzer	
Buellia elegans Poelt	
Buellia epigaea (Pers.) Tuck.	
Buellia geophila (Sommerf.) Lyngé	
Buellia hypoleuca H.Magn.	
Buellia hypophana (Nyl.) Zahlbr.	
Buellia insignis (Hepp) Th.Fr.	
Buellia papillata (Sommerf.) Tuck.	
Buellia reagens H.Magn.	
Buellia zoharyi Galun	
Caloplaca aetnensis de Lesd.	

Caloplaca ammiospila (Wahlenb.) H.Olivier	
Caloplaca aurea (Schaer.) Zahlbr.	
Caloplaca bryochryson Poelt	
Caloplaca canariensis (Follmann & Poelt) Breuss	
Caloplaca cerina (Hedw.) Th.Fr. var. muscorum (A.Massal.) Jatta	
Caloplaca cerina (Hedw.) var. chloroleuca (Sm.) Th.Fr.	
Caloplaca congregiens (Nyl.) Zahlbr.	
Caloplaca jungermanniae (Vahl) Th.Fr.	
Caloplaca limonia Nimis & Poelt	
Caloplaca livida (Hepp) Jatta	
Caloplaca nivalis (Körb.) Th.Fr.	
Caloplaca saxifragarum Poelt	
Caloplaca schoeferi Poelt	
Caloplaca sinapisperma (Lam. & DC.) Maheu & A. Gillet	
Caloplaca tetraspora (Nyl.) H.Olivier	
Caloplaca tirolensis Zahlbr.	
Candelariella kuusamoensis Räsänen	
Candelariella unilocularis (Elenkin) Nimis	
Candelariella vitellina (Hoffm.) Müll.Arg.	
Catapyrenium cinereum (Pers.) Körb.	154
Catapyrenium daedaleum (Kremp.) Stein	155
Catillaria contristans (Nyl.) Zahlbr.	
Catolechia wahlenbergii (Ach.) Körb.	132
Cetraria aculeata (Schreb.) Fr.	41
Cetraria ericetorum Opiz	40
Cetraria islandica (L.) Ach.	39
Cetraria muricata (Ach.) Eckfeldt	41
Cetraria obtusata (Schaer.) Van den Boom & Sipman	40
Chaenotheca furfuracea (L.) Tibell	
Chromatochlamys muscorum (Fr.) H.Mayrhofer & Poelt var. muscorum	
Chromatochlamys muscorum (Fr.) H.Mayrhofer & Poelt var. octospora (Nyl.) H.Mayrhofer & Poelt	
Chrysothrix chlorina (Ach.) J.R.Laundon	
Cladonia acuminata (Ach.) Norrl.	74
Cladonia amaurocraea (Flörke) Schaer.	54
Cladonia arbuscula (Wallr.) Flot. subsp. arbuscula	51
Cladonia arbuscula (Wallr.) Flot. subsp. mitis (Sandst.) Ruoss	53
Cladonia arbuscula (Wallr.) Flot. subsp. squarrosa (Wallr.) Ruoss	52
Cladonia bellidiflora (Ach.) Schaer.	65
Cladonia borealis S. Stenroos	65
Cladonia botrytes (K.G.Hagen) Willd.	80
Cladonia caespiticia (Pers.) Flörke	84
Cladonia cariosa (Ach.) Spreng.	80
Cladonia carneola (Fr.) Fr.	62
Cladonia cenotea (Ach.) Schaer.	63
Cladonia cervicornis (Ach.) Flot. subsp. cervicornis	69
Cladonia cervicornis (Ach.) Flot. subsp. verticillata (Hoffm.) Ahti	71
Cladonia chlorophaea (Flörke ex Sommerf.) Spreng.	61
Cladonia ciliata Stirt.	51
Cladonia coccifera (L.) Willd.	66
Cladonia coniocraea (Flörke) Spreng.	77
Cladonia convoluta (Lam.) Anders	83
Cladonia cornuta (L.) Hoffm.	76

<i>Cladonia crispata</i> (Ach.) Flot.	54
<i>Cladonia cryptochlorophaea</i> Asahina	60
<i>Cladonia cyanipes</i> (Sommerf.) Nyl.	75
<i>Cladonia cyathomorpha</i> Walt.Watson	60
<i>Cladonia decorticata</i> (Flörke) Spreng.	75
<i>Cladonia deformis</i> (L.) Hoffm.	59
<i>Cladonia digitata</i> (L.) Hoffm.	58
<i>Cladonia dimorpha</i> S. Hammer	70
<i>Cladonia diversa</i> Asperges	66
<i>Cladonia ecmocyna</i> Leight.	67
<i>Cladonia fimbriata</i> (L.) Fr.	63
<i>Cladonia firma</i> (Nyl.) Nyl.	68
<i>Cladonia foliacea</i> (Huds.) Willd.	83
<i>Cladonia furcata</i> (Huds.) Schrad.	55
<i>Cladonia glauca</i> Flörke	76
<i>Cladonia gracilis</i> (L.) Willd.	71
<i>Cladonia grayi</i> Sandst.	62
<i>Cladonia humilis</i> (With.) J.R.Laundon	60
<i>Cladonia incrassata</i> Flörke	73
<i>Cladonia macilenta</i> Hoffm. subsp. <i>floerkeana</i> (Fr.) V.Wirth	81
<i>Cladonia macilenta</i> Hoffm. subsp. <i>macilenta</i>	72
<i>Cladonia macroceras</i> (Delise) Hav.	71
<i>Cladonia macrophylla</i> (Schaer.) Stenh.	82
<i>Cladonia macrophyllodes</i> Nyl.	67
<i>Cladonia mediterranea</i> P.A.Duvign. & Abbayes	52
<i>Cladonia merochlorophaea</i> Asahina	61
<i>Cladonia parasitica</i> (Hoffm.) Hoffm.	74
<i>Cladonia peziziformis</i> (With.) J.R.Laundon	84
<i>Cladonia phyllophora</i> Hoffm.	72
<i>Cladonia pleurota</i> (Flörke) Schaer.	68
<i>Cladonia pocillum</i> (Ach.) O.J. Rich.	69
<i>Cladonia polycarpoides</i> Nyl.	77
<i>Cladonia polydactyla</i> (Flörke) Spreng.	73
<i>Cladonia portentosa</i> (Dufour) Coem.	52
<i>Cladonia pseudopityrea</i> Vain.	77
<i>Cladonia pyxidata</i> (L.) Hoffm.	70
<i>Cladonia ramulosa</i> (With.) J.R.Laundon	64
<i>Cladonia rangiferina</i> (L.) F.H.Wigg.	50
<i>Cladonia rangiformis</i> Hoffm.	55
<i>Cladonia rei</i> Schaer.	63
<i>Cladonia scabriuscula</i> (Delise) Leight.	54
<i>Cladonia squamosa</i> Hoffm. var. <i>squamosa</i>	68
<i>Cladonia squamosa</i> Hoffm. var. <i>subsquamosa</i> (Leight.) Vain.	66
<i>Cladonia stellaris</i> (Opiz) Pouzar & Vězda	53
<i>Cladonia strepsilis</i> (Ach.) Grognot	82
<i>Cladonia stygia</i> (Fr.) Ruoss	50
<i>Cladonia subcervicornis</i> (Vain.) Kernst.	68
<i>Cladonia subrangiformis</i> Sandst.	56
<i>Cladonia subulata</i> (L.) F.H.Wigg.	64
<i>Cladonia sulphurina</i> (Michx.) Fr.	59
<i>Cladonia symphycharpa</i> (Flörke) Fr.	78
<i>Cladonia turgida</i> Hoffm.	79
<i>Cladonia uncialis</i> (L.) F.H.Wigg. subsp. <i>biuncialis</i> (Hoffm.)	57

Cladonia uncialis (L.) F.H.Wigg. subsp. uncialis	57
Clavascidium umbrinum (Breuss) Breuss	157
Collema bachmanianum (Fink) Degel.	93
Collema ceraniscum Nyl.	93
Collema coccophorum Tuck.	91
Collema crispum (Huds.) F.H.Wigg.	88
Collema flaccidum (Ach.) Ach.	88
Collema limosum (Ach.) Ach.	94
Collema tenax (Sw.) Ach.	87
Dactylina ramulosa (Hook.) Tuck.	56
Dibaeis baeomyces (L. fil.) Rambold & Hertel	49
Diploschistes diacapsis (Ach.) Lumbsch	
Diploschistes muscorum (Scop.) R.Sant.	
Diploschistes ocellatus (Vill.) Norman	
Diplotomma pulverulentum (Anzi) D.Hawksw.	
Endocarpon adscendens (Anzi) Müll.Arg.	148
Endocarpon pallidum Ach.	148
Endocarpon pusillum Hedw.	149
Epigloea grummannii	
Epigloea medioincrassata (Grummann) Döbbeler	
Epigloea soleiformis Döbbeler	
Epilichen scabrosus (Ach.) Clem.	
Epiphloea terrena (Nyl.) Trevis.	
Farnoldia muscigena (Vězda) Tretiach & Hafellner	
Flavocetraria cucullata (Bellardi) Kärnefelt & Thell	42
Flavocetraria nivalis (L.) Kärnefelt & Thell	43
Frutidella caesioatra (Schaer.) Kalb	
Fulgensia bracteata (Hoffm.) Räsänen subsp. bracteata	
Fulgensia bracteata (Hoffm.) Räsänen subsp. deformis (Erichsen) Poelt	
Fulgensia bracteata (Hoffm.) Räsänen var. alpina (Th.Fr.) Räsänen	
Fulgensia desertorum (Tomin) Poelt	
Fulgensia fulgens (Sw.) Elenkin	
Fulgensia fulgida (Nyl.) Szatala	
Fulgensia poeltii Llimona	
Fulgensia pruinosa (Körb.) Poelt	
Fulgensia schistidii (Anzi) Poelt	
Fulgensia subbracteata (Nyl.) Poelt	
Fuscopannaria praetermissa (Nyl.) M.Jørg.	114
Gloeoheppia turgida (Ach.) Gyeln.	120
Gyalecta foveolaris (Ach.) Schaer.	
Gyalecta friesii Körb.	
Gyalecta geoica (Ach.) Ach.	
Gyalecta peziza (Mont.) Anzi	
Gyalecta ulmi (Sw.) Zahlbr.	
Gyalidea scutellaris (Bagl. & Carestia) Lettau	
Gyalideopsis athalloides (Nyl.) Vězda	
Halecania lecanorina (Anzi) M.Mayrhofer & Poelt	
Helocarpon pulverulum (Th.Fr.) Türk & Hafellner	
Heppia adglutinata (Kremp.) A.Massal.	121
Heppia despreauxii (Mont.) Tuck.	122
Heppia lutosa (Ach.) Nyl.	120
Heppia solerinoides (Nyl.) Nyl.	121
Heteroplacidium imbricatum (Nyl.) Breuss	156

<i>Icmadophila ericetorum</i> (L.) Zahlbr.	
<i>Involucropyrenium sbarbaronis</i> (Servít) Breuss	155
<i>Involucropyrenium tremniacense</i> (A.Massal.) Breuss	156
<i>Involucropyrenium waltheri</i> (Kremp.) Breuss	154
<i>Japewia tornensis</i> (Nyl.) Tønsberg	
<i>Lecania pusilla</i> Tretiach	
<i>Lecanora bryopsora</i> (Doppelb. & Poelt) Hafellner & Türk	
<i>Lecanora epibryon</i> (Ach.) Ach.	
<i>Lecanora hagenii</i> (Ach.) Ach. var. <i>fallax</i> Hepp	
<i>Lecanora leptacina</i> Sommerf.	
<i>Lecidea alpestris</i> Sommerf.	
<i>Lecidea miscella</i> Ach.	
<i>Lecidea rufofusca</i> (Anzi) Nyl.	
<i>Lecidella wulfenii</i> (Hepp) Körb.	
<i>Lecidoma demissum</i> (Rutstr.) Gotth.Schneid. & Hertel	
<i>Lempholemma chalazanum</i> (Ach.) de Lesd.	92
<i>Lempholemma polyanthes</i> (Bernh.) Malme	92
<i>Lepraria cacuminum</i> (A.Massal.) Loht.	
<i>Lepraria caesioalba</i> (de Lesd.) J.R.Laundon	
<i>Lepraria eburnea</i> J.R.Laundon	
<i>Lepraria incana</i> (L.) Ach.	
<i>Lepraria lobificans</i> Nyl.	
<i>Lepraria neglecta</i> (Nyl.) Lettau	
<i>Lepraria nivalis</i> J.R.Laundon	
<i>Lepraria nylanderiana</i> Kümmerl. & Leuckert	
<i>Lepraria rigidula</i> (de Lesd.) Tønsberg	
<i>Lepraria umbricola</i> Tønsberg	
<i>Leprocaulon microscopicum</i> (Vill.) Gams	43
<i>Leproloma diffusum</i> J.R.Laundon	
<i>Leproloma membranaceum</i> (Dicks.) Vain.	
<i>Leproloma vouauxii</i> (Hue) J.R.Laundon	
<i>Leptochidium albociliatum</i> (Desm.) M.Choisy	89
<i>Leptogium biatorinum</i> (Nyl.) Leight.	
<i>Leptogium byssinum</i> (Hoffm.) Nyl.	
<i>Leptogium corniculatum</i> (Hoffm.) Minks	90
<i>Leptogium gelatinosum</i> (With.) J.R.Laundon	90
<i>Leptogium imbricatum</i> M.Jørg.	116
<i>Leptogium intermedium</i> (Arnold) Arnold	115
<i>Leptogium lichenoides</i> (L.) Zahlbr.	91
<i>Leptogium schraderi</i> (Bernh.) Nyl.	113
<i>Leptogium subtile</i> (Schrad.) Torss.	116
<i>Leptogium tenuissimum</i> (Dicks.) Körb.	117
<i>Leucocarpia biatorella</i> (Arnold) Vězda	
<i>Lobaria linita</i> (Ach.) Rabenh.	106
<i>Lopadium pezizoideum</i> (Ach.) Körb.	
<i>Massalongia carnosa</i> (Dicks.) Körb.	89
<i>Megaspora verrucosa</i> (Ach.) Hafellner & V. Wirth var. <i>verrucosa</i>	
<i>Micarea bauschiana</i> (Körb.) V. Wirth & Vězda	
<i>Micarea botryoides</i> (Nyl.) Coppins	
<i>Micarea cinerea</i> (Schaer.) Hedl.	
<i>Micarea lignaria</i> (Ach.) Hedl. var. <i>lignaria</i>	
<i>Micarea melaenida</i> (Nyl.) Coppins	
<i>Micarea peliocarpa</i> (Anzi) Coppins & R.Sant.	

Micarea prasina Fr.	
Moelleropsis nebulosa (Hoffm.) Gyeln.	
Mycobilimbia berengeriana (A.Massal.) Hafellner & V.Wirth	
Mycobilimbia hypnorum (Lib.) Kalb & Hafellner	
Mycobilimbia lurida (Ach.) Hafellner & Türk	141
Mycobilimbia pilularis (Körb.) Hafellner & Türk	
Mycobilimbia tetramera (De Not.) Hafellner & Türk	
Myxobilimbia accedens (Arnold) Hafellner	
Myxobilimbia lobulata (Sommerf.) Hafellner	139
Myxobilimbia microcarpa (Th.Fr.) Hafellner	
Myxobilimbia sabuletorum (Schreb.) Hafellner	
Nephroma expallidum (Nyl.) Nyl.	107
Nephroma parile (Ach.) Ach.	87
Ochrolechia androgyna (Hoffm.) Arnold	
Ochrolechia inaequatula (Nyl.) Zahlbr.	
Ochrolechia upsaliensis (L.) A.Massal.	
Pannaria hookeri (Sm.) Nyl.	118
Parmelia omphalodes (L.) Ach.	104
Parmelia saxatilis (L.) Ach.	103
Parmelia sulcata Taylor	104
Parmelina tiliacea (Hoffm.) Hale	102
Peltigera aphthosa (L.) Willd.	109
Peltigera canina (L.) Willd.	101
Peltigera degenii Gyeln.	97
Peltigera didactyla (With.) J.R.Laundon	94
Peltigera elisabethae Gyeln.	96
Peltigera horizontalis (Huds.) Baumg.	99
Peltigera hymenina (Ach.) Delise	98
Peltigera kristinssonii Vitik.	101
Peltigera lepidophora (Vain.) Bitter	95
Peltigera leucophlebia (Nyl.) Gyeln.	109
Peltigera malacea (Ach.) Funck	96
Peltigera membranacea (Ach.) Nyl.	102
Peltigera monticola Vitik.	100
Peltigera neckeri Müll.Arg.	98
Peltigera neopolydactyla (Gyeln.) Gyeln.	98
Peltigera polydactyla (Neck.) Hoffm.	99
Peltigera ponojensis Gyeln.	100
Peltigera praetextata (Sommerf.) Zopf	95
Peltigera rufescens (Weiss) Humb.	100
Peltigera scabrosa Th.Fr.	97
Peltigera venosa (L.) Hoffm.	108
Peltula patellata (Bagl.) Swinscow & Krog	119
Pertusaria bryontha (Ach.) Nyl.	
Pertusaria geminipara (Th.Fr.) Brodo	
Pertusaria glomerata (Ach.) Schaer.	
Pertusaria oculata (Dicks.) Th.Fr.	
Phaeophyscia constipata (Norrl. & Nyl.) Moberg	110
Phaeophyscia hispidula (Ach.) Essl.	103
Phaeorrhiza nimbose (Fr.) H.Mayrhofer & Poelt	133
Physconia muscigena (Ach.) Poelt var. bayeri (Nádv.) Poelt	106
Physconia muscigena (Ach.) Poelt var. muscigena	106
Placidiopsis cinerascens (Nyl.) Breuss	153

<i>Placidiopsis cinereoides</i> Breuss	151
<i>Placidiopsis custnani</i> (A.Massal.) Körb.	150
<i>Placidiopsis dermatocarpoides</i> Anzi	153
<i>Placidiopsis oreades</i> Breuss	152
<i>Placidiopsis pseudocinerea</i> Breuss	151
<i>Placidiopsis tenella</i> (Nyl.) Zahlbr.	150
<i>Placidiopsis tirolensis</i> Breuss	152
<i>Placidium adami-borosi</i> Szatala	160
<i>Placidium imbecillum</i> (Breuss) Breuss	161
<i>Placidium lachneum</i> (Ach.) de Lesd.	160
<i>Placidium lacinulatum</i> (Ach.) Breuss	157
<i>Placidium michelii</i> A.Massal.	158
<i>Placidium pilosellum</i> (Breuss) Breuss	161
<i>Placidium rufescens</i> (Ach.) A.Massal.	162
<i>Placidium semaforonense</i> Breuss	158
<i>Placidium squamulosum</i> (Ach.) Breuss	159
<i>Placidium tenellum</i> (Breuss) Breuss	159
<i>Placynthiella icmalea</i> (Ach.) Coppins & P.James	
<i>Placynthiella oligotropha</i> (J.R.Laundon) Coppins & P.James	
<i>Placynthiella uliginosa</i> (Schräd.) Coppins & P.James	
<i>Polyblastia epigaea</i> A. Massal.	
<i>Polyblastia evanescens</i> Arnold	
<i>Polyblastia helvetica</i> Th.Fr.	
<i>Polyblastia rouxiana</i> Vězda & Vivant	
<i>Polyblastia sendtneri</i> Kremp.	
<i>Polyblastia terrestris</i> Th.Fr.	
<i>Polychidium muscicola</i> (Sw.) Gray	38
<i>Porina mammillosa</i> (Th.Fr.) Vain.	
<i>Protoblastenia terricola</i> (Anzi) Lynge	
<i>Protomicarea limosa</i> (Ach.) Hafellner	
<i>Protopannaria pezizoides</i> (Weber) M.Jörg. & S.Ekman	119
<i>Protothelenella leucothelia</i> (Nyl.) H.Mayrhofer & Poelt	
<i>Protothelenella sphinctrinoidella</i> (Nyl.) H.Mayrhofer & Poelt	
<i>Protothelenella sphinctrinoides</i> (Nyl.) H.Mayrhofer & Poelt	
<i>Psilolechia lucida</i> (Ach.) M.Choisy	
<i>Psora decipiens</i> (Hedw.) Hoffm.	133
<i>Psora globifera</i> (Ach.) A.Massal.	142
<i>Psora gresinonis</i> de Lesd.	142
<i>Psora rubiformis</i> (Ach.) Hook.	140
<i>Psora saviczii</i> (Tomin) Follmann & A. Crespo	140
<i>Psora vallesiaca</i> (Schaer.) Timdal	141
<i>Psoroma hypnorum</i> (Vahl) Gray	134
<i>Pycnothelia papillaria</i> (Ehrh.) L.M.Dufour	81
<i>Rinodina conradii</i> Körb.	
<i>Rinodina intermedia</i> Bagl.	
<i>Rinodina mniaraea</i> (Ach.) Körb. var. <i>cinnamomea</i> Th.Fr.	
<i>Rinodina mniaraea</i> (Ach.) Körb. var. <i>mniaraea</i>	
<i>Rinodina mniaraea</i> (Ach.) Körb. var. <i>mniaraeiza</i> (Nyl.) H.Magn.	
<i>Rinodina olivaceobrunnea</i> C.W.Dodge & G.E.Baker	
<i>Rinodina roscida</i> (Sommerf.) Arnold	
<i>Rinodina turfacea</i> (Wahlenb.) Körb.	
<i>Sarcosagium campestre</i> (Fr.) Poetsch & Schied.	
<i>Schadonia alpina</i> Körb.	

Schadonia fecunda (Th.Fr.) Vězda & Poelt	
Solenopsora holophaea (Mont.) Samp.	134
Solorina bispora Nyl. subsp. bispora	111
Solorina bispora Nyl. subsp. macrospora (Harm.) Burgaz & I. Martínez	111
Solorina crocea (L.) Ach.	105
Solorina octospora (Arnold) Arnold	107
Solorina saccata (L.) Ach.	108
Solorina spongiosa (Ach.) Anzi	112
Solorinella asteriscus Anzi	
Sphaerophorus fragilis (L.) Pers.	47
Squamarina cartilaginea (With.) P.James f. cartilaginea	136
Squamarina cartilaginea (With.) P.James f. iberica Mattick	135
Squamarina cartilaginea (With.) P.James f. pseudocrassa Mattick	136
Squamarina concrescens (Müll.Arg.) Poelt	130
Squamarina lentigera (Weber) Poelt	135
Squamarina stella-petraea Poelt	137
Staurothele geoica Zschacke	
Staurothele terricola (Bagl.) Poelt & Nimis	
Steinia geophana (Nyl.) Stein	
Stereocaulon alpinum Laurer	46
Stereocaulon condensatum Hoffm.	44
Stereocaulon glareosum (Savicz) H.Magn.	47
Stereocaulon incrustatum Flörke	47
Stereocaulon rivulorum H.Magn.	46
Stereocaulon tomentosum Fr.	44
Teloschistes flavicans (Sw.) Norman	37
Thamnia vermicularis (Sw.) Schaer. var. subuliformis (Ehrh.) Schaer.	78
Thamnia vermicularis (Sw.) Schaer. var. vermicularis	79
Thelidium zwackii (Hepp) A.Massal.	
Thelocarpon citrum (Wallr.) Rossman	
Thelocarpon epibolum Nyl.	
Thelocarpon intermediellum Nyl.	
Thelocarpon laureri (Flot.) Nyl.	
Thelocarpon lichenicola (Fuckel) Poelt & Hafellner	
Thelocarpon macchiaae Nimis, Poelt & Puntillo	
Thelopsis isiaca Stizenb.	
Thelopsis melathelia Nyl.	
Thrombium epigaeum (Pers.) Wallr.	
Toninia albilabra (Dufour) H.Olivier	145
Toninia aromatica (Sm.) A.Massal.	139
Toninia coelestina (Anzi) Vězda	138
Toninia diffracta (A.Massal.) Zahlbr.	145
Toninia lutosa (Ach.) Timdal	138
Toninia massata (Tuck.) Herre	146
Toninia opuntioides (Vill.) Timdal	146
Toninia physaroides (Opiz) Zahlbr.	131
Toninia rosulata (Anzi) H.Olivier	144
Toninia sedifolia (Scop.) Timdal	147
Toninia squalida (Ach.) A.Massal.	137
Toninia taurica (Szatala) Oksner	144
Toninia toepfferi (Stein) Navàs	131
Toninia tristis (Th.Fr.) Th.Fr. subsp. asiae-centralis (H.Magn.) Timdal	143
Toninia tristis (Th.Fr.) Th.Fr. subsp. pseudotabacina Timdal	141

Toninia tristis (Th.Fr.) Th.Fr. subsp. tristis	143
Topelia rosea (Servít) M.Jørg. & Vězda	
Trapelia coarctata (Sm.) M.Choisy	
Trapeliopsis gelatinosa (Flörke) Coppins & P.James	
Trapeliopsis granulosa (Hoffm.) Lumbsch	
Trapeliopsis pseudogranulosa Coppins & P.James	
Trapeliopsis wallrothii (Spreng.) Hertel & Goth.Schneid.	130
Varicellaria rhodocarpa (Körb.) Th.Fr.	
Verrucaria geophila Zahlbr.	
Verrucaria xyloxa Norman	
Vezdaea aestivalis (Ohlert) Tscherm.-Woess & Poelt	
Vulpicida tubulosus (Schaer.) J.E.Mattsson & M.J.Lai	85
Xanthoparmelia somloënsis (Gyeln.) Hale	111
Xanthoria calcicola Oksner	85
Xanthoria contortuplicata (Ach.) Boistel	37
Xanthoria elegans (Link) Th.Fr. subsp. elegans	86
Xanthoria elegans (Link) Th.Fr. subsp. orbicularis (Schaer.) Clauzade & Cl.Roux	86