The Lichens
Baden-Württemberg

555 Color photographs
55 Black and white photos and drawings
996 Distribution maps

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(English translation by Doyle Anderegg)
In the last ten years studies of the lichen flora of the region have made substantial progress. This progress goes hand in hand with a general advance in the knowledge of the lichens in and around central Europe – a phenomenon who’s parallel is found in many other fields of knowledge and not ultimately associated with our days of easy circumstances. The strongly rising interest in lichens reflects also in the large number of new publications, which makes an entrance into lichen studies and lichen floristics possible. To these publications are to be added also the “Lichen Flora” and “The Lichens of Baden-Württemberg” by the author, which are sold out in spite of later editions. The first of these books aids in the determination of species and refers to the surrounding ecological characteristics of single lichens; the other introduces the results of an extensive charting of the lichens of the region and it is richly illustrated. Both have been completed. It was then obvious, a synthesis of the two – or more precisely – the expense of the two books, that was important. Basic work on the lichens of Baden-Württemberg to include keys and to expand the ecological diagnoses was repeatedly suggested in the interval. This synthesis is herewith submitted. Whereas the ecological characteristics of the lichens of the vicinity are unaltered from the lichen flora of 1980, the determination keys had to be entirely new work. They required not only considerable research into the knowledge of characteristics of species, but also the numerous new records of species of the region. On the side of the “Lichen Atlas” over 50 new species have been recorded for Baden-Württemberg alone. Newly added were descriptions of the systematic and diagnostically important characteristics of the representative genera. These previous species keys with morphological-anatomical characterizations of genera, which have had a long tradition in comprehensive keys and e.g. also are contained in the newer lichen flora of POELT & VEZZDA and PURVIS et al. seem for this work especially necessary, since the genus key is often only introduced in the interest of an easier keying of “accumulated genera.”

Numerous special publications of the genera served with regard to more modern characters, which refer to lichen flora and the guiding work of HAFELLNER (1984) as a well of information. The portion with color photographs was supplemented. In the species distribution maps extensive further charting has been allowed. We have however shown on a series of charts the unsatisfactory mapping of generally known species. We have the general desire of the land owner for environmental protection in establishing oversight in retaining the genera, although the known circumstantial data at the moment was handled in connection with special interests.

The preparation of this book was made possible in this lavish form, first of all by the financial support of the Foundation for the Protection of Nature in the Environmental Ministry (Stiftung Naturschutzfonds beim Umwelt-Ministerium). I sincerely thank the managing director of the foundation, Dr. E. HEIDERICH, for the extensive uninterrupted support. The book could not have begun without the essential financial help in support of the printing. Because the work stands on the shoulders of almost all other fundamental works and with the greater financial support made available, the lichen work rather than being the single handed work of one, the writing and daily managing was an equal effort with others. The free space for the work in this book was always restricted and the print is to provide greater continuity. Inadequacies, which may not be found in small number but which like to be avoided, have their cause here. I am therefore grateful to those, who assisted with patience, encouragement and support, to manage and to ease these situations: Dr. W. KRAHL, Dr. K. H. HÄRMS and Dr. J. MARX and the publisher ULMER with Miss U. STAMMEL, Mr. D. KLEINSCHEOT, Dr. S. VOLK and Mr. R. ULMER. I recognize also those who have assisted, in giving an attractive format to the first edition of these basic works: Dr. G SCHMID and Dr. U. KÜHL of the Foundation for the Protection of the Environment for beginning the venture, later – in the realization – especially Dr. S. KÜNKELE.
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At the beginning and end of this foreword is an expression of thanks to my family for their patience and forbearance.

Stuttgart, Herbarium 1994 Volkmar Wirth
Foundations and Illustrations

1 Introduction

1.1 What are lichens?

Lichens are not homogeneous organisms, but consist of two entirely distinct organisms, and indeed of one fungus and at least one alga, living together in close contact. Their double nature is outwardly not recognizable. Often the lichen resembles neither of the synthetic partners. The lichen is first rate in numerous specific attainments in structural independence. These are possible only through "cooperative work" of the partners. Several phenomena are only known from this plant group.

One such, the common living together in harmony by two different organisms one calls symbiosis. Symbiosis is known in several animal and plant groups, yet rarely is the symbiosis so perfected as in the case of lichens.

The lichen symbiosis brings fungus and alga substantial profits. The fungus receives carbohydrate from the algae necessary for its existence. The alga is protected in the enveloping intertwining fungus from rapid water loss, from intensive solar rays, or from easy clutches of algae feeding animals. With the help of symbiosis in the lichen the involved fungus and alga have their ecological potentiality considerably widened and are in the position, to colonize habitats, where each alone could not be successful.

The vegetative body of the lichen is known as a "thallus." According to the growth form of the thallus, one differentiates crustose lichens, leafy or foliose lichens, and fruticose lichens having shrubby to beard-like forms, foliose lichen lobes, more flat developing thallus, and crustose lichens crust-like or scruffy, the thallus grows together with the substrate, from which they can not be removed uninjured. Gelatinous lichens are brittle in the dry state, when moist they are swollen and more or less like tough-gelatin (see further below).

1.2 The Ecology of Lichens

Lichens are distributed world wide. Also in Central Europe they are species rich represented in a truly large number of forms and variety of colors. We find them on tree bark and wood, on rocks, walls, grave stones and tiles, on the soils of open forests, in heaths and moors. Most of the species live under very specific habitat conditions. One knowing these conditions, can search according to the species.

Many lichen species live almost exclusively on bark, others on wood, still others on calcareous rock (e.g. limestone, or dolomite) or on lime-free silicate rock (e.g. granite, gneiss, or basalt), others live on soil.

The mostly epiphytic, i.e. species living on tree bark do not occur equally on all tree species, but display a definite emphasis. One reason for that is that the barks of various tree species exhibit differing chemical-physical properties, above all, differing pH-conditions produced have accommodated single lichen species under certain conditions. Many occur on "acid" bark (e.g. spruce, birch, or alder), others on "base-rich" (bark) (e.g. walnut, Norway maple, or alder). Many species are limited to smooth bark and then disappear, when the tree, with increasing age, develops a rough cracked bark; others establish first on such older stems. Such relationships between the lichen species and the habitat conditions, hence ecological characteristics, can be fully valued key characters.

Similarly single lichen species are more or less limited to certain substrate attributes, “preferences” by definite light and moisture conditions. Many are “sun species”, others “shade species”, many are limited to cool, humid habitats and are more often found in forests, others tolerate even sunny, dry conditions and live on free-standing trees. Some are able to live on rain-protected flanks and in bark crevices – they cover their water budget from the water vapor of the air --, others are dependent upon the frequent soaking of the thallus with water. Such ecological characteristics are presented in the main part of the species descriptions.

One of the fundamental properties for the appreciation of the biology of lichens is the inability of these double organisms to continue constant metabolic activity, as we know it in the flowering plants during the vegetative period as an independent activity. Lichens can not regulate their water budget. They have no true roots. They can neither actively take up water nor in the case of dryness appreciably slow down the water loss; they have no evaporation protection. This means that in case of dry weather they gradually lose water that is necessary for the maintenance

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of metabolism and in metabolic inactivity, turn into an almost “lifeless” condition. At first in the case of renewed water supply, above all in the form of rain or dew, the metabolic process begins anew. The lichen thallus takes up the water with their entire upper surface like a sponge in a relatively short time.

These properties compel the lichen to lead a true alternating half life with constantly alternating pauses and times of activity. The inability to establish an enduring stable metabolic activity presence itself however on a few habitats is an advantage and makes them here superior to flowering plants. On tree bark and on naked rock flowering plants have no superiority because of the lack of root accommodation and with that the corresponding water shortage. Lichens have no problems thriving here. In the case of moisture they take up water from the atmosphere and utilize it for metabolic activity, in the case of drought they fall into a resting condition, surviving the difficulty.

Many lichens are not restricted, in their water budget directly by the direct wetting by rain and dew. Thanks to their remarkable ability to take up humidity (even when not saturated) from the atmosphere, they are active even at times of high humidity. Many species grow even in habitats, which are not touched by rain, as e.g. on overhanging rocks or deep in bark cracks and root hollows.

The quality of the described “changing moisture” and the frequent resting periods are one of the causes for the, to some extent, extraordinarily slow development of lichens. Yet a stronger basis for the phenomenon for all of that is the symbiotic nature of lichens: in the main a smaller part of the lichen mass – algae which often makes up about 10% of the volume – must support an unequally very much larger fungus part, so that for the growth of the double organism only negligible reserves of energy rich combinations remain for disposition.

Crustose lichens have, in our climate, a growth of about one to few millimeters per year, foliose lichens to little more than a centimeter, sometimes even less. This indicates that larger lichen thalli are already truly old. A greater age is reached especially in rock lichens, where the substrate subjected to atmospheric weathering is only very slowly altered and thereby the prerequisite is offered for a long time undisturbed growth. Such rock-dwelling lichens become, as a rule, at least several scores of years, often several hundred years, old. In the case bark

lichens, especially foliose and fruticose lichens, the dynamic forces are on the other hand accepted as having much larger role than the fact of the slowness of growth. Leaf- and foliose lichens fall from the bark often early after aging a few years above all in the winter months, when they, because of higher water content, become heavy and the attachment of the thallus is loosened by frequent freezing and thawing.

The lichens are in principle, so far as rain and dew falls, active throughout the year. Cool moist conditions are favorable. This is expressed e.g. also in that lichens are especially rich in species and individuals in humid, high precipitation regions and in the mountains. One extraordinary achievement of lichens is the ability of very many species, even at temperatures which lie substantially below the freezing point, to still carry on photosynthesis, also to remain metabolically active and grow. In cold regions lichens can thank this ability for being able to compete with flowering plants and produce soil dwelling lichen heaths.

1.3 Distribution of Lichens

Every plant species colonizes a well-defined, for it, characteristic region (see also chapter 4.5). Extension and form of these habitats or areas depend among other things intimately with the ecology and species together. Thus are the base-rich substrate directed soil lichens constrained within calcareous regions or moisture-requiring directed lichens, limited to strongly humid regions frequently dampened with rain.

Areas are not constant. Over a long time period they are altered, e.g. as a reaction to a climatic change. By way of example occurrence of ice-age relicts successively collected out of alpine Central Europe in a natural process, while the climatic changes of the refugium are moving further away from the optimum for these species. In the case of lichens and mosses growing on trees, their distribution may be altered as a result of the change in the area of their “favorite” carrier tree.

The natural alteration or oscillation of the frequency and distribution of lichen species have been since historical time overlaid and furthered exaggerated by changes caused by man. Thereby came about both the decline and advance, the shrinkage of area as well as the expansion of area.
1.3.1 Decline of Lichens

Many lichen species are becoming rare, while their living area due to the activities of man is destroyed or all too often is subjected to change. Their slow growth, often also in association with the late onset of reproduction, brings about an always stronger and more frequent meshing with the onset of an ominous environment. The dwindling of the occurrence of lichens has reached a dismaying degree. In Baden-Württemberg alone, that by its richly variable landscape offers much better conditions for the existence and the survival of lichens than many other regions of Germany, clearly over 10% of the species are missing or extinct. Dozens of lichens here are immediately threatened with extinction. Many have only a few refugia where especially favorable climatic and pure air conditions as well as little disturbance make survival possible up to this time. By stopping stronger decimation of the incidence and populations is to reckon with the complete disappearance of these lichens within the next year or next two decades.

Evidence for the decline is produced by old publications about the lichen flora, from others still maintaining access to collections of lichens from an earlier time. In old herbaria species are represented, which no longer exist today; many lichens extremely rare today are present from places, where they in the meantime have certainly disappeared.

The reasons for the decline of lichens are many fold. The intensive land and economic utilization in the widest sense, e.g. “destoning” and fertilization of poor turf (especially in the Black Forest) and the shifting of vineyards with the destruction of the typical vineyard wall on sloping sites. The massive clearing of farm land in the severe style of the years of the sixties and seventies have led to a scarcely assessable decimation of the lichen populations. A greater loss to the occurrence of the typical bark lichen flora came about through cutting down the street trees. From topographic maps we can determine that within the past forty years at least four fifths of the rows of trees along avenues and streets were exterminated. Methods of forestry utilization have lead to considerable impoverishment and to a change in the lichen vegetation of the forest, which had the effect of habitat alteration on large areas, especially clear-cutting and afforestation with exotic tree species, above all conifers. The scarcity of old trees in today’s managed forests produces a very negative effect upon the species diversity. It demonstrates that near natural richly structured forests with a correspondingly high portion of older trees and dead trees are especially rich in lichen species.

The most important causes of lichen decline includes the air pollution by power stations, industry, domestic combustion, and traffic. Lichens react to the emissions in many ways essentially as susceptible as other organisms; the modest resistance depends likely upon their (already referred to) special constitution, particularly their symbiotic nature, the lack of an effective protective tissue and their longevity. According to our knowledge, acid producing emissions are especially devastating, on the one hand directly as toxic substances, on the other hand indirectly by acidifying rain water, that as a rule is directly taken up by the lichen thallus. Sulfur dioxide is especially injurious to lichens, as it leads to injury of fundamental metabolic processes, which arise by acidifying the water and the substrates, resulting in many lichen species being no longer supported.

The impoverishment of the lichen flora is further advanced, as the increase in the burden of acid emissions. Many species are especially sensitive and therefore only still occur in regions with nearly pure air. Other species disappear in the case of moderate or at first stronger concentration of harmful materials. One can correlate the reading of the lichen flora, as an approximation of the degree of the burden of lichen damaging air pollution; that apparently the sulfur dioxide and the acid content of the rain water are most significant in the decimation of lichens, leading to indexing the region with more or less higher burden with respect to these factors with the help of certain lichen species (Wirth 1987). Numerous widespread species of bark-dwelling lichen species in this book allow – by the knowledge of the ecology of these groups – the use of bio-indication of that kind of burden.

Lately – as a result of decreasing sulfur dioxide emissions – a recovery has been identified in many species. The acid emissions, especially sulfur dioxide, are an especially important factor in emission caused lichen decline, but by no means the only one. Even dust and heavy metals play a role. In earlier times eutrification (fertilizing) increased air pollution and led then to extensive alteration of the lichen vegetation.
1.3.2 Extension of Areas

Occasionally one seeks vainly in old herbaria after lichen species, which today are more or less widespread. In a series of this kind of failures it is likely that it is in the order of the past one hundred fifty years that an increase in the frequency and an expansion of the region of distribution has occurred. This concerns e.g. several subatlantic distributed bark lichens. As a result of the missing continuity and intensity of the lichenological exploration we are left certainly – other than in the case of higher plants – with scarce data to bring to the history of expansion. The final conclusion in the case of tree-dwelling lichens is not entirely excluded, in that the species earlier were only overlooked and – of course substantially more rare – already was on hand in the region under consideration.

In one series of rock lichens, which also grow upon habitats from man’s activities, such as walls, boundary stones, and grave monuments, is the record of the distribution almost certainly leading (to man’s activities), since rock lichens in nature, from stone free regions only develop on these anthropogenic substances which promise necessary habitat. Possibly an exception are pioneer species, which are able to colonize small stones (e.g. river transported). Calciphytic lichens, which in nature are missing even from rock-rich regions, where the geologic basis is built upon acid silicate rock, find in the substrate ecology, very diverse offerings of human created materials and woodworks which likewise are existence requisites for lime-avoiding species in limestone regions. These lichens have expanded their areas more or less widely in geologically “inappropriate” regions and accordingly occupied only substrate-., not climate-caused spaces. These “opportunistic” species show a tendency to, with the help of humans in their potentials, take in an area limited only by climatic factors.

In contrast to the rock lichens existing in the region of Baden-Württemberg, bark lichens are substrate-determined in limits of their area, since the tree species limits of lichens with few exceptions is unimportant and the lichen ecology is accepted as of more significance (base-poor or base-rich) “bark qualities” in the entire region. The oft times very well marked area picture of epiphytic lichens must be interpreted therefore as extensively climatic, if not in the meanwhile (overlooked) due to interfering air pollution associated factors, which have controlled the fluctuation of the areas.

An appearance of neophytes, also non indigenous taxa earlier in the entire region, may in Baden-Württemberg in the case of lichens be proved for only very few, almost always inconspicuous and easy to confused species were drawn for consideration. An indication, that a certain species did not occur at one certain point in time in the region, is naturally scarcely to be furnished. By incorporation of ecological and plant geographic viewpoints it must be accepted in most cases, that the species in question certainly might formerly have been definitely more rare, but likely however having a natural occurrence, from which they spread out. It is indeed remarkable that even in the last 30 years numerous subatlantic species new to southwest Germany or larger parts of Germany have been identified; among these are a few meanwhile not only widespread, but locally frequent. These exceptions may be even a result of the milder climate of recent years.

2 Collection and Herbarium Preparation of Lichens

The collection of lichens is easy. As far as removing them without more of the substrate (many soil lichens), they are removed with a knife or with hammer and flat chisel together with a piece of the substrate. One wraps the lichens on the spot in paper bags and notes habitat, substrate and date. Plastic bags are suitable only for short-time transport, since fresh material mildews in longer storage in plastic bags.

One must dry fresh material; after that it may be placed in herbarium packets (covers) without further expense. Shrubby fruticose lichens take much room and break easily. One must, while they are still fresh and elastic, press them lightly (usually slightly moistened beforehand). One places a thin card in these herbarium packets for stabilization and support of the lichens.

Specimens of lichens on bark, rock etc. may also be glued to the card; a gluing of soil lichens avoids a breaking up of the specimen. However the (foliose and fruticose) lichen itself should never be glued by their undersides, since then the character of the underside could not be analyzed.

Herbarium specimens ought to be furnished with a label, on which is noted the locality,
habitat (to facilitate determination), date and collector.

Without any doubt impending in the consequences of the precipitous increase in the number of those interested in lichens is a further danger to these already richly collected organisms: is the decimation and extirpation by lichenologists. In collecting lichens one ought to consider that many lichens are rare and endangered. In many cases the collection of only five to ten specimens would have the result of extirpation of the species in Germany. One collection of rare species is without justification, especially so, when the lichen already is known and documented from the region. Occasionally one can in a certain region collect species endangered in other regions, where they are still frequent, without an aggravating result being "provided."

A completely removed specimen grows no longer. The decimation of a population can lead to the endangering of the rest of the population. A resettling of a species on a locality, on which it was obliterated, seems in the case of rare foliose and fruticose lichens in many ways extremely unlikely. This is valid especially for species, which reproduce with the help of relatively heavy soredia and isidia.

3. Investigations and Determinations of Lichens

3.1 Introduction

Most foliose and fruticose lichens may be determined without more than the aid of a hand lens, a few without the aid of optical devices. Important are e.g. form and color of the thallus and the fruiting body, occurrence of warty outgrowths (isidia) and "mealy" eruptions (soralia) and other organs. For the determination of crustose lichens the use of a microscope is as a rule necessary. Indeed the experienced lichen specialist can easily distinguish almost all lichens including the crustose lichens by habitat and ecological characteristics alone, but in determination one can not commonly by external characteristics alone, sufficiently through our grammatical potentiality, be exact enough about the fine distinctions in coloring and structures to define them in keys. For this reason measurable and clearly defined microscopic characteristics must be applied, e.g. spore form and size, structure of the fruiting body, coloring of the fruiting body parts etc. For the determination of such characteristics sections through the fruiting body are often necessary.

The producing of sections is not difficult. They are made much easier, when a binocular or a dissecting scope is used, under which one can work with both hands. At least in the larger fruiting bodies, sections may be prepared without the aid of lenses.

With one hand one holds the lichen fast, with the other hand one draws an unused razor blade parallel (vertical) sectioning through the fruiting body. At best one removes to begin with a marginal part, perhaps a fourth or a third of the fruiting body and next cuts the thinnest possible slice, as from a loaf of bread, in many lichens the fruiting body is easily broken loose and then is more difficult to manipulate. In this case one can capture the fruiting body with a tweezers or a preparation needle and glue it to a wooden or paper support. The section can be accomplished dry or (above all, in the case of hard fruits better) with objects swollen with water. It can be very helpful when one holds the object fast with one finger so that the fingernail is almost at a right angle and is used as "backdrop" for the razor blade. The section may be lifted easily from the object with the (under the circumstances) moistened edge of the razor blade or with the point of a preparation needle. It is then placed in a small water drop on the slide and covered with a cover glass. If the section is not thin enough, one may squash it somewhat. For which one places the slide with the cover glass beneath upon a page of filterpaper and presses.

A considerable aid in determination is offered by color reactions of the lichen thallus with designated chemicals. Many lichens contain the same substances, which with these substances yield colored reaction products. The most important reagents are calcium hydroxide (KOH), calcium or sodium hypochlorite (Ca(OCl)2 / NaOCl2) and para-Phenyldediamin (H2NC6H4NH2). The procurement of reagents becomes increasingly more difficult. Chemical handling comes into question, under circumstances even for apothecaries and druggists. Druggists of commercial chains today do not accept individual orders.

3.2 Important Diagnostic Characteristics of Lichens

3.2.1 Color of the Thallus
The lichen species are for the most part white-gray to bluish-gray, greenish-gray, or yellow-greenish, rarely brown, yellow or orange colored. Although the color of the thallus is an important character, the proper specification of thallus color is problematic. The lichen colors are frequently difficult to describe. At first the practice was to show to the reader a key little by little, whatever he was to understand under many color descriptions. Here the aid of color photos is a way around the deficiency of our language. Thus documenting a picture of Parmelia caperata or the beard lichen Usnea, it becomes understood what blue-greenish to yellow-greenish is in lichens, while the mere color description without picture documentation always leads to further misunderstanding.

### 3.2.2 Structure and Organs of the Thallus

#### Growth Forms

Three main types of growth forms of lichens are described: crustose lichens with pure crustose thallus, foliose lichens with leaf-like, ± lobed thallus and fruticose lichens with shrubby to filamentous thallus. Between foliose and crustose lichens are intermediate forms with squamulose thallus and such crustose lichens, whose margins are clearly lobed. These crude divisions do not do justice to the majority of the forms of the lichens. They are however very useful for a first response. The more precise characterization or the growth form arises from the preparation of key parts. The group of gelatinous lichens is characterized by the gelatinous consistency of the thallus (in the moist condition swelling gelatin-like); they can include various growth forms.

Especially in the level of organization the crustose lichens are differentiated into many types of thallus forms, whereby above all their position is accepted on the degree of division of the thallus and upon nature of the upper surface.

#### Organization and Nature of the Upper Surface of the Thallus

The upper surface of the foliose and fruticose lichens is – apart from the occurrence of isidia and soralia (see below) – smooth to rugose or from time to time weakly organized raised ridges. In many crustose lichens the thallus is cracked or subdivided into ± separated areoles; it may even consist or more or less closely crowded to scattered granules or sometimes completely mealy disintegrate. One speaks of a coralloid thallus when it is made up of elongate branched “granules.”

Organization of the Thallus of Crustose Lichens

- **Egg-shaped, varnish-like, or membranous**
- (not or scarcely cracked)
- **Cracked**
- **Cracked areolate** (reticulate cracked, thereby consisting of areas, area flat)
- **Areolate** (clearly separate areas)
- **Warty areolate** (Areoles convex)
- **Squamulose** (Areoles isolated, in the form of ± overlapping other areoles, the edges often crenate or lobed, usually raised from the substrate at the edges; if squamules more strongly divided of clearly erect: crossing over to “small foliose”)

Upper Surface Condition of the Thallus of Crustose Lichens

- **Mealy** (very finely granular, “dusty”; when the upper surface is totally disintegrated it is called “leprose”)
- **Granular** (finely or coarse granular)
- **Warty** (Thallus uneven, unevenness warty convex)
- **Wrinkled** (Thallus irregularly uneven)
- **Coralloid** (of coral-like branched granules)
- **Smooth**

#### Soralia and Isidia

The soralia and isidia are among the most important diagnostic organs of the lichen thallus. They serve for vegetative reproduction. Existence and form of soralia and isidia are species specific characters.

Isidia are usually simple peg or clavate form to coralloid branched or even almost spherical outgrowths of the upper side (see illustration), they are easily broken off and may grow into young lichens. They are generally colored similar to the thallus and are even anatomically not basically constructed other than the thallus from which they are an outgrowth.

Soralia are a somewhat mealy, usually whitish to greenish-gray outgrowth of the thallus, which
consists of an accumulation of tiny, + spherical reproductive granules, the soredia. The soredia usually lie close to the algae layer of the thallus. Position and form of the soralia are species specific distinctions. They may sit upon the surface, at the edge or on the ends of lobes, have a long streak linear or rounded outline and be concave to strongly convex or lip-form. The various types of soralia are considered in the list of technical terms. An oversight of distinct forms results in the following illustration. Many lichen species produce no normal bordered soralia, but large areas of the upper surface becomes sorediate or even the entire thallus.

**Rhizines, Cilia, and Pseudocyphellae**

On the underside of foliose lichens are found attachment organs which serve to attach the thallus to the substrate. The most frequent are rhizines (fastening filaments); which may be regarded as simple, forked or like a brush or bottle cleaner (Illustrated on page 729). In the case of many foliose lichens the underside is covered with a ± thick hairy layer, in others a network develops. Soil-dwelling fruticose lichens sit loosely on the substrate, rock and bark dwellers are generally attached with a somewhat broader base, an attachment disk.

In the case of some few species of foliose and fruticose lichens the indigenous flora the lobe margins or lobe ends are provided with characteristic setiform projections (also known as cilia) (See page 75). Pseudocyphellae are also important diagnostic structures. These are very delicate point or linear whitish eruptions or lacunae in the cortex above all of foliose and fruticose lichens (See page 75 and 276). Sometimes the lines are reticulate and sit upon very weakly raised ridges (See page 663).

### 3.2.3 Structure of the Thallus

In the lichen the fungus envelops with a mesh of filamentous structures (hyphae) usually numerous single, rarely multicellular algae the partner species. The algae are commonly concentrated in a zone, in the case of gelatinous lichens mostly distributed over the whole thallus. The residual space in the lichen is taken up by the fungus partner, which also by the arrangement of the hyphae often determines the form of the lichen.

Toward the outside the fungus hyphae often produces a thick protective, especially structured cortex. The algae layer, in which the algae are entwined by fungus hyphae, lies under the cortex. Under the algae layer is developed a usually relatively thick medulla of loosely interwoven hyphae. In the case of crustose lichens, the thallus with the medulla rests upon the substrate. In the case of foliose and fruticose lichens, a cortex is usually also developed on the underside, i.e. the lichen is encircled by a surrounding cortex layer. Special attachment organs often also occur on the underside, e.g. rhizines.

The cortex in section shows a structure of more or less rounded-multiangular cells (see page 24), which are called paraplectenchymous or pseudoparenchymous (reminiscent of a parenchyma of higher plants). If they are more parallel structured of elongated cells, they are called prosoplectenchymous (see page 24).

Almost all lichen fungi belong to the ascomycetes, to which e.g. also are numbered the cup-fungi and morels. Yet the lichen fungi do not often occur free-living, but have become completely dependent upon the lichen symbiosis. The lichen algae belong for the most part to the green algae, to a smaller degree to the blue-green algae or cyanobacteria. Each lichen species is characterized by a specific fungus, occurring only in it, as well as by a mostly definite species of algae. One and the same alga species may occur in various lichen species. For an oversight of the most frequent algae see page 64 and illustrations on page 64 and 65.

### 3.2.4 Form and Structure of the Fruiting Body

**General**

Fruiting bodies are relatively frequent in the case of crustose lichens. Many native foliose and fruticose lichens on the other hand do not commonly fruit and reproduce instead vegetatively with the help of soredia, isidia, thallus fragments. Conversely, as a rule, regularly fruiting species do not produce vegetative reproductive organs.

Fruiting bodies appearing in lichens result in connection with sexual process of the lichen fungus. Since almost all lichen fungi belong to the Ascomycetes, the fruiting bodies are the so called ascosporangia. When the spore generating tissue (hymenium) lies open to view, it is an **apothecium**, if it is enclosed in a more or less spherical structure and only open to the world
through a pore, as a rule it is a **perithecium**. Apothecia are generally sharply set off from the thallus, in outline rounded, disk- to bowl-form or hemispherical structures, which may be variously colored. In many groups the apothecia have an elliptic to elongate form; which may even branch or be stalked. Often the apothecia are clearly bordered (see illustration). If the margin is colored like the remaining part, the so-called disk, it is called a proper margin; if it has the color of the thallus and includes it, corresponding to the structure of the thallus, and algae, it is considered a thalloid margin.

The apothecium consists fundamentally of the hymenium, and the hypothecium which lies under the hymenium and is a ring- to bowl-form enclosing tissue. These structures protecting the hymenium may be similarly constructed like the thallus and contain algae; they are then outwardly recognizable as a thalloid margin. Apothecia with a thalloid margin are designated as lecanorine. In apothecia without a thalloid margin whose structure is algae-free and is constructed only of hyphae and is called an excipulum (proprium). The excipulum often externally recognized as a proper margin; sometimes is completely lacking. Excipulum and hypothecium are colorless or pigmented. In lecideine apothecia the excipulum is at least partially carbonaceous hardened.

The upper surface of the hymenium is externally visible as the disk. The uppermost region of the hymenium, the epihymenium, is generally colored, sometimes also interspersed by the smallest crystals. The whole hymenium is rarely ± colored. It is made up of more or less perpendicularly arranged hyphal threads, the paraphyses, a structure which is easy to recognize in the section of the fruiting; between the paraphyses sit the cylindrical, clavate, or bulging asci, in which the spores grow to maturity. Up to eight spores are generally produced and they are single or multicellular, colorless or colored.

The crustose lichens may be divided into groups according to the form and structure of the fruiting body, which makes the first response easy, e.g. pyrenocarpic lichens (with perithecia), coniocarpic lichens or goblet lichens (species with delicately stalked fruiting bodies) or lirellocarpic lichens (species with “streak form” fruiting bodies).

**Morphologic Characteristics**

The determination of the size, structure, color, margin and position of the fruiting body on the thallus plays a role in the morphologic characteristics of the fruiting body.

**Size**

With respect to the width (diameter), rarely (in the case of “pin-shaped” fruiting bodies) the height; often only the maximum size is given (without the whole range of values), sometimes minimum- and maximum size.

**Form**

Here the outline of the fruiting body (e.g. rounded or elongate), form and upper surface structure of the disk (concave, flat, convex, channeled) plays a role.

**Margin**

The external visible border of the apothecial disk is described as the margin. A very prominent margin is called “bulging.” With increasing age of the apothecium often there are changes in the curvature of the disk and the prominence of the margin: in youth the disk is flat, the margin is clearly developed, in old age the disk becomes convex and the margin gradually disappears. A thalloid margin (see above) is commonly thallus colored, a proper margin is generally the color of the disk.

**Position**

It varies between sessile, partially (±) sunken, completely sunken (i.e. not penetrating the thallus upper surface) and deeply sessile fruiting bodies. Sessile apothecia may be closely attached to the thallus or somewhat more loosely, i.e. sitting on a narrow base.

**Anatomic (microscopic) Characteristics**

Characteristics under the microscope of importance in determination are color and structure of the excipulum and hypothecium, form and branching as well as color of the end cells of the paraphyses as well as coloring, septation, form and size of spores.

**Excipulum, Hypothecium, and Hymenium**
The color intensity of the excipulum, ephihymenium and hypothecium depends on the section selected. The color given in the keys, so far as possible, relates to that which would be perceived from a thin hand section. The structure of the excipulum is often only perceptible on really thin sections, at best on microtome sections of 15-20 µm thick. The height of the hymenium is measured from the base of the ascus to the outer boundary of the ephiymenium, therefore including the ephiymenium. The hymenium height corresponds to the height of the paraphyses. Here the outermost colored region of the hymenium is designated as the ephiymenium, no matter where the color is located. The hymenium is commonly colorless. Sometimes rays of color penetrate deep into the hymenium.

Paraphyses and Paraphyses-like Structures

It is the practice, in the determination keys of this book, to call all sterile filamentous structures within the hymenium paraphyses. According to the developmental layering viewpoint one may therefore distinguish more forms of paraphyses-like structures. True paraphyses grow from the underlying region of the hymenium toward the upper and are from the first free at the ends. Paraphysoids, in contrast to the true paraphyses, originate largely from ascus production; they are often especially thin, the cell septa wide apart. Pseudopara-physes grow from the upper part perithecia-like fruiting bodies developing between the asci and binding to the base of the hymenium; they are commonly regularly septate, relatively thick, branched and bound to one another. Diagnosis of genera depend upon the various types of “paraphyses.”

The paraphyses may be thickened at the tip or not thickened, may be branching or reticulate bound (anastomosing). Simple, entirely, or predominantly unbranched paraphyses are known. The relationships are often difficult to judge. Adding KOH often results in greater clarity. Weakly cemented paraphyses are loosened from one another by a slight pressure on the cover glass, at least after addition of KOH (characteristic “paraphyses easily free”). In rare instances paraphyses are missing or deliquescing and are then only to be recognized in the young.

Periphyses occur in perithecia; they are filamentous hyphae, which project from the mouth region (ostiole).

Asci

The structure of the ascus has attained great importance for systematics in recent years. This is reflected also in the diagnostics of lichens. Fissitunicate (or bitunicate) asci have walls whose layers are loose from one another at the opening of the ascus, they are also functionally distinct in action; the more frequent non-fissitunicate (or unitunicate) asci have walls which are not made up of functionally distinct layers. At the tip of the asci are frequently found the so called apical structures, which serve as the opening of the asci. An analysis of these structures which are especially recognizable after coloring with iodine, aids in genus determination. Their study requires however a great deal of experience and accurate observation. The tholus, the thickened inner part of the ascus apex, has especial importance. A protrusion of the ascus interior into the tholus in certain respects a trench-like recess of the tholus into the ascus lumen is called “chambre oculaire” or ocular chamber. Within the tholus one can often distinguish a region not or weakly colored with iodine (“axial mass”). A table (page 30) gives illustrations of important ascus forms and apical structures.

Spore

Spore size and form are very important characteristics. The size is carefully measured with the ocular micrometer (length and breadth). Significant forms: spherical, broadly ellipsoidal (less than twice as wide as long), narrowly ellipsoidal (more than twice as long as wide), elongate, fusiform, peg-like, or needle-form (see illustration on the right p.31).

Pycnidia

Pycnidia are as a rule spherical to pear shaped receptacles, which commonly are sunken in the thallus and resemble perithecia. In their interior, pycnospor (p=pycnidiospores) are segmented off of specialized hyphae and expelled to the outside through a narrow opening (ostiole). The pycnospor are mostly single celled and colorless. They function as asexual reproductive bodies (conidia), in other cases it is very probable that they have a sexual function, as male sex cells (spermatia). In a few species two or three different types of pycnidia are found with various sizes and shapes of pycnospor,
which are then described as macro-, meso-, and microconidia; microconidia are always single celled.

Pycnidia are usually recognized as very small blackish points on the thallus; in many cases the pycnidia are stalked or are sessile on the thallus as warts.

3.2.5 The Chemistry of Lichens: Determination with the Aid of Color Reactions

Many lichens contain well-defined secondary metabolic products, so called lichen substances. These are organic compounds of most variable structure, which for the most part are known only from lichens. Well versed lichenologists can discover them by means of various processes, e.g. thin layer chromatography. A few of these substances are colored (pigments). These pigments are commonly localized in the cortex of the lichen thalli and are responsible for the yellow, yellow-greenish, brown, or red coloring of many species. Most of the lichen substances are colorless; with few exceptions they are localized in the medulla of the lichen thalli.

The awareness of lichen substances is of considerable importance, in some for the systematics of lichens, in others even for the determination of species. One part of the lichen substance reacts with the reagents such as calcium hydroxide or sodium hypochlorite to produce a color. Since similar appearing species often have truly varying lichen substances, these color reactions provide worthwhile additional information and a simple determination aid. (Table page 34-36).

In practice the smallest possible drops of the reagent is placed upon the site of the lichen thallus to be tested and the reaction ascertained, whether immediate or gradual, commonly occurring within 15 seconds. The reaction of the lichen cortex (i.e. the upper side of the lichen) and of the lichen medulla is often distinct because of differing lichen substances in these thallus parts. Since sometimes interesting diagnostic lichen substances lie in the medulla, it is in these cases important to test the reaction of the medulla. Therefore the medulla must be uncovered in a sufficiently large surface through a section almost parallel to the upper surface. Each must develop his own technique. One can, for example, “clamp” the razor blade at the narrow side between the thumb and index finger, bringing it by the slightest pressure of the finger into a weak concave form and in very small angle section through the upper surface of the lichen.

This manipulation and the observation of the reaction is most easily carried out under the binocular scope. The large reagent drop spreads over a large surface. The differentiation of the reaction between lichen cortex and lichen medulla may then be made difficult. In foliose lichens the best section for testing the medulla reaction is from the underside of the lichen, since here an eventual reaction of the lichen upper cortex can be avoided or less bother.

For doing the color reactions one transports the reagent e.g. with a pipette or on the tip of a glass rod. Often the bore of commercial pipettes is too large and the droplet adhering to the pipette is too large, so that the reagent spreads out on the lichen over an unnecessarily large surface. It is better to bring a droplet from the pipette to the edge of a razor blade or onto a toothpick, scraping off excess liquid and only then applying it.

For testing the reaction one takes a piece of the lichen which will be disposed of later. One avoids the testing of original portions that must be placed in the herbarium. It may be spoiled by dispersion of the drops. In other cases the customary reagent is toxic and easily stains the paper envelop. The clarity of the reaction depends upon the concentration of the lichen substance. In many cases it cannot be clearly determined whether the reaction is positive or negative. This reaction arises, when the reaction of the thallus is questionable or not otherwise specific, as carried out on the upper side of the thallus.

In testing for color reaction on dark lichens (e.g. Bryorias) one lays the lichen tested upon a piece of white filterpaper on a slide. Then a few drops of reagent, e.g. P, are dropped upon it: the reagent diffuses into the white paper, so that the color reaction is better recognized than upon the dark lichen. Also when the lichen has the same color as the anticipated color of the reaction or in the case of very weak coloring (e.g. K+ yellowish), it ought to dealt with in the way described (color is often more definite after drying the paper).

Contact of the reagents with the skin and with materials of sundry type ought to be avoided. Above all para-Phenylendiamine is very injurious to health and not infrequently causes in the process damage to garments, paper and furniture. Calcium hydroxide and
hypochlorite produce corrosion and bleaching. It is self evident that contact with the eyes is hazardous. If this comes to pass, immediately rinse the region of the eye with flowing water.

**Reagents for the Determination of Lichens**

The following reagents are required: 1. Potassium hydroxide (Abbreviation: K), 2. Calcium or sodium hypochlorite (C), 3. Para-Phenylenediamine (P), and 4. Iodine solution (J). The regents keep longer when stored in brown bottles and in the dark.

**Potassium hydroxide:** 2-4 g of potassium hydroxide is dissolved in 20 cc of water. The solution is infinitely stable. A false judgment of the yellow reaction is sometimes possible, since K makes the cortex transparent and the underlying yellow-green algae layer gives a misleading ± yellow-greenish coloring (see remedy below: white filter paper).

**Calcium Hypochlorite or Sodium Hypochlorite Solution:** Calcium hypochlorite is obtained by dissolving chloride of lime (bleaching powder) in water to saturation. Since at best the solution is stable for one day and in addition the precipitating chloride of lime may cause annoying whitish flecks, it is better to use sodium hypochlorite solution. They must however be renewed from time to time, at best every two months. Equally effective are chlorine containing household cleansers (e.g. Clorox, also of finite stability). Verification of the strength of the solution is produced by a simple test with a test lichen (e.g. Hypocenomyce scalaris). The reaction with C is often very fleeting, therefore observe immediately!

In the case of the occasionally needed KC reaction, first potassium hydroxide is used, then C is brought to the same test site. As a rule, in this way the C reaction is stronger and more definite; the KC reaction is not however always identical to the C reaction. In rare instances a CK reaction is asked for (first C, then K!).

In the case of the test with KC on yellowish species proceed in the following manner: lay a piece of lichen on a slide and drop a little K over it. After a little time take up the K with white filter paper. Afterwards put a drop of C on the paper and observe the color.

**Para-Phenylenediamine solution:** This reagent is poisonous and leaves behind flecks on clothing etc. (see above). Do the reaction with P when it is stated in the species description. Avoid however the reaction with P on principle, when it is not essential for the determination.

The reagent (according to Steiner) is prepared as follows: 1 g para-Phenylenediamine, 10 g sodium sulfite and 1ml of a detergent in 100 ml water. In this form it is stable for more than a month.

An alternative to the health threatening para-Phenylenediamine is offered by the Color Developer 1 of Merck; it was formulated for the color film developer process. According to the formula: 10 g sodium sulfite, as (Na2SO3) completely dissolved in distilled water + 3 g N4,N4-Diethyl-1,4-phenylene-diaminesulfate (color developer) + 1 ml of a detergent, shake until completely in solution. The solution is stable for more than a month. The reactions with this reagent appear merely somewhat later on and the color is in the majority of cases pale (orange instead of red).

**Iodine Solution,** for the study of the reactions of the hymenium and of asci best in the form of Lugol’s Solution (Merck): 0.5 g iodine, 1.5 g potassium iodide, 100 ml distilled water. A pretreatment with 10% potassium hydroxide is advantageous, in making possible reliable statements in studies of ascus structure. The abbreviation for this is K/I.

**Over sight of the most important lichen substances and their reactions**

Explanation: Indicated color reaction only with a sufficient concentration of the lichen substance. Above all in the case of P the reaction often alternates between yellow-orange and red. In parenthesis: in practice the reaction (on the lichen) is often unclear or fails to appear, therefore to be carried out on isolated material.

Without indication: reaction the lichen negative, not proven on isolated material.

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<td></td>
</tr>
<tr>
<td>-2-methyl ester</td>
<td></td>
<td>red-orange</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oxypannaric acid</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-6-methy ester</td>
<td></td>
<td>red-orange</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pannaric acid</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pannaric acid-6-methyl ester</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pannarin</td>
<td></td>
<td>orange</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parietin</td>
<td>red</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perlatolic acid</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physodic acid</td>
<td></td>
<td>(red)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physodalic acid</td>
<td>yellow-brown</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Picrolicheninic acid</td>
<td></td>
<td>violet</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pinnastrinic acid</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Placodiolic acid</td>
<td></td>
<td>(yellow)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Planaic acid</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Porphyric acid</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Protocetraric acid</td>
<td>yellow-brown</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Protolichesterinic acid</td>
<td></td>
<td>red</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Psoromic acid</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pulvinic acid dilaecton</td>
<td></td>
<td>yellow</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rangiformic acid</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rhizocarpic acid</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rhodocladonic acid</td>
<td>dark red</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roccellic acid</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salazinic acid</td>
<td>yellow/red</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Schizopeltic acid</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scrobiculin</td>
<td>(yellow-red)</td>
<td>red</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sekikaic acid</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skyrin</td>
<td>red</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sordidon</td>
<td>yellow</td>
<td>yellow</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sphaerophorin</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Squamatic acid</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stenosporic acid</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stictic acid</td>
<td>yellow</td>
<td>orange</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strepslin</td>
<td>green</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thamnolic acid</td>
<td>yellow</td>
<td>orange</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thiophanic acid</td>
<td>orange</td>
<td>orange</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thiophaninic acid</td>
<td>yellow</td>
<td>orange</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thuringion</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Usnic acid</td>
<td></td>
<td>(yellow)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Variolaric acid</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vicanicin</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vinetorin</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vulpinic acid</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zeorin</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Oversight of the most important Pigments

<table>
<thead>
<tr>
<th>Pigment</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calycin</td>
<td>orange-red</td>
</tr>
<tr>
<td>Parietin</td>
<td>yellow-orange</td>
</tr>
<tr>
<td>Pulvinic acid</td>
<td>yellow</td>
</tr>
<tr>
<td>Pulvinic acid dilaecton</td>
<td>yellow</td>
</tr>
<tr>
<td>Rhizocarpic acid</td>
<td>yellow</td>
</tr>
<tr>
<td>Skyrin</td>
<td>yellow-red</td>
</tr>
<tr>
<td>Sordidon</td>
<td>yellow</td>
</tr>
<tr>
<td>Usnic acid</td>
<td>light yellow</td>
</tr>
</tbody>
</table>

**Use of UV-light as an aid to Determination**

Many substances – corresponding as well to the lichen parts containing these substances – glow white, blue-white, or other colors, in the light of commercial UV-lamps (e.g. as used for postage stamps). As a rule, these phenomena are to be seen in the medulla of lichens, therefore a
abrasion or a cut is to be recommended. The UV-lamp is used in the dark; the eyes ought to be protected by spectacles. The test ought to be done on a base, which does not glow in UV-light. White paper often glows strongly and interferes with observing the UV-reaction. Many UV-lamps allow observing in short wave (254 nm) and long wave (e.g. 366 nm) UV. In the short wave region one generally gets the clearer result.

4 Explanation for Geobotanical Characterization of Species

In the attachment to the Key the species of each genus is presented in alphabetical order under the title “Ecology and Distribution.” If necessary synonyms with author names and species names are provided after them in parenthesis. The description, which follow the method of Oberdorfer's plant sociological excursions flora, include in the first line data about the habitat, the association, the vegetation, the higher divisions, distribution and frequency in southwest Germany and environs as well as about the entire distribution in Europe. In addition to the frequency indications, the estimate about the threat of the species in Baden-Württemberg is presented in parentheses. An enclosed in parentheses ecological conception signifies an attenuation: example: “extreme-considerable (moderately) acidophytic” means that the plant is extremely to considerably acidophytic, less strongly even moderately acidophytic. Ecological and sociological characteristics become of considerable value when a similarity with other lichen species is present.

4.1 Evidence about Vertical Distribution and Large Scale Climate

The evidence about the vertical distribution and the large scale climatic conditions play a large role in the distribution of the species in each case of examination of territory. These data may not without addition be carried to other regions, and one must always be conscious of their systematic characters. Following altitude readings were employed (applicable to Central Europe, altitude readings for southwest Germany and environs): Foothills: Hilly country, below mountainous country up to ca. 400 m, with warmth loving communities, e.g. oak-hornbeam forests; growing susceptible fruits and vineyards. Submontane: the transition between the foothills and montane phase. Montane: Mountain region, approximately between 500 and 100 m. Predominantly of beech- and beech-fir forests. High montane: Mountainous country approximately between 1100 and 1600 m. beech-fir, fir-spruce, spruce-forests, high shrubs-mountain mixed forests, shrubby heaths and setaceous grass turf. Subalpine: Krumholtz zone between 1600 and 1800 m, shrubby Scot’s pine, and pine forest outposts. Alpine: Mountain region above the forest and tree line, alpine meadows, dwarf shrubby heaths, and rock fields. The snow level is not included here. Dealpine: From the alpine level down to the submontane (or foothills region) locations (in lower locations occurring e.g. as ice age relicts and by flooding). The amount of rainfall is very significant. It is within known limits also a measurement of relative humidity, since rainfall charts and humidity charts show a rather good correlation with one another. The following representation was employed for characterizing the rainfall level:

<table>
<thead>
<tr>
<th>Rainfall Level</th>
<th>Precipitation</th>
</tr>
</thead>
<tbody>
<tr>
<td>very low</td>
<td>-600 mm/year</td>
</tr>
<tr>
<td>moderately low</td>
<td>600-750 mm</td>
</tr>
<tr>
<td>moderately high</td>
<td>750-1000 mm</td>
</tr>
<tr>
<td>rather high</td>
<td>1000-1400 mm</td>
</tr>
<tr>
<td>very high</td>
<td>1400- &gt;2000 mm</td>
</tr>
</tbody>
</table>

Areas were designated as Warm sites, in which vineyards are possible, as fairly warm such areas in which fruit trees are favored, as moderately cool sites in which corn growing is favored. Mild sites are distinguished by relatively little annual variation in temperature, a small number of freezing days and late frosts.

4.2 Evidence about the Habitat

4.2.1 The Substrate
Many lichen species are fairly substrate specific to the extent that they are limited for the most part on bark or wood or silicate rock or limestone or soil and scarcely ever change over to other substrates. A further substrate related specialization is caused by pH conditions, nutrient supply, water capacity (water storage capacity) and other chemical and physical properties of the substrate. A few examples: Many bark lichens are limited to acid and nutrient poor bark and therefore are found predominately on conifer trees, others are specialized on base-rich bark, certain rock lichens live only on heavy-metal rich silicate rocks, others prefer fine granular, relatively porous calcareous rock. Very rotted wood is floristically distinct from tough and hard wood.

**pH Value**

Soil- as well as bark- and rock-dwelling lichens at times show pH characterized dependence. For example certain lichen species occur only upon calcareous and base rich soils, others only on very acid.

The evidence for the critical point pH-value of sites colonized by the species is supported by extensive pH-measurements with a portable pH-meter with a flat membrane electrode (see Wirth 1972); they were for the most part accomplished on site on rain moistened or distilled water moistened substrates. The pH conditions were described as follows:

<table>
<thead>
<tr>
<th>Substrate</th>
<th>pH</th>
<th>Plants</th>
</tr>
</thead>
<tbody>
<tr>
<td>extremely acid</td>
<td></td>
<td>- pH 3.3</td>
</tr>
<tr>
<td>acidophytic</td>
<td></td>
<td>extreme.</td>
</tr>
<tr>
<td>very acid</td>
<td>pH 3.4-4.0</td>
<td>very acidophytic</td>
</tr>
<tr>
<td>rather acid</td>
<td>pH 4.1-4.8</td>
<td>rthr acidophytic</td>
</tr>
<tr>
<td>moderately acid</td>
<td>pH 4.9-5.6</td>
<td>mod acidophytic</td>
</tr>
<tr>
<td>sub neutral</td>
<td>pH 5.7-7.0</td>
<td>sub neutrophic</td>
</tr>
<tr>
<td>neutral</td>
<td>pH 7</td>
<td>neutrophic</td>
</tr>
<tr>
<td>moderately basic</td>
<td>pH 7.1-8.5</td>
<td>mod basic</td>
</tr>
<tr>
<td>basic</td>
<td>over pH 7</td>
<td>basic</td>
</tr>
<tr>
<td>embracing a wide pH range</td>
<td></td>
<td>euryion</td>
</tr>
</tbody>
</table>

The buffering capacity in size and range nearly parallels the pH value: the higher the pH value the higher the buffering capacity. The buffering capacity attains a great significance, above all through the onset of wide distribution of acid air pollution, which acidifies the tree bark. A relatively high buffer capacity possessed by the bark of the ash, which often bears a flora, which is typical for trees with higher pH values. The sycamore is unchanged. Here a relatively small buffer capacity in the case of a relatively higher pH goes along with an often narrow acidophilic lichen flora.

**Mineral Content, Nutrient Content, and Eutrophication**

Only little is known today about mineral content and above all about the nutrient content (in a narrower sense, foremost nitrogen and phosphorus compounds) of lichen inhabited substrates. Justifiable are statements about the extent of eutrophication of the habitat by animal manuring (e.g. bird roosts), by dust films (tree bark, rocks, walls, etc.) and by mineral fertilizer (vineyard walls). For the ecological characterization of the lichens of this kind of habitat one can use the relatively appropriate and neutral expression “coniophytic” (in the case of dust impregnation) and “coprophytic” (in the case of animal manuring). Here is employed a known but without doubt truly problematic term based on the nitrogen content: “nitrophytic”; here it makes use of, the quantity of nutrient supply to illustrate.

<table>
<thead>
<tr>
<th>Substrate</th>
<th>Plant</th>
</tr>
</thead>
<tbody>
<tr>
<td>not eutrophic</td>
<td>antrophytic</td>
</tr>
<tr>
<td>moderately eutrophic</td>
<td>m. nitrophytic</td>
</tr>
<tr>
<td>(m. nutrient-rich)</td>
<td></td>
</tr>
<tr>
<td>rather eutrophic</td>
<td>rthr. Nitrophytic</td>
</tr>
<tr>
<td>(rather-nutrient rich)</td>
<td></td>
</tr>
<tr>
<td>very eutrophic</td>
<td>v. nitrophytic</td>
</tr>
<tr>
<td>(strongly nutrient-rich)</td>
<td></td>
</tr>
<tr>
<td>extremely eutrophic</td>
<td>ext. nitrophytic</td>
</tr>
<tr>
<td>(extremely nutrient-rich)</td>
<td></td>
</tr>
</tbody>
</table>

Perhaps tree bark on the interior of extensive forests are not eutrophic, bark of field and avenue trees rather eutrophic, extremely eutrophic are very nitrogen-rich habitats as well as very strongly dunged tops of bird roosts, the dog urine impregnated base of walls, and the surfaces near manure piles. Rock habitats naturally nutrient-poor are not eutrophic, but not counting others in
the case of bark habitats, since bark (especially on young twigs) nutrients (e.g. nitrogen compounds) may be contained in no small measure. Rocks or wall habitats in the drip zone of the foliage of trees are usually relatively mineral-rich habitats, since the water drops contain plant sediment as well as minerals wafted onto the leaves.

A close connection exists between the mineral content of bark (total concentration as electrolytes, measured as ash content) and the epiphytic lichen flora. Very mineral-poor barks are species poor and are floristically very strongly distinct from mineral-rich barks.

The barks e.g. of elder, aspen, Norway maple and walnut are mineral-rich; ash, beech, and oak, very mineral rich; birch, spruce, and fir, mineral-poor.

A sharp floristic caesura (cut off) exists in general between calcareous and lime-free rocks. Also the amount of the lime content of the calcareous rock and the amount of the SiO₂ content of the lime-free silicate rock has a floristic differentiating influence. Indeed floristic distinctions were first evident in the case of significant quantitative differences in the chemical composition of the rock, as a comparison of lime-poor rock (as e.g. of siliceous limestone, or calcareous slate) and lime-rich marl or refined pure lime and dolomite.

Very SiO₂ - rich rock (acid silicate rock e.g. quartzite, quartz-rich sandstone) bear an altered and poorer flora than SiO₂ -poor (basic and ultra-basic rock, e.g. basalt, melaphyrite, and serpentinite). Rock with a content of more than 70% SiO₂ as crude true value was designated here as acid silicate rock, as neutral silicate were those with a SiO₂ content somewhere between 65-70 and 50%, as basic those with a SiO₂ content of less than 50%.

In lichenological circles the expression “mineral-rich” is often used with quartz-poor, above all characterizing feldspar-rich (above all plagioclase-rich) rock, is treated approximately as basic and neutral silicate rock.

As calcareous rock (= carbonate rock) here was understood to be rock with a homogeneous distribution of calcium. Limestone is more or less pure lime (CaCO₃). Silicate rocks (= sandstone) are, when not otherwise noted, lime-free.

**Hardness and Porosity of Rocks**

About the hardness, porosity and the weathered condition we are presenting only the stronger deviations from the norm (e.g. extremely hard rocks as many basalts, and porphyries). Porous rock (many sandstones, and many dolomites) produce by relatively high water absorption and water-holding ability (even at the upper surface) favorable moisture relations at their upper surface; moreover from outcrops of porous rocks often even humidity is drawn out (mountain humidity). These rocks may therefore bear a relatively hygrophytic lichen flora; humidity requiring species descend farther into lower sites on them than on compact (dense) rocks.

**Decay of Wood Substrates**

The following expressions are used for the degree of progress of decay of stems and stumps: *hard, tough (- decay)*: Wood hard through and through, only difficult to work with a pocket knife

*rather decayed*: Upper surface of stumps and stems still intact, but the interior already significantly decomposing. Wood pieces with the center breakable

*very decayed*: Upper surface no longer intact i.e. very slightly decayed, inner wood spongy, rotten, or disintegrating

**Slope of the (rock-) surface: as varying from horizontal-, inclined-, steep- (= subvertical-), vertical- and overhanging surfaces (= overhanging surfaces or surfaces under overhangs).**

**Moisture (content) of Substrates**

Species which favor flooded substrates, which hold the moisture a long time i.e. relatively much water may be hoarded (moss covered, soaked, spongy bark, long-time dewy rock, porous rock [see above]), are known as “substrate hygrophytic.”

A significant and typical lichen habitat is ‘moisture seeping’ rock surfaces. Habitats of this kind are sporadically to frequently moistened by seeping water and always dry out again. In the typical case the surfaces are more or less discreet. The water comes out of crevices or out or the grasses overlaying the top of the rock and is this way through the soil and through soil filled cracks often relatively nutrient rich. The seep-water emerges first of all according to rainfall. For characterizing this type of plant site
in the descriptions the term “subhydrophytic” is used.
Amphibious species are temporarily flooded (streams, or rivers). Species living submerged colonize almost constantly flooded sites.

4.2.2 Climate

The climatic reality of the lichen habitat is indicated in the main with the aid of a statement about the light available, relative humidity, the measure “rainfall” and frequently the temperature relations.

Moistening by rain: The measure of the moistening of the habitat with rain is of considerable influence on the habitat selection. Many species live only on rain excluded sites.

<table>
<thead>
<tr>
<th>Habitat:</th>
<th>Lichen:</th>
</tr>
</thead>
<tbody>
<tr>
<td>very rain-protected</td>
<td>very anam-bryophytic</td>
</tr>
<tr>
<td>rather rain-protected</td>
<td>anam-bryophytic</td>
</tr>
<tr>
<td>moderately rained-on</td>
<td>m. ombrophytic</td>
</tr>
<tr>
<td>rather rained-on</td>
<td>r. ombrophytic</td>
</tr>
<tr>
<td>very (strongly) rained-on</td>
<td>v. ombrophytic</td>
</tr>
</tbody>
</table>

The habitats not or only exceptionally rain moistened were designated as very rain protected sites. In the case of rather rain protected sites, moistening occurs only occasionally and relatively belatedly. The stem-dwelling lichens and the species on vertical and subvertical surfaces may be counted as normally in a moderately rained-on habitat. Here designated as very ombrophytic were only lichens of frequently rained-on surfaces in heavy precipitation regions.

Humidity: Statements about the humidity relationships are only to be understood as a crude orientation. They are only made with difficulty and are problematic. The following gradations are found:

<table>
<thead>
<tr>
<th>Habitat:</th>
<th>Lichens:</th>
</tr>
</thead>
<tbody>
<tr>
<td>extremely humid</td>
<td>e. hygrophytic</td>
</tr>
<tr>
<td>very humid</td>
<td>v. hygrophytic</td>
</tr>
<tr>
<td>rather humid</td>
<td>r. hygrophytic</td>
</tr>
<tr>
<td>moderately humid, or</td>
<td>mesophytic</td>
</tr>
<tr>
<td>moderately dry air</td>
<td>r. xerophytic</td>
</tr>
<tr>
<td>rather dry air</td>
<td>v. xerophytic</td>
</tr>
<tr>
<td>very dry air</td>
<td></td>
</tr>
</tbody>
</table>

Oceanic (as a climatological conception): Lichens were designated as strongly oceanic (very oceanic), which depend upon very high rainfall or foggy and very/extremely humid places with mild temperatures (relatively small temperature variations) (above all high places and west exposures of the Vogesen, or the Black Forest). For rather oceanic lichens similar values, but less pronounced conditions (mostly high rainfall, rather mild climate). Rainfall occurring is of paramount importance of the factors determining moisture relationships. Fog and (less so) humidity may partially compensate for the amount of rainfall.

Light: Light conditions are characterized as follows:

<table>
<thead>
<tr>
<th>Habitat:</th>
<th>Plants:</th>
</tr>
</thead>
<tbody>
<tr>
<td>v. poorly lighted</td>
<td>v. skiophytic</td>
</tr>
<tr>
<td>r. poorly lighted</td>
<td>r. skiophytic</td>
</tr>
<tr>
<td>m. well lighted</td>
<td>m. photophytic</td>
</tr>
<tr>
<td>v. well lighted</td>
<td>v. photophytic</td>
</tr>
<tr>
<td>deep shade plants</td>
<td>half-shade plants</td>
</tr>
<tr>
<td>shade plants</td>
<td>Full light plants</td>
</tr>
</tbody>
</table>

Plants with a relatively very wide ecological amplitude of light use were designated as photoindifferent.

Statements about the preferred occurrence of lichen species in certain vegetation types or land forms may give further indication about climatic conditions of the habitat. Thus species which are designated as characteristic for forest regions, commonly live on wind-protected sites with relatively balanced moisture conditions.

4.3 Statements About the Sociology

Like flowering plants certain lichen species frequently occur associated with one another. Numerous such typical combinations of lichen species found again and again have been described as lichen communities. For the naming of such communities certain rules are valid, which are laid down in a code of plant sociologic nomenclature.

So far as the community names are produced from species names, which are no longer in use, they were altered here according to today’s valid species names, without the code of plant sociologic nomenclature.
Class: Chrysothrichetalia chlorinae Wirth 1972
(!Leprarietalia chlorinae), community on rain sheltered silicate rock walls – Order: Chrysothrichetalia chlorinae
Hadac 1944 (!Leprarietalia Hadac 1944)
Alliance: Cystocoleion nigri Wirth 1972 --
Association: Cystocoleo-Racodietum Schade 1932 ex Kelm. 1955 (!Coenogonio-Racodietum rupestris),
Alliance: Chrysothrichion chlorinae Smarda & Hadac 1944 (!Leprarion chlorinae) -- Association:
Lecideetum lucidae Schade 1934 ex Klem. 1950,
Chrysothrichetum chlorinae Schade 1934 ex Wirth 1972 (!Leprarietum chlorinae), Lecanoretum orostheae Hil. 1927
Class: Rhizocarpetea geographicbi Wirth 1972
community of rain exposed silicates
Order: Rhizocarpetalia obscurati Wirth 1972 –
Alliance: Porpidion tuberculosa Wirth 1972 (!Lecideetum subdenticulatae)
Association: Porpidietum crustulatae Kelm. 1950 (!Lecideetum crustulatae),
Lecideetum lithophilae Wirth 1969, Porpidietum tuberculosa Kelm. 1946 ex 1955 (!Lecideetum soredizae),
Lecideetum erratica James et al. 1977, Rhizocarpetea geographici Wirth 1972
Alliance: Lecanoretum rupicolae –
Association: Porpidietum glaucophaeae Wirth 1969 (!Lecideetum kochianae)
Order: Rhizocarpetalia lacustris Wirth 1972, community
of sweet water lichens. – Order: Rhizocarpetalia lacustris
Drehwald 1993 (syn. Hydroverrucarrietalia Cern. &
Hadac 1944 em. Wirth 1972)
Alliance: Verrucarietum hydrelae  ass. prov. (syn. Hydeoverrucarietalia Cern. &
Drehwald 1993)
Order: Acarosporetalia sinopicae Creveld 1981 –
Alliance: Porpidietum hydeophilae
Order: Rhizocarpetalia sinopicae-Pleopsidietum chlorophaenae
Dermatocarpetea miniati Wirth class. nov.,
subneutrophytic silicate lichen community. – Alliance:
Physcion dimidiatae Wirth 1972 –
Alliance: Ramalinio capitatae Rübel 1933 –
Class: Aspicilletia lacustris Wirth 1972, community
of sweet water lichens. – Order: Aspicilletia lacustris
Drehwald 1993 (syn. Hydroverrucarrietalia Cern. &
Hadac 1944 em. Wirth 1972)
Alliance: Verrucarion fundici Wirth 1972
(!Verrucarion sinopicae) – Ass.P Verrucarrietum fundici
Ullrich & Wirth 1972 (!Verrucarietum sinopicae),
Verrucarietum hydrelae ass. prov. (syn. Verrucarietum laevato-denudateae) – Position unclear:
Verrucarietum elaemelaenae ass. prov. (syn. Verrucarietum praetermissae Cern. &
Hadac 1944 em. Wirth 1972)
Order: Porpidietum glycerophila
Alliance: Ionasprisponciae Wirth 1980 – Ass.: Porpidietum glycerophila
Class: Dermatocarpetea miniati Wirth class. nov.,
subneutrophytic silicate lichen community. – Alliance:
Physcion dimidiatae Wirth 1972 –
Order: Acarosporetum sinopicae Creveld 1981 –
Alliance: Porpidiotypum sinopicae Wirth 1972 –
Class: Aspicilietalia candidae Asta & Roux 1977, class. prov., community of lime lichens of nutrient poor rocks (?) Xeroverrucarietalia Hadac 1962


Class: Protoblastenietalia immersae Roux 1978, class. prov., community of lime lichens of nutrient poor rocks (?) Xeroverrucarietalia Hadac 1962

Class: Chrysotrictetalia candelaris Wirth 1980 (!Leprarietalia candelaris), Bark lichen-Soc. rain sheltered sites – Order: Chrysotrictetalia candelaris Wirth 1980 (Leprarietalia candelaris)


Class: Pleurocoddetalia vulgaris Hil. 1925 (!Lecanoretum pityreae), Usneetum silesiaceae Bibinger 1970


4.4 Statements about Frequency, Endangering, and Toxic Tolerance

The statements about frequency hold true for southwest Germany and the immediate bordering regions (without the Alps). The frequencies of the species are stated in 6 intervals: very rare – moderately frequent rare – rather frequent rather rare – very frequent

Most of the lichen species are rare (v. - r. rare). Truly frequent species, as compared with dandelion or stinging nettle of higher plants, exist in very restricted numbers.

Many lichens are in a more or less high degree of danger i.e. threatened with extinction.
The causes are many, the sensitivity to air pollution plays an important role.

For Baden-Württemberg (valid also for the immediate environs) after the frequency statements the statement in parentheses about the endangerment is in the form of the number from the Red List. They mean

0: Extinct or missing
1: In danger of extinction
2: Strongly endangered
3: Endangered
R: Extremely rare

Annotations of the categories (according to the definitions of the BfN/Institute for vegetation studies):

1: Species which are so severely endangered that they face extinction, if the threatening causes continue. One of the following criteria must be fulfilled: (1) the species is so considerably regressed that they are rare; the remaining population is endangered; (2) they are now rare and because of continuing human influence extraordinarily strongly endangered.

2: Species, which are extensively regressing or because of continuing or foreseeable human influence are strongly endangered. One of the following criteria must additionally be fulfilled: (1) the species has already disappeared in the greater part of the region; (2) it is very rare to rare; (3) it is still moderately frequent, but strongly endangered; (4) the diversity of their formerly colonized habitat is extensively restricted.

3: Species, which are moderately regressing or because of continuing or foreseeable human influence are endangered. One of the following criteria must additionally be fulfilled: (1) the species is already very rare in the greater part of the region; (2) it is rare to moderately frequent; (3) it is still frequent, but strongly endangered; (4) the diversity of the formerly colonized habitat is restricted.

R: Extremely rare species at this time. They are not appreciably regressed or not noticeably endangered and they may on the basis of their scarcity be suddenly destroyed or essentially decimated due to unforeseen developments, e.g. by a combination of unexpected human intrusion or natural events like rock slides. A statement in italics means that the classification must be seen as relatively uncertain. An asterisk (*) after the Red List Rating means that the species in the environs around Baden-Württemberg is clearly less endangered.

In the case of species not occurring in Baden-Württemberg (as a rule after the statement of natural area) the following symbol was used:

+: extinct, (+++): in danger of becoming extinct, (+): strongly endangered, *: extremely rare. Species with especially remarkable value of resistance to (mostly acid) air pollution were designated as toxic tolerant.

4.5 Statements of Plant Geography

For the characterization of plant areas one uses certain geographical statements in which particularly the north to south extending (zonation), in addition to the west to east extending (continents) and the elevational distribution. The clarification of the concepts used here comes from the following combination. The definition of the individual geographic regions is from the diagram (refer to MEUSEL, JAEGER & WEINERT).

4.5.1 Floral Regions and Floral Elements (Europe)

\[ arct = arctic \]: Tundra region north of the polar tree line. Many of the species occurring in this region are also to be found in the alpine zone of the vegetation zones lying further south (arct-alp).

\[ bor = boreal \]: Region of the boreal pine belt. The species occurring in this region are further found for the most part in the montane and high montane zones of the temperate (central European) zone.

\[ s'bor = southern boreal \]: Southern region of the boreal zone (narrowing toward the east).

\[ mieur = middle European \] (or temperate): Temperate zone, region of green summer deciduous forests (in part intermixed with pine forests).

\[ s'mieur = southern middle European \]: Southern region of the temperate zone.

\[ smed = sub-Mediterranean \]: Region of green summer dry forests (above all oak forests) and steppes, northern Mediterranean region.

\[ med = Mediterranean \]: Non deciduous evergreen and pine forests, steppes and semi-desert southern Mediterranean.

\[ atl = Atlantic \]: Deciduous forested region near the Atlantic (in central Europe eastern to NW Germany, central and upper Rhine).

\[ subatl = Sub Atlantic \]: Region of the deciduous forest of west and central Europe. Species in the
near desert region occurring or lacking, in the east European deciduous region lacking or culminating.  
subco = sub continental: East European deciduous forest region, east European boreal pine forest, westward to central Europe. Species lacking in west Europe. 
co = Continental: Steppes and semi-desert region of east Europe (and Asia). Species only isolated to advancing into the dryer region of central Europe. Continental boreal region. 
pralp = pre-alpine: Montane to high montane regions in the periphery of central-, east- and southeast European high mountains. The species seldom penetrating often also into the corresponding higher zones of the mountain. 
zentr = central Europe: Central Europe. Distribution focal point in central Europe, more or less clearly culminating in the periphery of central Europe. 
oc = oceanic: Occurring in the lowlands of the near Atlantic region, decreasing toward the east in the interior increasingly up the mountain and only occurrence of isolated species (Attention: in the ecological characterization of the species the term oceanic is used only in the pure ecological sense: having an oceanic climate).

4.5.2 Elevation Zones

(Importance in region see p. 37)
mo  montane  
h’mo  high montane  
subalp  sub-alpine  
alp  alpine

4.5.3 Diagnosis of the Areas

The statements made about the area of single lichen species in this book show only for Europe and use a rough orientation of the extent of the area. Often an extensive area is given as possible or probable. Thus many species distributed in Central Europe undoubtedly still occur in the montane region of the sub-Mediterranean or Mediterranean belts, even when the area diagnosis of these zones in not named. Statements about the zones were given priority. In many cases the vertical distribution and the east-west extensions is indicated; in this the Central European zone was especially considered.

The area-zone statement in parentheses means that the species in the region concerned consists only of isolated occurrences. A continental designation of vertical zone in parentheses means that the corresponding distribution tendency exists or that the statement is relatively uncertain.

Example of diagnosis of area:

arct-mieur: The species occurs from the arctic to the Central European zone.
bor-med: Occurring from boreal conifer forest into Mediterranean region.
bor-mieur-mo: Occurring in the boreal and in the temperate (central European) zone, here however predominantly in the montane zone; for that reason in the southern part of the area mostly in definite distributional lacunae.
arct-alp: Occurring in the arctic and in the alpine zone of the boreal to the Mediterranean zone. The area strongly disrupted (disjunct).
arct-mieur-alp: Occurring in the arctic and in the alpine zone of the boreal and the Central European zone.
mieur-subatl-med: Occurring in the sub-Atlantic region of the temperate zone over the sub-Mediterranean region to the Mediterranean zone. Thereby it is mostly though with a sub-Atlantic tendency in the sub-Mediterranean and Mediterranean region.

A designation, which is separated by a comma from the remainder of the area diagnosis, covers the same area. Example:
mieur-med, pralp: Occurring in the vicinity of the alpine mountains and in lower elevations of the mountains themselves, from the temperate to the Mediterranean zone.
mieur-subatl-smed, oc: Occurring in the sub-Atlantic region of the temperate zone into the sub-Mediterranean region, toward the east where an increasing restriction to the mountains is observed.

4.5.4 Habitat Remarks on Extent and Natural Uniformity/landscape

Al   Allgäu
Av   Foothills of the Alps (pre alpine hills and moors)
Ba   Baar
BayW  Bavarian Forest (with Bohemian Forest)
Bit  Bitburger Land
Bo  Lake Constance (Lake Constance basin and the Hegau)
Do  Danube (Iller valley and Danube pastures)
Eif  Upland region between the Rhine, Moselle and Ruhr valleys
Erz  Erzgebirge (and Fichtelgebirge)
Fi  Fichtelgebirge
Fr  Franconian Terrace
FrJu  Franconian Alp
He  Hessian upland, (Lahn valley, and the Taunus)
HeBgl  Hessian upland (with the Rhön and Vogelsberg)
HRh  Upper Rhine region
Hü  Hunsrück (southern part of Rhenish uplands)
Hü  Loess- and calcareous hilly land on both sides of the Rhine plains (with Kaisersstuhl)
Hz  Hartz
Ju  Schwäbische Alp and surroundings (Brown Jura-Malm-region)
Lahn  Lahn valley
Lux  Luxemburg
Mfl  Central Franconian
Ml  Central Switzerland (Hügelland Aargau/Zürich)
Mn  Mainfranken Plateau and barren land (with Windsheimer Bay, Stiegerwald-Vorland, and tomb stones)
Mos  Mosel valley
MRh  Central Rhine
Ne  Neckar region, Neckar-Gäu plateau and Alp foothills (Keuper-Lias region), with Baar
nöHü  Northern Hügelland
nöPf  North Platinate mountains
nöRh  North upper Rhine
nöSch  North Black Forest
O  Odenwald
Obay  Upper Baravian Heights (foothills of the Alps)
Opf  Upper Platinate
Pf  Platinate (with Platinate Forest, Hardt, and North Platinate Mountains)
PfW  Platinate Forest
Rh  Upper Rhine
RhL  Rhine Land
Rh-Mn-T  Rhine-Main lowlands
Rhön  Rhöne
RhSch  Slate range of the Rhine (Hu, Mos, MRh, Ts, Eif)
Ries  Ries (a basin formed by meteorite impact)
Saar  Saar Land
Sauerl  Sauer Land
Sb  Schönbuch
Sch  Black Forest
SFW  Schwarzwald Forest
Sju  Schwarzwald (northernmost part)
Sp  Spessart
süHü  Southern Hügelland (with Black Forest foothills)
süRhön  Southern Rhön foothills
süSch  Southern Black Forest
Th  Thüringer Hügelland
ThW  Thüringer Forest
Ts  Taunus
Ubay  Lower Baravian Hügelland
Vgb  Vogels Mountain
Vgt  Vogt Land
Vog  Vogesen
We  Wester Forest
WeBgl  Wesserbergland

Habitat remarks set in italics means that the last known by the author to have been found from this region in the last hundred years

5 The Distribution of Lichens in Baden-Württemberg in Chart Representation

In Baden-Württemberg – the heart of the region considered in this work – the awareness of the distribution of lichens has been for some time so extensively advanced, that for most of the species, representative distribution charts may be produced. The charts consider, if not otherwise stated, the distribution in Baden-Württemberg (Ordinance-Survey map with the Baden-Württemberg portion delimited see the chart page 49). In the case of many charts, the distribution in the region of the whole sector is shown, even beyond Baden-Württemberg. In these cases the species name is shown with an asterisk *.

5.1 Natural Basis of the Regions Charted

Baden-Württemberg lies in the southwest of the Federal Republic of Germany. It extends between 7°30' and 10°30' east latitude from
Greenwich as well as 47°31’ and 49°47’ north longitude (Fig. page 47) and includes an area of 35,750 km². The altitude lies between 85 m and 1493 m above sea level. The region is geologically variable. Large flat portions resulted from sedimentation of the Jurassic period (especially the Malm) and the Triassic period (Bunt Sandstone, shell limestone and red marl) as well as from crystalline soil from the mountains. The predominantly occurring rocks are metamorphic (gneiss) and magmatic rock (granite) in the mountain ranges, non calcareous sandstone in the Bunt Sandstone and lime-rich sediments in the Malm and shell limestone (Fig. p. 51f.). The climatic specified extremes are rather diverse corresponding to the altitude differences and distinct weather- and lee-situations (Fig. p. 53ff), it lacks, of course, alpine regions with their lichen favorable conditions. In Baden-Württemberg lies all or part of the nature zones Upper Rhine lowlands, Black Forest, Oden Forest, Swabian Alp, Swabian-Franconian Mountain Forest (Keuper-Lias-region), Neckar (Gäu plateau), Main Franconian plateau, and Upper Swabia (Fig. p. 48).

5.2 Charting and Illustration Method

The charting of lichens follows according to the point-raster or grid method, the analysis region was calibrated by the grid into practicable equal size charting units, the raster or base field. The evidence of one or more occurrences in the region of a raster field is given by a point in the corresponding field of the raster chart. The Area of a species is in agreement with a point raster of definite extent and form in the chart. The advantage of the point raster method lies in the potentiality gained to unite, in the planning and economy of charting, and in addition to make full use of the data with the help of a statistical-mathematical analysis over EDV, e.g. to compare the distribution charts with factor-raster charts (e.g. climate charts). The economical element lies above all in the finding that the charting i.e. the inclusion of a species with entering the evidence in a base field, the quest after the species also may gradually find a conclusion. Among other things in the aspect of the information on area it is not very intrinsic, as many single occurrences are concealed by one raster point.

That the charts take as a basis raster or grid over another is in accord with the sectional view of the topographic charts 1:25000 (TK 25, so called ordnance-survey map). Each charting base field corresponds therefore with the surface of one such sheet of the TK 25 and encloses 10 minutes geographic longitude and 6 minutes geographic latitude, in Baden-Württemberg that is equivalent to about a surface e.g. a rectangle of 11.1 times 12.2 km pages long. This raster was selected as first policy for this reason, because it also had been established for charting the higher plants of central Europe and because it is universally easy to obtain. Baden-Württemberg is covered by 313 raster fields. These raster fields were designated with the established four digit number for the TK 25.

In the case of minute grid small diverging of the lateral line of the base field from north toward south, and corresponding increase in the base field in the same direction by chance in size, a fixed drawback compared with similar quadratic base fields. In the framework of the national project it was however the extensive declivity of the minute base field from the geographic latitude in the main did not interfere with the raster point illustration of the distribution, especially since these grids are able to be drawn to correct section (as in the case of the present charts). For Europe-wide undertaking, a grid with 50 x 50 km units as a base was used. Regional and national charting in minute-raster may be undertaken without grave error in such small scale UTM grid charts. Transportation maps will work for this.

5.3 Important Site Data

The charting units were as a rule repeatedly called on and dealt with according to prevailing diversity of the habitat. In the site study various climatic and edaphic site-observations were undertaken to capture potential breadth of a species spectrum. Because of the wide ranging specialization of the lichen species on the substrate types bark, rock and soil, there was a corresponding observing of habitat presumption in the charting effort for each base field. A part of the basic plan of the site work – due to at the time truly differing lichen flora – was the consideration of various habitat types with regard to substrate and climate.

The charting data was ordered according to base fields in the resulting lists, from which the data found are also apparent. Protocols in addition are in hand from each single excursion.
The most important sample points were plotted onto topographic charts.

Voucher collections (lichen specimens) are deposited in the herbarium of the Public Museum for Nature Study, Stuttgart (STU).

5.4 Consideration of Old Data Found

Numerous botanists and amateurs have in the past, through their collecting, contributed to a truly solid lichenological knowledge of the region of Baden-Württemberg, though the research was very uneven and the inconspicuous species are strongly under represented. From the published finds and the vouchers deposited in herbaria it appears that many species are, since that time extinct or strongly decreased (see topic 1.3). Since earlier a systematic inclusion of lichen occurrences was not given and as a rule only a narrow vicinity around home and some few excursion areas were collected, are also single discoveries outside the today proven areas of definite reference from one in the interval following shrinkage of the area of distribution; even less the climatic and edaphic divergence of the former habitat from the wider surroundings, all the more in all likelihood the evidence is representative and not an isolated discovery.

To document the decrease of lichens, herbarium data and reliable published statements were assimilated for the raster point charts and were emphasized with special signatures. Different time ranges were differentiated:

1. recorded previous to 1900,
2. recorded in the time range 1900 to 1949,
3. recorded from 1950 to 1974,
4. recorded after 1975

Actual occurrences have “priority” over old records in the same base field. A regression of area is documented accordingly by the corresponding symbol for old discoveries in the chart picture. Although the regression of lichens in the last hundred years has taken a dismaying dimension, it can be expressed only in especially grave cases because of the relatively coarse ordinance survey raster in the chart picture, since it often still has retained the residue population.

5.5 Consideration of Anthropogenic Habitat

As laid out in topic 1.3, numerous species have found new habitats on human created substrates, such as grave- and boundary-stones, walls and monuments or roof tiles. It is of interest in area information to document, as an addition to the occurrence of a rock lichen on their spreading to such anthropogenic substrates. There were plotted separately in the distribution charts numerous species which are restricted to such anthropogenic substrates (used smaller than normal size point). So the natural and that area conquered, thanks to man, can to a certain extent be differentiated.

6 Glossary

Notice: Ecological and plant geographical terms were treated extensively in the previous topic.

adventitious, adentitious plants: Plants which only immigrate with human assistance; not originally occurring in the floral region.

Algal layer: in most lichens the algae lie in an ± continuous layer near the upper surface.

amyloid: colored blue or violet by I (iodine).

anastomosing: in the case of paraphyses: reticulate bound.

angiocarp: fruiting body, in which the hymenium is enclosed until the asci are ripe; hemiangiocarp: fruiting body enclosed at first, in which the hymenium to begin with is covered by a protective layer, which when fully mature frees the asci.

anisotomic: branching type; branching in a rather long and often thick main axis and in one (or more) shorter and weaker side axis.

anticlinal: perpendicular to the upper surface.

apical: at the tip, toward the tip.

apical structure: structure at the tip of the ascus, which functions in taking over the releasing of the spores, often in the form of a visible thickening, often colored blue (partially) with I. Of systematic importance.

apothecium: fruiting body of ascomycetes e.g. the corresponding lichens, usually of disk forming, cup form or hemispherical form, with entirely free lying [exposed] hymenium (see perithecium).

areolate: divided into small areas

aspicilioid: Ap. sunken into the thallus.

ascus (pl. asci): usually ± cylindric to clavate cells, in which the spores (usually 8) are produced in the fruiting bodies of the ascomycetes or in the corresponding lichens, sit in the hymenium.

erect: inclined upward growing or toward the top of up turned end of lobes.
axial mass: to be found in the tholus, often a region definitely weaker colored with iodine solution.
beard lichen: beard-like pendant lichens with filamentous segments.
basal thallus: primary thallus.
pruinose: thallus or apothecium with whitish, yellow-gray, or bluish, frost-like layer.
biautorin: apothecia with no black proper margin.
bifusiform: weak dumbbell-form, with weak swelling near both ends.
bipolar: in the case of spores: content ± two parts.
bistunicate: fissitunicate.
blastidia: (sing. blastidium) producing rounded diaspores by marginal budding of thallus areoles.
foliöse lichen: ± lobe-like divided lichen, predominantly growing on the surface with previously constructed underside.
border soralia (margins sorediate): the margin of the lobes border-like edged, ± long streaked soralia.
calciicolous: lime-dwelling.
calephic: growing on calcareous substrate.
cephalodium: in green-algae lichens bearing separate region, containing blue-green algae, either in the interior or sessile on the thallus.
chemotype: a group of chemically different individuals of smaller taxonomic importance.
chemosyndrome: biogenetically closely related group of contents.
chlorococcoid: single, ± spherical (also colony producing) algae related to the Chlorococcaceae (green algae).
cilia: hair-like projections.
coccoid, coccal: of approximately spherical form (in the case of single-celled, also colony building algae).
dichotomous: forked branching into two branches.
dimidiate: in the case of perithecia – outer wall reaching down to half the perithecium.
effigurate: in the case of crustose lichens – margin of the thallus appearing lobed (e.g. through elongation of radially arranged lobe-like areoles). Thallus often rossetted.
proper margin: (exicle without algae) margin of the apothecium not or only a little distinct from the disk and the interior without algae.
endolithic: lichen thallus living within the rock.
endophloeic: lichen thallus living within the tree bark.
epihymenium: outermost colored region of the hymenium, because of coloring of the paraphyses or a granular layer or diffuse coloring.
epiphytic: growing on other plants, e.g. trees.
epispore: (outer) wall of spores, sometimes sculptured.
eroded: hollow, frayed.
evryök: occurring over a broad habitat regions, under various habitat conditions.
etrophic: nutrient-rich.
excipulum: (true exciple) which is clearly distinguished from the sterile envelop of the hymenium (without hypothecium), often recognized as the margin of the apothecium, here always understood as excipulum proprium (without algae), in contrast to excipulum thallinum = thalloid margin.
fibril: predominantly used in the case of beard lichen description for short, mostly ± horizontal side branches.
fissitunicate (= bitunicate): ascus consisting of 2 functionally different layers. When ripe and emptying spores, the rigid outer layer separates from the inner layer and surges outward (only rarely observed).
fleck soralia: delimited fleck-like soralia on the thallus upper surface.
fruiting bodies: very general term for the production of reproductive parts.
fundort (locality): topographical concept, site of an occurrence (not to be confused with habitat).
gelatinous lichen: blue-green algae lichens which when moist swell and take on a gelatin-like consistency.
gelatinous layer: gelatin-like, usually thin envelop, in the case of spores (perispore) or in the case of asc the thin outer layer (fuzzy coat).
gehause: (receptacle) general term for the sterile surrounding bowl-form or spherical surrounding of the hymenium and possibly hypothecium.
layered: lichen thallus, in the case of which the algae lie in a layer.
goniocyst: ± spherical group of algae cells surrounded by hyphae, of thallus construction, not used as a diaspore.
haustorium: sucking organ with which the fungus hyphae bore into the algal cells or nestle closely to the algae.
hemerochor: (introductions) plants, which arrive into a region only with the help of man.
hemiendolithic: Thallus partially in the interior of the rock.
heterocyst: cells of bluegreen algae, which often differ in their lighter content and the wall
thickening from the remaining cells; site of nitrogen fixation. 
**hymenial algae:** algae which are in the interior of the hymenium of perithecia and become ejected with the spores, smaller than the remaining algae. 
**hymenial gelatin:** gelatin-like filling material in the hymenium, cementing paraphyses etc. 
**hymenium:** layer of paraphyses and asci in the fruiting body of lichens (fungi). 
**hyphae:** filamentous organs, of which fungus or for the most part even the lichens are constructed, producing dense tissues in lichen thallus or in the fungus fruiting body. 
**hypothallus:** spongy tissue of the underside of many foliose lichens. 
**hypothecium:** region within the hymenium. 
**inspersed:** (hymenium) having fine oil droplets. 
**involucrellum:** the receptacle partially or completely surrounding a perithecium, often a dark colored envelop or ± covering layer of the apex of the perithecium. 
**isidium:** warty, peg-form, coralloid branching or ± spherical outgrowths of the thallus upper surface, used for vegetative reproduction. 
**isidiate:** with isidia. 
**isotomic:** in the case of branching; the branching equally strong and growing uniformly. 
**core:** interior of a perithecium. 
**conidia:** asexual reproductive body, e.g. produced in the pycnidia. 
**capitate soralia:** spherical soralia on the ends of the lobes. 
**coraloid:** coral-like, i.e. of cylindric branching segments. 
**crustose lichen:** lichens one with the substrate lying closely bound crust-like, coherent, areolate or ± squamulose thallus, not or scarcely able to loosen without destroying. 
**cryptolecanorine:** apothecia sunken into the thallus, bordered by the thallus, but without a thallloid margin (set off). 
**spherical soralia:** (capitate or laminal): ± spherical soralia on the upper surface of the thallus. 
**Kurzweig:** short unbranched side branches. 
**thallloid margin** (thalline exciple): produced by the thallus and commonly ± thallus colored algae containing border of an apothecium. 
**Laubflechte:** foliose lichen. 
**lecanorine:** apothecium with thallloid margin. 
**leciideine:** apothecium with black proper margin. 
**leprose:** thallus completely erupted dusty, without cortex. 
**lichenized:** producing a lichen, i.e. the fungus is associated with algae, or algae with a fungus. 
**lip soralia** (labriform) lip-form curved soralia on the underside of the lobe end. 
**lirellae:** long narrow apothecia. 
**macroconidia:** in the case of species with at least two conidia forms (pycnospore forms) the larger conidia type. 
**collar soralia:** in the case of soralia, the ring form produced around a hole. 
**medulla:** loose hyphal tissue underneath the algal layer. 
**muriiform:** cross and longitudinally divided spore; weakly muriiform: with less cells. 
**mazaedium:** dusty mass of spores and remains of asci and sometimes also paraphyses, covering the fruiting body. 
**mesoconidia:** in the case of species with at least three conidia forms (pycnospore forms) the middle sized conidia type. 
**micareoid:** algae small (4-7 µm), thin-walled, often in pairs (in the case of Micarea). 
**microconidia:** in the case of species with at least two conidia forms (pycnospore forms) the smaller conidia type. 
**modification:** environmental influenced, non hereditary change. 
**navel (umbilicus):** ± central, often single attachment of a foliose lichen, also a pointed nipple-like outgrowth of the disk of an apothecium. 
**navel lichen** (umbilicate lichen): foliose lichen attached with a navel. 
**needle-form** (acicular): in the case of lichen: long, narrow, long pointed on one end. 
**net-ribbed** (reticulately ridged): upper surface divided by weakly raised ridges surrounding weakly concave regions. 
**ocular chamber:** short finger-like projections of the ascus interior region into the (inner) wall of the ascus tip. 
**ostiole:** pore-form opening at the apex of the perithecium. 
**palisade parenchyma:** tissue, whose hyphae are oriented ± at right angles to the upper surface. 
**papillae:** small, usually ± regularly round, convex outgrowths of the thallus, not sharply separated from isidia. 
**parallel multicellular** (septate): spores in the case of 3 or more ordered one behind the other. 
**paraphyses:** filamentous, branched or unbranched, usually vertical ordered hyphae in the hymenium, attached at the base.
**paraphysoid**: arising before or during the production of asci “tissue”, that through lengthening becomes similar to an accumulation of pseudoparaphyses, very flaccid and reticulate. **paraplectenchymatous**: a ± uniform fungus tissue consisting of rounded-multiangular, non elongated cells, resembling the parenchyma of higher plants. **parasymbiont**: in lichenology: an additional fungus partner in the lichen symbiosis, living at the expense of the photobionts, but in contrast to a parasite not clearly damaging. **periphyses**: in the case of perithecia: true filamentous hyphae in the ostiole region. **periphysoids**: in the case of perithecia: filamentous hyphae growing down from near the tip of the ostiole. **perithecium**: spherical to pear-form fruiting body, which opens by a ± central pore, usually ± strongly sunken into the thallus. **photobiont**: the only photosynthesis capable partner in the symbiosis, i.e. bluegreen or green algae. **phyllocladium**: squamule-like finger-form, coral-like to granular covering of fruticose lichens (above all in the case of podetia of *Stereocaulon*). **placoid**: ± rosette growing, marginal lobed crustose lichens (with “radial” arranged elongated marginal lobes). **plectenchyme**: thick tissue of fungus hyphae. **podetium (-ia)**: cup-, peg- to fruticose-form, usually ± erect part of a lichen thallus, apothecia arise on them (above all in the case of *Cladonia*). **primary thallus (basal thallus)**: in the case of species with a thallus of two different parts, the part spreading over the substrate is the first part developing. **polar 2-celled, polar diblastic, polarilocular**: 2-celled spores with a thick dividing wall, which is penetrated by a thin canal connecting both cells. **prosoplectenchymatous**: fungus tissue made up of elongated cells. **protococcoid = chlorococcoid.** **pseudocyphellae**: delicate whitish points or (often branching) streaks or flecks, breaking through the cortex, used for air exchange. **pseudoparenchyma = paraplectenchyma.** **pseudopodetia**: podetia-like shrubby to peg-like structures in the case of *Stereocaulon*. **pycnidium -ia**: organ, in the asexual spore production (pycnospores), usually small point-like and sunken in the thallus, rarely projecting wart-form to cylindrical, in the interior with mostly spherical or pear-form lumen. **pycnospores (conidia)**: asexual reproductive parts produced in the pycnidia. **pyrenocarp (pyrenocarpous)**: lichens with perithecia as fruiting bodies. **marginal soralia** = border soralia. **rhizine**: hyphae producing grasping or bunches of grasping, simple or branched (structures), usually used in attaching the lichen thallus. **rind (cortex)**: the outer delimiting layer of thick backed fungus hyphae. **disk**: upper surface of the hymenium in the case of apothecia. **scheitel (apex)**: the visible part of the perithecium. **schizidium**: squamulose-like outermost layers of lichen thallus which peel off or loosen as diasporas. **slime envelop (gelatinous sheet, perispore)**: envelop of slime or gelatin-like substance around spores and asci. **secondary thallus (vertical thallus)**: in the case of species (e.g. *Cladonia* and *Stereocaulon*) with one thallus of two different parts which consist of the primary thallus and the ± vertical oriented part. **septum**: dividing wall. **scleroplectenchyma**: plectenchyma of very thick-walled, cemented hyphae. **soralium -ia**: delimited dusty-granular structure (thallus eruption), that develops soredia. **soredia**: small, ± spherical granules used in vegetative reproduction (diaspores), which consist of a clump of algae surrounded by a web of hyphae. **sorediate**: with soredia. **fissure soralia**: soralia consisting of a streak or fissure-form crack in the thallus upper surface. **sporodochia**: pillow form, apothecia-like structure that produces pycnospores. **peg-form**: narrow cylindrical. **habitat**: the ecological condition of a growth type (e.g. sunny boulder, deep cracked bark, cold collecting basin); not to be confused with “fundort = locality where found”. **stenök**: with narrowly delimited habitat region. **strahlig**: radially ordered. **fruticose lichen**: bushy branched to simple peg-form, erect growing or bushy or beard-form pendent, usually only attached to the substrate in a few places. **stylariform**: asexual spore-like reproductive parts, which are produced in pycnidia-like organs.
subhymenium: structurally diverging from the hypothecium layer immediately below the hymenium, only rarely clearly developed.
synanthrop: plants, whose occurrence have been widened through the activities of man (e.g. limestone dwelling species on walls).
syndrom = chemosyndrom.
thallinocarp: gall-like thallus swelling, in which asci develop.
thermophytic: warmth loving.
tholus (apical dome): the thickened inner part of the ascus-wall at the ascus tip; loosely: clearly developing at the tip of an ascus.
torus: ring structure around the separate lamellae in the septum of Rinodina-spires, in optical section recognized as a dark point on both sides of the septum near the outer wall.
tuberculate: projecting warty.
unlayered (homoiomerous): algae not limited to a certain layer or concentrated.
unitunicate: ascus with a wall which does not split when into two layers when the spores are ripe (see bitunicate).
cemented: in the case of hyphae: hyphae or paraphyses closely backed to one another, difficult to loosen from one another.
vertical thallus = secondary thallus.
prothallus: algae-free border about the margin of the thallus or the thallus areoles, often colored blackish.
warty: thallus with wart-like swellings (larger than “granules”); warty areolate; areoles convex.
water capacity: water storing capability.
cilia: hair- or bristle-like accessory organs at the margin of thallus lobes, rarely on the margin of apothecia.
dissolving (gelatinizing and disappearing): in the case of paraphyses: strongly slimy, so that in the ripe hymenium the paraphyses are scarcely or no longer visible, above all in the pyrenocarpic lichens.
cilia = bristles.

± more or less
Ap.: apothecium
C+/C-: reaction with hypochlorite positive/ negative (see chapter 3.2.5)
Ch-: lichen substances lacking, no reaction with K, C, or P
Char.: characteristic species
CK+: reaction with C and later adding K positive (see chapter 3.2.5)
Ephym.: Epiphyllum
Exc.: Exciple
f(hf): photo shows lichen thallus in moist (semi moist) condition
Ges.: society
GS: Group Key. The key to this genus takes into consideration species of other genera. Which in the genus key mentions characters of value for further understanding of other genera.
H: photo of herbarium material
Hym.: Hymenium
Hyp.: Hypothecium
Invol.: Involucrellum
I+/I-: reaction with iodine solution (see chapter 3.2.5)
KC+/KC- reaction with K and later adding C (see chapter 3.2.5)
K/I+ reaction with I after previous treatment with K (see chapter 3.2.5)
P+/P-: reaction with P (see chapter 3.2.5)
Paraph.: paraphyses and similar structures
Per.: perithecia
Pseudocyph: pseudocyphellae
Pcylnosp.: pycnospores
R-: reactions with K, C, & P negative
s.l.: in the broader sense
Sp.: spores
tol.: tolerant
PT: (part of the key). In the case of extensive genera the keys are divided in to various parts.
UV+/UV- in UV light fluorescing or not fluorescing (see chapter 3.2.5)
v.a. above all
W.: forest, forests
z.: rather, rather strong
zus.: together

7.2 Clarification of Symbols
Symbols in the Keys:
- refer to illustration
- in connection with the species characteristics: the species contains (additional) lichen substances, which are in addition to those identified.
- before the species name: the material of the species is probably non uniform in the region.
- after the alternative number means that yet another possibility is given before the species name: insufficiently known species

Symbols in the Literature Cited:
- summary works without particular application
- chemotaxonomically directed works

Symbols in the Geobotanical Species Descriptions see page 43

Symbols in the Distribution Charts
- ‘open circle’ last verification of the species pre 1900
- ‘half closed circle’ last verification of the species between 1900 and 1949
- ‘3/4 closed circle’ last verification of the species between 1950 to 1974
- ‘closed circle’ verified since 1975
- ‘tiny closed circle’ occurring only on anthropomorphic substrate
- ‘tiny open circle’ distribution strongly below average because of taxonomic problem or insufficient observations.
- ‘asterisk’ in the case where covering the distribution would consider the entire chart.
Key to the Determination of Lichen Genera and Algae

1 Organization and Use of the Key
The general key makes possible the determination of the most important commonly distinguished lichen groups according to the growth form of the thallus or the form of the fruiting body. In a second step following after the lichen group, genus keys leads to the lichen genus. The species keys are likewise brought under the corresponding genera, where they are treated in alphabetical order.

In front of the general key for the determination of the lichens is concise key for the determination of the most important algae occurring in lichens.

The keys are alternative keys. Normally at any given time two contrasting possible choices are presented, of which one is correct for the species being keyed, the other is not. The two matching choice possibilities are designated with the same numeral. The correct alternative leads either directly or indirectly, by further alternative pairs, to the name of the species.

Example: Determining a brown foliose lichen with a light underside:

1 Thallus yellow
1* Thallus brown
2 Thallus with fruiting bodies
2* Thallus without fruiting bodies
3 Thallus on bark
3* Thallus on rock
4 Lichen underside black
4* Lichen underside whitish
5 etc.

The alternative 1/1* with the possible choice “Thallus brown” leading to 4, here leads to the fitting possible choice “Thallus underside whitish” to no further alternative, but directly to the name of the species keyed (Lichen D). A yellow lichen with fruiting bodies would key out by alternative 2 to (Lichen A).

The keys are arranged so that the decisive differentiating characters are at the beginning, so that often a “rapid keying” is possible, that above all dispenses with the consideration of other mentioned characters. At the next place are often characteristic attributes, which will not be used under any circumstances in accordance with the contrast in the case of the alternative.

The goal of the genus key is not the keying of the entire genus. These keys frequently lead in the interest of easier keying to groups of genera (“GS” = group key), where differentiation according to taxonomically relevant characters avoids many unnecessary problems, because the keying out of the similar often presents no difficulties.

In the determination keys are given in the case of keyed species at times also the lichen substances, as a rule however only so far as they may be determined with the help of thin layer chromatography and are significant. Abundant side by side lichen substances are as a rule not known (e.g. Lecanoric acid is side by side with Gyrophoric acid); accordingly known sometimes as the lichen substance syndrome, with which is designated a group of biosynthetic related substances. If the name of the lichen substance is in parentheses, it occurs only in low concentration (and is then often difficult to demonstrate with TLC), if before the name is placed “±”, then the material may also be lacking.

The reference to an illustration helps verify the keying result at hand by examining the photograph. Considering the large variability of many species one must notwithstanding from time to time choose between considerable habitual differences of that to be determined and the illustrated example. In the genus keys only judicious illustrations are put forward, when a large part of the species in question are illustrated and consequently essential habitual attributes of the genus are rendered. “↑” attached to the species name means that species in the corresponding genus were described earlier. A number in parentheses “(18)” behind the species name means that the species in the same key, keys out at another place (here at alternative 18). Author names behind a species name lets us know that the species concerned in the main part (in the case of the genus) will not be further considered. “!” after the alternative number means that still another possible choice is given. See topic 7 for additional symbols and abbreviations.

2 Key to the Lichen Algae
Presented are only genera and groups the knowledge of which is necessary or helpful for the keying of lichens in the following genus keys. Most of the algae treated are recognized without great difficulty. Squash preparations and sections through the lichen thallus are enough for identification. A thorough going determination becomes problematic, since the algae in the
lichen thallus are often deformed and the typical form is only acquired after first isolating and cultivating.

1. Cell content of the algae ± blue-green, rarely brown-green or ± brown. No defined chromatophore, no recognizable pyrenoid, coloring diffuse (blue-green algae)  

2. Cell content of the algae pure green, yellow-green, orange-green, orange, brown-orange, or yellow with defined chromatophore, sometimes with pyrenoids (green algae)  

3. Cells single or in 2-8 gelatin packets (colonies), spherical to ellipsoidal, all more or less similar formed, never branching threads (squash preparation?)  

4. Cells in branching threads  

5. Cells surrounded by a thin, slimy, colorless, not or indefinitely layered gelatin envelop, usually in colonies of 2-4. In very rare silicate lichens (Phyllicium)  

6. Cells with ± thick, clearly encased together, for the most part inflated gelatin envelop. The envelop often reddish or violet near upper surface parts of the lichen thallus (“Gloeocapsa s.str”) or yellow-brown to brown colored (“Xanthocapsa”)  

7. Threads made up of several cell series, branching. Cells mostly brown-green, in aspect mostly ± elliptical to rectangular, 9-15 x 3-11 μm. In small shrubby to filamentous lichens on seeping moist silicate rocks (Ephebe, or Spilonema)  

8. Cells uniformly rounded, about 3-7 μm wide, in unbranched threads (with occasionally intercalated colorless cells: heterocysts), either lying loose in a gelatin mass and then chain- or pearl necklace form (gelatin lichens) or clustered in gelatin spheres (e.g. in Sticta, Nephroma, Pannaria, and Parmeliella)  

9. Cells uniformly not normally thick wall, 4-7 μm in size, attacked by the lichen fungus in the form of haustoria.  

3 Determining the Lichens:  

Overview of the Key  

1. The fruiting body is a 1-2.5 cm high stalked cap-fungus with lamellae on the underside. The basic thallus gray to deep green, squamulose of small globules  

Omphalina  

2. Fruiting body otherwise, not a cap fungus or fruiting body is lacking  

Omphalina vernalis  

3. Lichen consisting of a basic small foliose, squamulose or crustose part covering the substrate and a ± upright, peg-form, cup-form or other formed, simple to branched part  

I: Fruticose Lichens
Fruiting bodies are perithecia and opening with a hand lens of microscope, keg like to ± pear shaped, but generally sunken and therefore only the upper, ± convex shield is seen as rounded to oval

V: Pyrenocarpic Lichens

9* Fruiting bodies are apothecia with ± wide openings, rarely crack-forms or openings like punctiform disks with concave, flat or convex upper sides, with or without margins

10* Apothecia long streaks to shortly elliptical or lobed or star shaped, simple or branched.

VI: Fleck or Streak Fruiting Crustose Lichens

VII: Disk Fruiting Crustose Lichens

4 Keys for the Lichens: Genera and Sterile Species

Genus Keys I: Fruticose Lichens

1 Thallus consisting of overlapping small foliose, squamulose or a crustose part on the substrate (basal thallus or primary thallus) and ± erect to ascending, peg-, lance- or cup form or ± shrubby branched part (vertical thallus or podetium). Apothecium generally biatorin.

2* Thallus not differentiated into two types

5 Podetia (vertical thallus) hollow, tubular, very polymorphic. Ap. usually terminal, brown, red, brown-yellow, often lacking. Sp. single celled. On various substrates

Cladonia

2* Podetia (vertical thallus) not hollow, never cup forming

3 Podetia simple, short peg-form, always with a single terminal shield-form to spherical brown to rose colored apothecium, -7 mm high. Stalk robust, whitish to greenish in places, lacking squamules. Thallus crustose to appearing squamulose, ± coalescing, whitish to gray-greenish. Sp. 1-2 celled. On soil or rock.

Baeomyces

3* Podetia usually branching, if simple, then generally without terminal ap

4 Primary thallus bright green to pale greenish, granular to mealy. Podetia very delicate, -0.3 mm thick, -10 mm high, whitish, covered with greenish granules, above all with open branches. In rain-protected, earthy rock crevices or directly on silicate rocks. Always sterile.

Leprocaulon microspermum

4* Primary thallus and podetia whitish to gray, occasionally with ± blackish streaks or rose brown warts (cephalodia). Podetia sporadically with granules, squamules or covered with projecting squamules. Ap. brown to dark brown, often lacking. Sp. four septate 3- to multicellular. On rock and soil.

Stereocaulon

5 Thallus orange, yellow to green-yellow, pale greenish, or gray-greenish.

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5* Thallus not with yellow or pale greenish tint.
6 Thallus yellow to orange, K+ deep red.
6* Thallus not K+ deep red, not orange.
7 Thallus with ciliate apothecia or lobes. Found in Central Europe.

**Teloschistes chrysophthalmus**

7* Thallus not with ciliate/lobed apothecia

8 Thallus ± erect (to inclined) on soil (or over moss covered rock).
8* Thallus not on soil.
9 Part of the thallus tubular-cylindrical, with sharply bordered hollow zone, usually branched, sharp pointed or ± blunt, occasionally with small projecting squamules or covered with decumbent squamules, bright yellow-green, yellow-gray, pale yellowish to pale gray-green.

**Xanthoria**

9* Thallus not tubular, not with sharply bordered hollow zone, however medulla occasionally with truly porous structure, not covered with squamules or small lobules.
10 Thallus of ± terete segments, usually richly bushy branched, yellow-green to yellowish, the tips usually blue-blackish. Pseudocyphellae numerous, fusiform. Cross section of the interior with ± loose medulla. Cortex almost granular. Generally in alpine wind protected niches

**Alectoria ochroleuca**

10* Thallus of flattened to channeled enrolled, wrinkled to smooth sections, sparsely branched, ± erect
11 Medulla yellow, thallus yellow, of incurved, pitted, wrinkled segments

**Vulpicida tubulosus**

11* Medulla not yellow, thallus greenish-white to greenish-yellow, of flattened to wrinkled enrolled segment

**Cetraria cucullata/nivalis**

12 Thallus branch about as broad as thick, cylindrical to slightly flattened, more or less angular, equally rounded and colored. Thallus beard-like pendent to bushy ascending or erect, moderately to richly branching.
12* Thallus branch substantially broader than thick, clearly flattened, equally rounded and colored or with the underside otherwise colored, weakly to richly branching.
13 Interior of the thallus branch with a tough whitish (rarely rose colored) central strand, which on stretching the strand becomes visible as a thread-like thallus segment between the ring-like broken cortex ( ). Thallus usually very richly branching, usually with numerous short, ± right angle projecting side branches, often with warts, isidia, soralia, bright greenish-yellow to gray greenish. Ap. large, thin, shield form, often ciliate, usually pale. Sp. single-celled.

**Usnea**

13* Thallus branch without clearly differentiated, tough central strand. Ap. (very) rare
14 Thallus intensively yellow to green-yellow, shrubby erect, richly branching, segments very narrow, all sides equally colored and structured, angular-wrinkled, often ± flattened, sometimes with cylindrical isidia, ±15 cm long, bushy to pendent. Ap. very rare, disks brown. Alpine, near alpine, Elbe sandstone mountains, Franconian forest, commonly on conifer bark and wood

**Letharia vulpina** (L.) Hue

14* Thallus bright yellowish, bright yellowish-green, without typical isidia
15 Thallus conspicuously angled to pitted overall, with pointed ends and pointed short branches, usually beard-like pendent, very limp, with loose white medulla and usually cross cracked cortex, moderately branched.

**Evernia divaricata**

15* Thallus not conspicuously angular to pitted overall, cortex not latterly cracked.
16 Commonly without soralia. Thallus long, pendent, thread-like to beard-like. Cortex of lengthwise lying hyphae (cross section)

**Alectoria sarmentosa**

16* As a rule with soralia. Thallus pendent or erect or bushy. Cortex of hyphae at right angles to the upper surface, rarely of longitudinal hyphae (then with minute capitulate soralia at the ends of the bent back branches: R. thrausta)

**Ramalina**

17 Thallus intensively yellow to yellow-green from all sides, angled, flattened, usually with isidia
17* Thallus not intensively yellow to yellow-green, without isidia
18 Thallus upper side yellow-greenish, pale greenish, pale gray-green, with a cortex, underside predominantly whitish and somewhat chanelled, without cortex, ± shrubby erect, rel. weak and flaccid. With granular-mealy soralia on the upper side and the margins, almost never with ap. (disks usually pale yellowish, pale greenish of beige).

**Evernia prunastri**

18* Thallus constructed and colored ± the same on all sides, usually bright gray-greenish, pale greenish, yellow-greenish, relatively stout and cartilaginous. With or without soralia, with or without ap. (disks usually light yellowish, pale greenish, beige).

**Ramalina**

19 Thallus part tubular-cylindric, with strongly defined hollow space, branched or unbranched, pointed or ± blunt ended
19* Thallus part not tubular, without a sharply defined hollow space, yet the medulla sometimes truly loosely structured
20 Thallus white, unbranched or with 1-2 short branches, pointed, decumbent to erect, from time to time turgid, smooth, without squamules or small lamellae. K+ yellow. Sterile. In alpine sites.

**Tammolzia**

20* Not both worm-like and white. Thallus richly branched to simple, pointed or blunt or definite

37
cup ends, with or without squamules or projecting lamellae

**Cladonia**

21 Thallus on lime-rich rocks, usually brown to black, also whitish pruinose, with bluegreen algae.

22 Thallus white, gray, olive, occasionally lightly browned

22* Thallus brown, dark brown, black, gray-black

23 Thallus segment clearly wider than thick, band like flattened to channeled, ± branched.

23* Thallus segment/branch ± cylindrical to weakly flattened, scarcely wider than thick

24 Thallus ± erect on peat, 2-6 cm, segments clearly channeled, flattened toward the ends, on one side bright brown to olive, on the other side usually lighter, brownish-white, olive-white, with numerous occurring whitish pseudo-cyphellae, the margins covered with small teeth, reddish at the base.

**Cetraria islandica**

24* Thallus whitish to gray, if gray-brown, then finely velvety (hand lens), base not reddish.

25 Thallus segment with isolated stiff whitish to dark cilia or bristles on the lobe ends occasionally marginal, usually with terminal lip or helmet-form soralia or with ap. Often loosely attached, not spreading, not pendent

**GS Physcia**

25* Thallus segment without such cilia, narrowly to broadly band like, ± forked, somewhat enrolled at the sides, therefore the underside slightly channeled. Ap. very rare

26 Thallus ± thickly covered with cylindrical isidia, gray, underside of the younger parts whitish to rose, the older parts dull blue-blackish to black, forked branching, very variable, up to over 10 cm long. Lobes 1-5 mm wide.

**Pseudovernia furfuracea**

26* Thallus without cylindrical isidia, with soralia at the margins and/or on the surface, gray, often with slightly unevenness, undersides whitish, usually to 5 cm long. Lobes 1-3 mm wide

**Evernia prunastri** var. **herinii**

(if the undersides black or brown, segments strongly protruding, but foliose: **GS Cetraria**)

27 Thallus thread-like, ± richly branching, pendent or decumbent, often ± beard-like, whitish, beige, gray, gray-brown, or olive. Threads commonly 0.3-1 mm thick, not clearly angular.

**Bryoria**

27* Thallus segment not thin and thread-like, if beard-like, then segment angular and with pointed shore branches

28 Thallus loosely pendent, loosely branched, angular long pitted, with cross-cracked cortex, whitish, like **Evernia divaricata** in habit, on tree bark.

**Evernia illyrica**

28* Thallus ascending to erect or bushy erect, of simple peg-form to richly branched segments, on peat, rock, or bark.

29 Thallus segments in places with large granules or with squamules or covered with small folia. Thallus of erect to ascending, simple to mostly branched, cylindrical to slightly flattened pegs or “stemlets” (“Pseudopodetia”), whitish to gray. The stemlets at times feltly layer. Ap. brown, dark brown, often lacking. Sp. ± to cross septate multicellular. On silicate rock and peat

**Stereocaulon**

29* Thallus segment with a smooth, cartilaginous, often slightly shiny upper surface, with cortex, not squamulose or granular. Thallus tufted erect to ascending, often coralloid, of cylindrical to flattened, moderately to strongly branching stems, light gray to light brownish, tips sometimes whitish. Ap. very rare, in spherical swellings, with dusty spore masses (Mazaedium). Spores on celled, spherical, dark. On silicate rock and bark.

**Sphaerophorus**

30 Thallus of very thin black to brown-black of a ± thick felt film growing over -20 μm thick thread, which in each case consists of a central Trentepohlia thread and a sheath of hyphae (microscope). On very shady vertical surfaces and overhangs of silicate rock.

**GS Cystocoleus**

30* Thallus not with Trentepohlia. If thallus threads similarly thin, then with bluegreen algae.

31 With bluegreen algae. Thallus small shrubby (1.5 cm high) or decumbent threads. Thallus segment usually only -0.2 mm thick, usually on occasionally moistened sites on rock or rock dwelling mosses, rarely on soil.

**GS Polychidium**

31* With true green algae. The thicker thallus branches at times (0.3-)4 mm thick. Lichens on bark, wood, rock, pear or mosses.

32 On peat, raw humus, or soil mosses. Thallus decumbent to bushy erect, commonly 1.5-6 cm high.

32* On tree bark, wood, or rock.

33 Thallus/medulla K+ yellow, C/KC+ red, P+ yellow. Thallus of ± cylindrical, only basally somewhat flattened, thick branches, very richly branching, dark gray-brown to gray-black, the base light gray-brown to rose-brown, with small whitish pseudocyphellae, ± 5 cm high. Alectorialic acid, or Barbaticolic acid. Only in alpine sites, Alps

**Alectoria nigricans**

33* Thallus/medulla R- or medulla P+ orange. K-, C-.

Thallus of weakly to clearly flattened or channeled rarely irregularly cylindrical, 1-10 mm wide segments, weakly to richly branched, bright brown to black-brown, usually with pseudo-
Genus Key II: Foliose Lichens

1 Thallus yellow, orange, red, gray-yellow or yellow-greenish 2
1* Thallus not so colored, without yellow tint 16
2 Thallus yellowish to orange-red, K+ deep red. Ap. if occurring, yellow to orange (brown). 3
2* Thallus yellowish-green, yellowish-gray, pale yellow to deep yellow, K- or K+ yellow. 6
3 On lime-rich soil, or limestone mosses. Sp. 1-celled or with a thin cross wall. Fulgensia
3* On bark, word or rock. Sp. 2-celled, almost always with thick cross walls, which are penetrated by a perceptible thin canal, at least in the young ones. 4
4 Thallus underside even with the substrate, closely attached, without rhizines and other attachment organs Caloplaca
4* Thallus underside attached to the substrate at a single place, by a differentiated underside, foliose lobed to small shrubby. Sp. mostly 10-17 x 6-10 µm. 5
5 Dying out in Central Europe. Lobes strongly ciliate at the margin, ± band-like. Thallus small tufted (to almost foliose), only attached at a single site, scarcely over 2.5 cm wide, yellow-orange, at times even gray. Ap. orange, margin often ciliate. Teloschistes chrysothalmus
5* In some cases abundant species. Lobes not ciliate. Usually with ap. or soralia. Underside pale. Xanthoria
6 Thallus very small and delicate, usually only 0.3-1.5 cm wide (but often coalescing into a composite thallus), strongly divided, light yellow. Lobes very narrow, 0.1-0.4 mm, only clearly visible with a hand lens, sorediate at the margins, underside whitish, with rhizines. Almost always sterile (ap. yellow, lecanorine, sp. 8-10 x 4-6 µm) Cetraria

Cetraria

34 Thallus thread-like, richly branched, decumbent to bearded-like pendent, segment cylindrical to (above all somewhat flattened at the branches), usually 0.3-1 mm thick GS Bryoria
34* Thallus not thread-like 35
35 Thallus of cylindrical to weakly flattened segments with smooth cortex, ± richly branched, thick cushion or coral-like bushes, gray-brown to light brown. Spherocephalus (29)
35* Thallus of flattened to leafy or channeled segments 36
36 Thallus closely attached to silicate rock, -2 cm high, consisting of small tufts of flattened, brown-black to almost black, -1 mm wide, sparsely branched segments, almost always with terminal black ap. Cornicularia normoerica
36* Thallus on bark and wood (if on rock, then loosely attached), segments flat to channeled or irregular, usually upper- and ± lighter underside distinguishable. Cetraria

Candelaria concolor

6* Thallus with clearly wider lobes (if narrow, then the underside black, upper side not pure yellow) 7
7 Thallus strongly yellow, also the medulla yellow, ± ascending to almost erect. Rhizines very sparse GS Cetraria: Vulpicida
7* Thallus yellow-green, pale (yellow) greenish, gray yellowish, or pale yellow. Medulla not yellow 8
8 Moist thallus lead-gray, dark gray or dull blue-greenish, dry upper side yellowish-grey to pale (ochre) yellowish or pale green yellowish, surface rough with blue-grey fleck soralia. Lobes at most 1 cm wide, broadly rounded, underside beige to light brown, occasionally thickly short hairy. With bluegreen algae. Very rare. Lobaria scrobiculata
8* Moist thallus not lead-gray to dull blue greenish, underside not short hairy velvety, but often with rhizines. With green algae. 9
9 “Navel-like” attached only at a single site, robust lichens on silicate rock in the high mountains (only rarely descending to lower places), usually light yellowish-green, undersides bark, brownish or blackish at the margins. Ap. rose, orange to discolored greenish or brownish Lecanora PT1 (Rhizoplaca)
9* Thallus not attached at a single site. 10
10 Underside bald or with very sparse rhizines, whitish to brownish (if the underside black, brown at the margins: see Parmelia) 11
10* Underside commonly with numerous, only at the margin often sparse rhizines or occasionally thickly hairy, light colored or black to brown. 15
11 On bark and mossy bark on very humid, cool places in the mountains. Lobes with border soralia, undersides pale to light brown, upper sides yellow- to gray-greenish Cetraria
11* On rock, peat, or lime loving mosses 12
12 On rock. 13
12* On peat or mosses. 14
13 Thallus crustose-squamulose, ± rosette, lobed at the margin, commonly with ± brown ap. with thallloid margins. Upper side light yellowish-green, whitish-green, or yellowish, underside whitish to slightly brownish, without rhizines. On limestone. Lecanora PT 1
13* Thallus lobed, deeply divided, rosette, with large projecting hemispherical to almost spherical light soralia, without ap. Lobes strongly convex to almost becoming round stems, ± tuberculate, greenish-yellow, gray-yellow, pale gray-greenish, underside slightly brownish, with isolated rhizines. On silicate rock in cool places Parmelia incurva
14 Thallus of irregular ordered, multiply divided, ascending to enrolled, -4 cm long and -1 cm wide lobes, undersides pale yellow, upper side
Thallus gelatinous swelling, dry very inflexible, gray, or brown to black. With bluegreen algae. Algae not arranged in a layer of thalloid margin.

**Cladonia foliacea s.l.**

14* Thallus ± rosette, lobed at least at the margin, closely appressed or ascending at the margins, upper side pale yellow-green, whitish green, or yellowish, undersides ± whitish, P-, medulla P- or P+ yellow. Commonly with ± brown ap. with thalloid margin .  

15 Thallus usually ±2, rarely 3 cm wide, rosette, closely attached, interior with often coalescing fleck soralia, underside black. Lobes narrow, flat, delicate, K+ weakly yellowish. Medulla R-. Above all on acid bark or wood, very rarely on rock.

**Lecanora PT 1**

16 Moist thallus gelatinous swelling, dry very inflexible, gray, or brown to black. With bluegreen algae. Algae not arranged in a layer of thalloid margin.

16* Moist thallus not gelatinous .  

17 Lichens attached to limestone, mortar, or concrete .  

17* Lichens on other substrates  

18 Thallus without rhizines, in the main attached to the rock only by a ± central post (navel), otherwise ± free, usually little organized and ± one lobed or rarely many lobed, without soralia or isidia .

**Parmeliopsis ambiguа**

15* Thallus with other characteristics (if habitat similar to the previous species, then the medulla and soralia K+ orange, P+ orange), underside pale or brown to black .

16 Moist thallus gelatinous swelling, dry very inflexible, gray, or brown to black. With bluegreen algae. Algae not arranged in a layer of thalloid margin.

16* Moist thallus not gelatinous .  

17 Lichens attached to limestone, mortar, or concrete .  

17* Lichens on other substrates  

18 Thallus without rhizines, in the main attached to the rock only by a ± central post (navel), otherwise ± free, usually little organized and ± one lobed or rarely many lobed, without soralia or isidia .

**Dermatocarpon miniatum**

18* Thallus attached at numerous sites by rhizines, divided deeply into many or few narrow lobes, usually with soralia or isidia .

19 Thallus in the main only attached by a ± centrally located post (navel) on (silicate) rock, otherwise ± free, usually little organized and ± single lobed or rarely many lobed (umbilicate lichens) .  

19* Thallus not attached by a ± central navel, on rock, bark, mosses or peat .  

20 Thallus upper side with pustiform small, sunken black perithecia, gray-white to brownish, underside ± brownish to rose, smooth to slightly wrinkled, without rhizines. Sp. colorless, single celled .

20* Thallus sterile or with black shield form ap., whitish-gray, brown, or black-brown, underside pale brown to black, with or without rhizines, smooth, warty or channeled. Sp. one-celled to muriform, colorless or brown .

**GS Physcia**

21 Thallus lobes welded into one almost shield-like thallus, closely attached, gray-blue, often with filamentous prothallus, with bluegreen algae. Extremely rare, on high oceanic habitats .

21* Thallus otherwise .  

22 Thallus lobes arched at the ends into flat to saddle form, undersides free ap., generally at least 2 mm wide, undersides with veins or hairy or bald. With bluegreen algae, rarely with green algae, then the thallus in the moist state deep green .

**Lobaria (pulm./lin.)**

22* Thallus lobes without such terminal ap. .  

23 Ap. on the upper side of the usually ascending lobes, flat or saddle form. Underside with coarse, branched and reticulate veins as well as with tufted rhizines or scattered long single rhizines, rarely uniformly felty, without cortex. Sp. narrow spindle like to needle form, four to many celled cross septate, brown, at least 30 µm long .

**Peltigera**

23* Ap. on the underside of the lobes, but often opening later, not saddle form, red-brown. Underside not with such veins, but sometimes wrinkled, bald or velvety hairy, beige, pale brown, rarely to black-brown, with cortex. Sp. 4-celled, fusiform, pale brown, up to 27 µm long  

**Nephroma**

24 Underside of the thallus orange-red. Alpine soil lichen .

24* Underside of the thallus not orange-red .  

25 Ap. sunken in definite rough depressions of the thallus, without thalloid margin. Thallus gray, green when moist, at times developed as only a ring around the ap., with green algae, in addition with bluegreen algae in parts of the thallus. Sp. brown to red-brown, 2-celled by a septum.

**Solorina**

25* Ap. not in excavated depressions .  

26 Lichen lobes over 5 mm wide. Relatively large lichens  

26* Lichens with narrower lobes  

27 Underside of the thallus with stout, branched and reticulate, raised veins as well as isolated to usually bushy rhizines, without cortex, therefore often ± felty rough and dull. Thallus broad lobed, ap., if occurring, at the ends of the lopes, flat to saddle-form. Lobes broad. Sp. 4-8celled, colorless to brown. Usually on soil and mosses, rarely directly on bark .

**Peltigera**

27* Underside of the thallus without raised vein net, often however rugose, at times with arched structures, which are divided by engraved depressions .

28 Thallus underside bald, without rhizines (examine carefully!), without hairs, smooth to engraved or felty  

28* Thallus underside with distinct rhizines or densely hairy  

29 Thallus upper side divided by wide meshed reticulate ridges with ± oval to elongate depressions lying between them, light brown, olive-brown, or greenish-olive. Greenish when moist, underside usually beige to pale brownish, the upper side pits corresponds to the underside by ± wrinkling “pits” leading to arches .
30 Thallus underside consistently felty, black-brown to black, coarse, without cortex, ascending at the tips, upper side gray to brownish or dirty greenish-brown, without soralia, soil dwelling

**Peltigera**

30* Thallus underside not felty, whitish, beige brownish or black-brown, smooth to wrinkled, with cortex, upper side gray, brown, or red-brown, with or without soralia.  **Nephroma**

31 Underside of the thallus at least partially thickly hairy (hand lens!), pale to brown. Rare lichens in very humid or nitrogen-rich sites

31* Underside not densely short-hairy, but often with rhizines

32 Thallus underside with numerous pits, sharply outlined as though punched out, densely hairy, beige to moderately brown. Upper side gray-brown to brown. Almost never with ap.

**Sticta**

32* Thallus underside without sharply bordered pits

33 Thallus with green algae, slightly altered to grass-green by soaking, never clearly blue-green to gray-black, dry white-gray or yellow-brown to brown, smooth to wrinkled or with large oval, very flat pits and raised ridges. Ap., if occurring, laminal or almost marginal, brown or red-brown, with definite thalloid margin. Sp. 2- to multicellular, fusiform to needle form, colorless to brown. Often additionally with bluegreen algae

**Lobaria**

33* Thallus only with bluegreen algae (Nostoc), soaked blue-gray to black-gray, dry pale brown, brown or gray-brown (to almost gray), smooth or slightly wrinkled

**Nephroma**

34 Thallus olive to brown, without gray areas

34* Thallus colored otherwise, usually gray-white to gray, but sometimes gray at the margin, even dusty green GS Parmelia

35 Thallus with ascending lobes, the wavy margins with border soralia, olive to brown, underside pale brownish, ± shiny, with sparse rhizines. Thallus/medulla R-

**Cetraria chlorophylla**

35* Thallus with isidia or warts or entirely without isidia, underside pale to black. Rhizines sparse to numerous. Medulla C+ red or C-

**GS Parmelia**

36 Thallus with scattered fine white dots, gray, very slightly bluish-gray, broad lobed, with rounded ascending margins with border soralia, never with fleck soralia.

**Cetraria**

36* Thallus with other characteristics, if with white dots, then with fleck soralia. **GS Parmelia**

37 On limestone, line rich soil, lime loving mosses. With green algae (if only with bluegreen algae, ↑ Key III)

37* On other substrates

38 Thallus clearly lobed at the margin (placoid), but lichen truly crustose, without an underside structure. ↑ Key VII (Lecanora/Solenopsora)

38* Thallus foliose, with an underside structure, deeply dissected, with narrow lobes, underside with rhizines, or of tiny divided lobules, gray to brown, also pruinose, not becoming green when moist.  **GS Physcia**

39 Thallus with bluegreen algae, without green algae. Unusual species of nitrogen rich sites (today almost only still in the mountains). Thallus brown to gray-brown, moistened becoming blue-gray to dark gray (bluer when moist). ± decumbent, with granular-sorediate margins or with reddish apothecia. Not with typical or with very few rhizines

39* Thallus with green algae, moisture not clearly discoloring or more greenish

40 Thallus underside paraplectenchymous (cellular) cortex, beige, pale to dark brownish, without rhizines, but occasionally with finely short hair, upper side brown, brown-gray, when moist dark gray, with ascending margins (ap. on lobe ends)

**Nephroma**

40* Thallus underside without cortex (attached with medulla hyphae), closely appressed or somewhat ascending, producing small (in the range -3 cm large) rosettes or irregularly small squamules or narrow lobes, bluish-gray, gray or ± brown, often with gray to blackish to blue-green prothallus. Lobes flat to concave. Ap., when occurring, rose-brown to blackish, biaurine to lecanorine, -2mm.

**GS Pannaria**

41 Thallus very dainty, loosely attached, almost small fruticose, with very fine 0.05-0.3 mm wide brown-gray to brown (greenish when moist) lobes, K-. Lobes at the isidiate at the margins (disintegrating into soredia), underside pale. On eutrophic rock, rarer on dust impregnated bark

**Phaeophyscia nigricans**

41* Thallus more robust, with other characteristics

42 Thallus underside completely without definite rhizines

42* Thallus underside with (at times sparse) rhizines

43 Thallus upper side with cylindrical to coralloid isidia. Lobes gray, ± forked, underside somewhat concave, at the young parts white to rose, the older gray to blue-black, commonly attached to the substrate.  **Pseudevernia furfuracea**

43* Thallus without isidia

44 Thallus of pale gray to brownish-gray band form segments, are covered with stiff cilia on the ends (margins), underside whitish and sometimes wrinkled, often with ap., disks brown-black, often pruinose. Sp. 2-celled, brown

**GS Physcia**

44* Thallus margins/ends without cilia

45 Thallus K-, very closely (almost crustose) appressed to the substrate, scarcely to loosened, rosetted, -2 cm, underside pale to dark, with sparse attachment points, upper side brownish-

41
gray to brownish. Rare, on base rich substrates.

GS Physcia: Hyperphyscia

45* Thallus K+ yellow, not closely appressed, often over 2 cm, underside (with exception of the lobe ends) black, upper side white-gray or light bluish-gray, rarely slightly brownish. Ap. usually lacking, brown, lecanorine. Sp. 1-celled, colorless

46 Lobes hollow, narrow to wide, often with soralia, gray or bluish-gray, occasionally also brownish

Hypogymnia

46* Thallus lobes not hollow, narrow, high convex, closely crowded, sometimes roof tile like, without soralia, usually light gray (often brownish overlaid). Underside black. On silicate rock in the mountains

GS Hypogymnia: Brodoa

(If alternative 46 not correct, see also GS Parmelia: a few species have at times very sparse rhizines)

47* Ap. occurring. Key according to sp. characters

47* Ap. lacking or occurring. Key without sp. characters

48 Sp. brown to gray-green, 2-celled, ellipsoid, with usually partially thickened walls. Ap. usually blackish, sometimes pruinose

GS Physcia

48* Sp. otherwise, colorless (if colored, 4-celled, see bluegreen algae lichens)

49 Sp. 2-celled, ellipsoid to fusiform. Ap. ± brown, protruding. Thallus small- and narrow lobed, brown, when moist light brown to deep green (with bluegreen algae)

Massalongia

49* Sp. 1-celled Key further at 51

50 Rhizines viewed at right angles, bottlebrush-like, black (Fig. P. 729, there are always more threads attached to the rhizines than are shown, not only on young rhizines), underside black, only the margin sometimes pale. Thallus usually brownish, but often pruinose. (Sp. brown, 2-celled)

GS Physcia: Physconia

50* Rhizines mostly simple or further divided, never bottlebrush-like

51 Thallus shiny brown to shiny black-brown, not pruinose (only pruinose abnormally). (Sp. 1-celled)

51* Thallus not shiny brown/black-brown

52 Thallus lobes long streaked and sometimes wrinkled, with ± peg-like to spherical warts with pycnidia at the margins, underside with sparse rhizines. On silicate rock in the higher mountain sites

Cetraria

52* Thallus lobes not wrinkled, without such warts on the margins

53 Thallus undersid with sparse rhizines, pale brownish to almost whitish, almost pillow-form and thickly covered with ap. or with less dense granular-sorediate lobes projecting from the margins. Medulla and thallus R-. On bark and wood

Cetraria (sep./chloroph.)

53* Thallus otherwise, underside with sparse to numerous rhizines, light to black, not pillow-form. Thallus.medulla R- or R+. On bark, wood, or rock

GS Parmelia

54 Medulla of the thallus (if there are soralia) C+ orange to red

54* Medulla of the thallus not C+ orange to red

55 Thallus brown, sometimes also (partially) pruinose

55* Thallus usually whitish, gray, gray-green or green, without definite brown tint, only occasionally somewhat browned at the margins

56 Upper side usually flecked to completely pruinose (at least on the lobe ends). Underside whitish (only slightly brownish toward the center). Lobes sorediate to isidiate on the margins, later also over the surface, cortex and medulla R-. Ap. rare (sp. 2-celled, brown). Thallus robust

Physconia grisea

56* Upper side not pruinose

57 With laminal isidia and warts

57* Without or only with laminal isidia

58 Lobes over 0.5 mm wide. Isidia and warts only laminal

Parmelia

58* Lobes 0.3-0.5 mm wide, usually radiate-rosette arranged, brown-gray to black-brown. Isidia marginal and laminal, very dense in the center of the thallus. Ch-. On limestone and dust impregnated rock

↑Phaeophyscia sciastra

59 Lobes (sometimes isidiate becoming) bordered by marginal soralia, ascending, loosely arranged, flat to concave, often curved at the margin, 2-10 mm wide, olive, olive-brown to brown, underside pale brown, wrinkled, ± shiny, with sparse rhizines. Thallus/medulla R-. Ap. very rare

Cetraria chlorophylla

59* Lobes without marginal soralia. Soralia, if occurring, laminal

Parmelia

(If at the seacoast, thallus compressed, ± shiny, with ap. black-brown, with crenate margins, sp. 2-celled, brown:

Anaptychia runcinata

(With.) Laundon)

60* With soralia

61 Thallus brown-gray to brown, medulla KC-.

Rhizines entirely black or with whitish tips, dense, sometimes projecting beyond the thallus margin. Lobes usually elongate, ±1 mm wide, rosetted to irregular, decumbent, dull with whitish to often greenish- to dark gray circular lichens, flat to convex soralia, underside black, lighter only at the margin. Thallus K-, rare forms with yellowish medulla and here K+ violet.

Phaeophyscia orbicularis

61* Thallus olive brown, or dark brown to black-brown, underside black to black-brown, also brown at the margin. Medulla KC+ red or KC-.
Rhizines black to brown-black, scattered. Lobes -1.5 mm wide, decumbent, sometimes somewhat shiny at the ends. Soralia at first brown-gray or gray to blackish (sometimes also isidiate), later (when shaded) whitish. *Parmelia*

62 Thallus with laminal isidia  

63* Underside black, at the margin ± brown. *Parmelia* (if the lobes under 0.6 mm wide, isidia also marginal, see *Phaeophyscia sciastra*)

63* Underside whitish to pale brownish, thallus usually to 3 cm wide, rosette, decumbent, lamina thickly covered with isidia.

64 Thallus white to gray-white, P- or slightly yellowish, isidia often becoming sorediate, the lamina then ± completely sorediate. Lobes up to 0.8 mm. Extremely rare western and southern distributed species on base rich substrates

**Physcia clementei**

64* Thallus gray-white to occasionally partially slightly browned, P+ intensive yellow to orange, isidia often broken, then the upper surface appearing sorediate. Lobes 1-2.5 mm. On acid bark.

65 Thallus upper side with streak-form to reticulate bound pseudocyphellae, thereby provided with a collection of weak ridges. With soralia or isidiate soralia.

65* Thallus without such pseudocyphellae and collection of ridges

66 Thallus upper side whitish, white-gray or pale brownish. Ap., if occurring, brown-black to black. Pruinose or not (sp. 2-celled, brown) **Physcia**

66* Thallus underside dark brown to black, only at the margin often lighter.

67 Thallus K-, lobes usually narrow, not over 2 mm wide, swollen ± greenish. Ap. brown-black to black. (Sp. 2-celled, brown). On base rich substrates (if the thallus rosetted, with laminal fleck soralia, K+ weakly yellow, on acid bark and wood, see *Parmeliopsis hyperopta*) **GS Physcia (Phaeophyscia)**

67* Thallus K+ yellow, narrow to broad lobes. Ap. brown

68 Thallus closely appressed, with narrow, radially arranged lobes, -2.5(3) cm, with laminal disintegrating fleck soralia, white-gray. On bark in high montaine-subalpine sites

**Parmeliopsis hyperopta**

68* Thallus otherwise, narrow to broad lobed **GS Parmelia**

Genus Key III: Bluegreen Algae Lichens

1 Thallus small shrubby erect to thread-like decumbent, ± branched, with ± rounded stems (cylindrical) segments, brown to usually (brown-, green-)black, rarely pruinose, commonly on rock and mosses over rock. Sp. usually 1-2 celled, rarely muriform **GS Polychidium**

1* Thallus not small shrubby to thread-like decumbent, not with ± cylindric segments (but sometimes crustose areolate with cylindric outgrowths)

2 Thallus foliose, with definite lobes (at least at the thallus margin), broad lobed to small lobed dissected.

2* Thallus truly crustose or squamulose

3 Moist thallus ± gelatinous swollen, very pliable, when dry relatively rigid, black, gray or brown, sometimes whitish pruinose, underside usually blackish, greenish, (blue-) gray, rarely yellow, without typical attachment organs, only exceptionally attached by thick white hairs (*Lept. saturninum*). Lobes with or without cortex. Ap. clearly with a margin. Sp. almost always colorless

3* Moist thallus not ± gelatinous swollen, when dry usually brown to gray, underside whitish, beige, pale brown to moderately brown, ± bald or densely short hairy or with reticulate veins and attachment organs. Lobes usually with a (paraplectenchymatous) cortex on both sides, at the least clearly cellular above. Algae in closely compressed groups (*Nostoc* and other filamentous species).

4 Thallus without pearl necklace-like algae (*Nostoc*). Ap. lecanorine, disk at first or permanently point form and perithecia-like. Rare species. . **GS Physcia**

4* Thallus with loosely dispersed, pearl necklace-like *Nostoc* algae. Ap. with thalloid or proper margin, disk generally brown to brown-red, wide open.

5 Thallus with a cellular (paraplectenchymatous) cortex or almost transparent cells (surely easily recognized in crushed preparations). Sp. mostly weakly muriform, rarely multicellular cross-septate **Leptogium**

5* Thallus without cortex (yet ap. often with paraplectenchymatous cortex)


6* Sp. multicellular cross-septate to weakly muriform, rarely 2-celled. Thallus usually foliose lobed, often sterile. Ap. not clearly deepened. At times a relatively frequent species . **Collema**

7 Underside of the thallus orange-red. Alpine **Solorina crocea**

7* Underside of the thallus not orange-red .

8 Ap. clearly sunken into the thallus, which however occasionally develops only as a ring around the ap., gray, green when moist, with green algae, additionally with blue-green algae in parts of the thallus. Sp. brown to red-brown, 2-celled, constricted at the septum . **Solorina**

8* Ap. not in cavities
9 Ap. at the ends of the lobes, not sitting up, but "lengthening" the lobes, undersides free.
10* Ap. not at the lobe ends or ap. lacking.
10 Ap. on the upper side of usually ascending lobes, flat or saddle-form. Underside with coarse, branching and reticulate veins as well as with clustered rhizines or scattered long single rhizines, rarely uniformly feltly.

**Peltigera (II/23)**

10* Ap. on the underside of the lobes, but often bending back toward to top, not saddle-form. Underside without such veins, bald or velvety, with cortex.

**Nephroma (II/23)**

11 Underside of the usually large, broad lobed thallus with coarse, branched and reticulate veins as well as with clustered rhizines, without cortex, rarely only uniformly feltly. Thallus relatively coarse.

11* Underside without such veins.

12 Thallus underside at least in places densely (standing) short hairy (hand lens), (underside) beige, brownish, gray-brown, or brown, rarely black-brown. Relatively large lobed, rare lichens in very humid habitats, lobes easily detached, not growing attached to the surface.

12* Underside bald and ± smooth or at best uniformly feltly-rough or extensively attached by the surface.

13 Underside with numerous regularly rounded, sharply bordered, as though punched out pits, (almost) penetrating the dense short hairs. Upper side dark brown to brown-gray or gray, with isidia or soralia.

13* Underside without such pits.

14 Thallus yellowish-gray, blue-gray when moist, with flat depressions (pits), at first rounded blue-gray soralia, undersides light brown, only occasionally densely short hairy. Lobes very broad, rounded.

14* Thallus light to dark brown, brown-gray (to almost gray), when moist usually dark gray to blackish.

**Nephroma**

15 Thallus brown, usually dusty dark grey when moist. Underside (except the margins) largely black-brown to black, feltly, without cortex. Thallus coarse and rigid, with broad lobes ascending at the margins. Ap. rare, on the upper side of the lobe ends. Medulla white. In thin turf and sparse brushy sites.

15* With other characteristics. If thallus undersides black-brown to black, then lobes with a lower cortex, not coarse and not on such habitats.

16 With apothecia.

16* Without apothecia.

17 Thallus small lobed and dissected, brown, underside light, only with isolated dark rhizines at the base of the lobes. Lobes ± isidiate or nodular at the margin, 1-2 mm wide. Ap. brown, -2 mm, narrowly protruding, with proper margin. Sp. 2(3)-celled, 11-23(32) × 4.5-7(8.5) µm.

17* Thallus commonly rosetted, barely lobed to deeply divided, blush-gray, rarely somewhat brown tinged, sometimes pruinose, undersides ± whitish or (blue) gray, decumbent, attached by the medulla hyphae, often with a dark prothallus. Ap. reddish to red-brown, with a proper or thallloid margin. Sp. 1-celled, 7-10 µm wide.

**Massalongia carnosa**

18 Thallus blue-gray, ± rosetted, -3 cm, at the margins provided ± densely with granular to squamulose (to coraloid) isidia, marginal region pruinose. Lichens of strongly oceanic regions.

**Pannaria conoplea**

18* Thallus not blue-gray, not pruinose.

19 Lobes ± isidiate or nodular at the margins, 1-2 mm wide. Thallus small lobed and dissected, brown, underside light, with isolated dark rhizines only at the base of the lobes. Over silicate, more rarely on soil mosses.

**Massalongia carnosa**

19* Lobes as a rule wider, smooth at the margins or crenate or with small lobe, with or without soralia. Thallus brown, red-brown, rarely gray, underside beige to brown-black, without rhizines. On bark, mosses or silicate rock.

**Nephroma**

20 Thallus with scattered, necklace-form Nostoc-algae.

20* Thallus not with scattered, necklace-form Nostoc-algae (if with Nostoc, then in dense coils).

21 Thallus on bark and bark mosses, small squamulose to somewhat lobed, often upon a blue-gray to blackish prothallus.

21* Thallus not upon bark and bark mosses.

22 On peat or soil mosses, and plant remains.

22* On rock.

23 Thallus purely crustose, thin, coherent, light gray, slimy-gelatinous when moist, yet with green algae. With perithecia, sp. muriform. In high mountains on acid soils.

**Protothelenella sphinctr.**

23* Thallus granular to squamulose. Fruiting bodies are ap., sp. 1-celled, very rarely 2-celled.

24 Thallus granular to finely coraloid.

24* Thallus small squamulose to nearly lobed.

25 Ap. convex, without margin, red-brown. Thallus finely granular to finely coraloid, olive to gray brown. ..

**GS Pannaria: Moelleropsis**

25* Ap. flat (to concave) or clearly margined, with granular thalloid margin or sunken into the thallus. Thallus granular.

26 Thallus blackish (green). Ap. sunken, red-brown, flat to concave, -2 mm. Sp. 15-27 x 6.5-10 µm.

**Heppia**

26* Thallus light to dark blue-gray. Ap. sessile to sunken, red-brown to brown, flat to convex, -1 mm. Sp. 11-15(20) x 6-8 µm.

**GS Pannaria: Moelleropsis**
27 On dry calcareous soils (dry grass, stony soils).  
Algae:  Scytonema, in rounded groups (alga cells not regularly spherical). Thallus yellow-olive to brown, of scattered to crowded, 1-3 mm wide squamules (or granular, then blackish). Ap. sunken, red-brown, -2mm, single or a few, without proper margin. Sp. Without slim envelope, 15-27 x 6.5 -10 µm .  


GS Pannaria

28 Thallus squamulose, with sorediate, ± enrolled margins, 5-15 mm, dusty gray, olive-gray, undersides light, attached by a navel. Soralia ± gray, even lacking on many squamules, then the margin often somewhat down curved. Algae:  Scytonema in spherical groups  Peltophulicium  

28* Without soralia  

29 Thallus of a single to a few groups of navel attached squamules, crenate to lobed, blackish. Ap. for the most part at first with only a punctiform narrow opening (perithecium like), lecanorine. Sp. 1-celled. Algae cells single or in colonies, never combined into threads (squashed) .  

GS Phylliscum

29* Thallus not of navel-like attached squamules .  

30 With ap.  

30* Sterile lichens  

31 Fruiting bodies whitish, splitting star-form, uncovering a ± rose to orange colored disk. Thallus in the interior of calcareous rock. Sp. 4-celled, fusiform, with a perispore .  

Petractis clausa

31* Fruiting body not whitish and splitting star like. Thallus not endolithic  

32 Sp. fusiform to ellipsoidal, 2-4(8) celled, cross-septate. Ap. black, with black proper margin, with a spreading, never punctiform narrow disk. On calcareous rock  Placynthium  


33 Thallus of crowded, small (1.5 x 0.8 mm), crenate, gray, or brown-gray squamules with  Nostoc algae, on silicate rock. Ap. -1 mm, with flat to convex disk .  

GS Pannaria

33* Thallus not of crowded gray to brown-gray squamules, usually blackish, even red or green tinged blackish, occasionally bluish pruinose. Ap. at first often only opening punctiform. Not with  Nostoc-algae. Algae 1-celled (single on in colonies with a surrounding gelatin envelope) or with short algal chains, then however never like a pearl necklace with globose cells  

GS Porocyphus

34 Thallus with radially elongated marginal lobes (effigurate) or with green to blue-blackish (blackened) prothallus. With  Scytonema-like algae. On calcareous rock or wet silicate rock  

Placynthium

34* Without green-blue-black or blackened prothallus, not effigurate. Thallus crustose, granular to areolate  

35 With  Scytonema-like algae. Thallus not pruinose or bluish-white pruinose. Upper surface smooth or with cylindric to corallid outgrowths. Usually on calcareous rock .  

Placynthium

35* With short algal chains or single-celled algae (single or in colonies with enclosing gelatin envelope). Usually not pruinose. Difficult to determine without ap.  

GS Porocyphus

Genus Key IV: Coniocarpic Crustose Lichens  
(dusty or cup fruited crustose lichens)

Hint: The mazaedium develops upon the upper side of the capitulum.

1 Ap. sessile or very short stalked, at times even ± sunken, ± black, sometimes pruinose  

2* Ap. definitely stalked  


GS Cyphelium

2* On bark or wood .  

3 Sp. 9-15 x 3-4 µm, narrowly ellipsoidal to cylindric, light colored (pale greenish to pale brownish), 1 celled or with 1-3 indefinite septa. Thallus indefinite.  

Microcalicium disseminatum

3* Sp. broader, globose, angular to ellipsoidal, dark brown, 1-2 celled  

4 On silicate rock or soil  

4 Sp. 1 celled, globose (angular) to ellipsoidal, 1 row in a very long persistent ascus. On  Pertusaria species or without thallus on conifers and wood .  

Sphinctrina

4* Sp. 2 celled, ellipsoidal. Ascus soon disintegrating  

Cyphelium

5 On silicate rock (also moss covered rock) or soil  

6 As a rule on bark and wood as well as bark and wood dwelling lichens or on  Cladonia squamules .  

6 Stalk whitish (to slightly rose), the base even greenish, usually over 0.6 mm thick, coarse. Ap. capitulate usually 0.8-2(3) mm wide, shield shaped to globose, brown or rose, smooth, without mazaedium. Thallus wary to very small squamulose or purely crustose, never completely mealy, K+ yellow, P+ yellow to orange. Sp. 1-2 celled, colorless  

GS Baeomyces

6* Stalk black or yellow-green pruinose, seldom light, often very slender, up to 0.2(0.3) mm thick. Capitulum commonly clearly narrower, brown to black, sometimes pruinose. Thallus commonly
mealy, intensely citron yellow to yellow-green, rarely whitish. Sp. colored to colorless  

7  Ap. stalk and underside and the margin of the capitulum yellow-green pruinose (at first also the mazaedium), upper side (of the mazaedium) light brown. Sp. globose, light, 1 celled. Thallus yellow to yellow-green  

**Chaenotheca furfuracea**  

7* Sp. blackish, upper side of the capitulum (green) black, black or dark brown, not yellow-green pruinose. Sp. not globose, colored. Seissee or on the algae layer of a whitish or yellow-green to yellow, finely sorediate thallus .  

8  Sp. 12-16 x 4-6 μm, dark brown, 2 celled. Ap. short stalked, capitulum -0.5(0.7) mm wide. Thallus light yellow to greenish, parasitic on a whitish to beige crust .  

**Calicium corynellum**  

8* Sp. 5-8(10) μm long, 1 or 2 celled. Capitulum -0.3 mm wide .  

9  Sp. 0.6-2(2.5) mm high, long stalked, blackish, upper side of the capitulum with (green) black to dark brown mazaedium. Stalk black. Sp. light, 5-8 x 2-2.5(3) μm, narrowly ellipsoidal to cylindric, 1 celled, 2 celled when mature, spirally ribbed. On (green) yellow *Psilolechia lucida* and leprose crusts .  

**Microcalicium arenarium**  

9* Sp. -0.5 mm high, capitulum black, without mazaedium, stalk light to black. Sp. 6-10 x 3-4 μm, 1 celled. On whitish to beige crusts  

**Chaenothecopsis exerta**  


GS **Stenocybe**  

10* Not on alder or popular branches  

11  Sp. 1 celled .  

11* Sp. septate .  

12  Ap. even the upper side of the capitula (almost) black, without mazaedium, undersides and margins not pruinose. Sp. narrowly ellipsoidal to ellipsoidal, up to 10 x 3.5 μm large, brown, to light brown. Usually without thallus or on a foreign thallus .  

**GS Chaenothecopsis**  

12* Ap. upper side with brown or lighter mazaedium, not uncommonly the underside and margins whitish or yellowish pruinose. Sp. globose, more rarely ellipsoidal to cylindric, colorless to brown. Thallus definite, more rarely ± lacking  

**GS Chaenotheca**  

13 Capitula with brown mazaedium, undersides and at the margin yellow (green) pruinose. Sp. light brown, with 1-3 indefinite septa, when mature almost cylindric .  

**Chaenotheca laevigata**  

13* Capitula without brown mazaedium, either shiny black without mazaedium, or with black, rarely yellowish pruinose mazaedium, underside and at the margin black or brown, whitish or yellowish pruinose.  

14 Capitula with bulging black (rarely slightly pruinose) mazaedium, black or brown on the underside and at the margin, whitish or yellowish pruinose, usually top-shaped to cup-shaped in outline. Sp. (dark) brown, 2 celled, at best 3.5 μm wide. Ascus usually relatively rapidly disintegrating  

**Calicium**  

14* Capitula without bulging mazaedium, shiny blackish. Sp. brown, or light brown. Ascus persistent  

15  Sp. 4 celled, 20-32 x 7-10 μm. Capitula globose to 4 angled in outline. On old pines  

**Stenocybe**  

15* Sp. 2 celled .  

16  Sp. 10-13 x 4-6 μm, 2 celled. On poplar .  

**Psilolechia lucida**  

16* Sp. up to 10 x 3 μm. Generally not on poplar  

**Chaenothecopsis**  

**Genus Key V: Lichens with Perithecia**  

**(pyrenocarpic lichens)**  

1 Fruiting body yellow to greenish yellow  

1* Fruiting body not yellow to greenish yellow .  

2 Fruiting body shining yellow to greenish yellow. Sp. very many per ascus, 1 celled, small  

**Theilocarpon**  

2* Fruiting body yellowish (rose) to rose brown. Sp. to 8, many celled, needle-like, very long  

**Belonia**  

3 Thallus definitely foliose, for the most part, the underside free from the substrate, single unit rounded and attached at one place navel-like, or multiple and closely crowded, attached at several places. One thallus usually about 0.8-4 cm wide. Sp. 1 celled, colorless .  

**Dermatocarpon**  

3* Thallus crustose or squamulose, squamules -1 cm in size  

4 Thallus squamulose or indefinitely lobed at the margin, on soil, mosses, or rock. Per. Black. Paraph. In ripe per. indefinite or lacking .  

4* Thallus entirely crustose, coherent to areolate (to clod-like) or granular or indefinite  

5 Sp. muriform-multicellular, colorless to brown, usually 2. With or without hymenial algae  

5* Sp. 1-celled to cross-septate multicellular, colorless. Without hymenial algae .  

6 Thallus in fresh condition pale greenish to greenish-brown (in the herbarium yellow to gray-brown), moist shining green, very small squamulose, squamules 0.3-1 mm, usually close together and ± erect. Fruiting bodies conical to barrel shaped, with warty upper surface, sessile to moderately sunken, often between the squamules, -0.4 mm. Without hymenial algae. Sp. colorless to slightly brownish, 60-120(150) x 20-50 μm  

**Agonimia tristicula**  

6* Thallus brown, gray-brown, or olive-brown, squamulose. Squamules 0.5-2.5(4) mm.
Hymenium contains small globose to elongate, greenish algal cells. Sp. up to about 75 µm long

Endocarp

7 Sp. 2(4) celled  GS Placidiopsis
7* Sp. 1-celled  Catapyrenium
8 Sp. muraliform. Per. blackish  9
8* Sp. 1-celled to cross septate multicellular. Per. blackish or stained  11
9 With small globose or cylindric algae in the hymenium  Staurothele
9* Without hymenial algae .  10
10 Fruiting body strongly protruding to sessile, conical to barrel shaped, with warty upper surface, black. Thallus conspicuously granular to very finely squamulose, pale green to brownish green, clearly green when moist. Sp. 60-20 x 20-50 µm, 1-2. Paraph. Lacking. On bark, or mosses  Agonimia tristica (6)
10* Fruiting body otherwise shaped, hemispherical projecting to sunken, not warty  11
11 On bark. Sp. colorless to slightly yellowish.  12
11* On rock, or soil (even bark dwelling) mosses.  14
12 Fruiting body containing several perithecia like chambers, which open by pores or cracks. With true green algae or not lichenized  Mycoperum
12* Fruiting body is a normal perithecum with a punctiform opening and one hymenium. Paraph. Reticulate and bound  13
13 With Trentepohlia algae or not lichenized. Sp. with perispore, -27 x 17 µm (if without perispore or without algae: not treated fungus, above all Mycoglaena species) .  Julella
13* With globose green algae. Sp. without perispore, single row in the ascus, 25-42 x 11-17 µm. Per. without involucre .  Thelenella modesta
14 Paraph. Swelling and soon deliquescing, in mature per. lacking. On calcareous and silicate rock, rare on soil, or mosses. With globose algae. Sp. colorless to brownish .  Polyblastia
14* Paraph. Definite .  15
15 Sp. light to slightly brownish, clearly muraliform, at most 18 x 10 µm. With green algae with a thick gelatin envelope. On mosses, soil, soil and silicate rock  GS Prototellenella
15* Sp. brown, or red brown, with 1-2(4) longitudinal septa, up to 18(21) x 9(11) µm large. On silicate rock. Without algae or algae loosely associated .  Lichenothelia
16 Sp. 1 celled, generally colorless. Thallus with globose green algae .  17
16* Sp. 2 celled to cross-septate multicellular  24
17 On bark .  18
17* On soil or rock .  19
18 Sp. ellipsoidal, thick walled, very large. Fruiting body completely sunken in gray to gray-greenish thallus warts  Pertusaria
18* Sp. needle-like to narrowly fusiform, slightly curved, -3.5 µm wide. Per. blackish to pure black .  GS Leptophraxis: Crespophraxis
19 Sp. over 140 µm. Fruiting body sunken in over wide bulbous thallus warts Pertusaria
19* Sp. up to 40 µm. Per. blackish to pure black .  20
20 On soil or mosses .  21
20* Commonly on rock. Typically paraph. (between the asci) lacking or indefinite .  23
21 Paraph. Definite, unbranched. Dry thallus very indistinct, slimy when moist. Sp. 15-30 x 5-12 µm. On bare soil  Thrombium epigaeum
21* Paraph. Lacking in ripe Per. Thallus clearly developed .  22
22 Thallus areolate or squamulose, gray to brown Catapyrenium
22* Thallus of minute gray-green globules or 15-40 µm in diameter. Sp. 19-29 x 5-8 µm .  Verruca (bryoconia)
23 Sp. very slender, with globose thickened ends, ± sinuous, 30-40 x 3-3.5 µm ( ) (if filamentous ↑ S. beckausiana). Per. with projecting mouth, with a dark outer receptacle, -0.7 mm. Ascii soon deliquescing. Thallus indefinite or endolithic  Sarcopyrenia gibba
23* Sp. ellipsoidal to globose .  Verruca
24 Per. 2-12(50) in irregular to rounded, black fruiting bodies, divided by limiting walls. Algae often only loosely associated (or lacking). On bark  25
24* Per. not numerous in united chambered fruiting bodies, commonly single, in aspect mostly round, rarely elliptical .  26
25 Sp. with 3-5 cross-septa, soon also with longitudinal septa, ± colorless, 12-18 x 4.5-8 µm. Per. 2-6. Paraph. Commonly soon indefinite. Associated with green algae  Mycoperum quercus
26 Ripe spores strongly colored, usually brown. With Trentepohlia or without algae  27
26* Sp. colorless or lightly colored .  31
27 Sp. cells with lens-shaped interior space, in aspect therefore elliptical to rhomboidal, walls unequally thickened (see fig. S 31). Paraph. Simple, free, permanent. Sp. (2-)4(6) celled. With Trentepohlia. Per. dark brown to black, laterally often covered by thallus tissue. On bark  Pyrenula
27* Sp. cells not so. Walls uniformly thin .  28
28 On bark .  29
28* On rock. Paraph. Branched and reticulate. Without algae or algae only loosely associated. Per. black  30
29 Sp. 4-6(8) celled, with dark septa, end cells lighter. Thallus whitish, with Trentepohlia. Per. -0.35 mm, dark brown to black-brown. Paraph.
Simple to sparsely branched. Sp. (13)18-26 x 6.5-10(12) μm. Eopyrenula leucopepla

29* Sp. 2 celled, often one cell somewhat larger. Thallus commonly indefinite, without algae or algae only loosely associated. Per. black. Paraph. Branched and reticulate.

 Mycomicrothelia

30 On silicate rock. Thallus black, finely cracked to finely areolate. Per. black, flattened spherical protruding, flattened above. Sp. (2-)4 celled or rarely also with 1-2(4) longitudinal walls, ± smooth, with perispore, 13-21 x 6-11 μm. Lichenothelia (scopularia)

30* On calcareous rock. Sp. 25-36 x 12-18 μm, warty, 2 celled, ± egg-shaped. Per. sunken, when sessile, strongly flattened above. Fungus of pyrenocarpic lichens with whitish to gray-reddish or endolithic thallus. Polycoccm marmoratum (Krempelh.) Hawksw.

31 Sp. with about 20 septa, acicular, at best 50 μm long. Per. pale yellowish to pale rose or brownish (very light when moist). Paraph. Unbranched, permanent. Thallus with Trentepohlia. In higher sites. Belonia

31* Sp. with much fewer septa, if acicular, then per. black.

32 Per. red-brown to yellow-brown or rose.

32* Per. black, at times pruinose and ± gray.

33 Thallus with coccoid green algae, light greenish, or light yellowish, or elongated, cylindrical to branched, minute granules, also sometimes sorediate. Per. light brown to orange-brown, -0.4 mm, with cellular, 30-80 μm thick light exc., without paraph. Sp. 4-5(6) celled, 13-21 x 4.5-6 μm. Almost only on elder, maple, or elm.

 Macentina stigonemoides

33* Thallus with Trentepohlia, not consisting of cylindrical to branched light green granules. Paraph. permanent.

34 Sp. to 8 per ascus, 4-8 celled, fusiform. Porina

34* Sp. to much more than 8 in (at most 150 μm) long asci, 4 celled, 12-18 x 5-6 μm. Per. -0.6 mm, pale reddish to brown. Paraph. Simple. Thallus gray-rose to (in the herbarium) gray-greenish or lighter. Thelopsis (rubella)

35 On rock, soil, or mosses.

35* On bark.

36 Sp. fusiform to narrowly fusiform (to almost acicular), at best 4 celled. Paraph. Permanent. Sagediopsis barbara (Th.Fr.) R. Sant. &Triebel (=gongylia nadvornikii Servit)

36* Sp. ellipsoidal, 2-4 celled, if fusiform, then 2 celled. Paraph. Permanent or lacking in ripe per.

37 Per. on white rock-dwelling thallus with green algae and dispersed soralia (Porpidia glaucopephae), black, -0.6 mm. Sp. 25-38 x 3-5 μm, mostly 4-5 celled. Paraph. branched. Parasybiont. Rare: southern Black Forest and Vosges Mountains.

38 Thallus without soralia, with Trentepohlia. On rock, or mosses. Sp. fusiform, 4-8 celled. Paraph. branched or unbranched.

GS Porina

38 With globose green algae in the thallus. Hym. I+ orange to red. Paraph. lacking (but periphyses occurring in the ostiole region). Per. with or without involucrum. Sp. 2 to rarely 4 celled, septum usually in the middle. Thelidium (Verrucaria bryoctona and Pyrenocollema spp. also commonly have 2 celled sp.)

38* With Trentepohlia or blue-green algae. Paraph. occurring. Sp. 2 celled.

39 Sp. with very thick dividing wall, 1 ranked in the ascus (s.139), with (often finely warty) perispore, with rounded ends, with 2 equal cells. Per. 0.5-1(1.5) mm. Ascus cylindrical. Paraph. sparsely branched or bundled. Thallus with Trentepohlia, often in the substrate.

GS Arthopyrenia: Acrocordia

39* Sp. with the thicker walls and not 1 ranked, with or without a very thin smooth perispore, usually 2 unequal cells, in species of this hemisphere -24 x 7 μm, sometimes even larger. Per. only -0.3 mm, always without an involucre. Hym. I-. Asci ventricose to almost cylindrical. Paraph. richly branched and reticulate. With blue-green algae or Trentepohlia in the thallus (cells yellowish, orange or blue-green, in P. saxicola yellowish to orange) GS Arthopyrenia: Pyrenocollema

40 Sp. at times curved or ± spiraled, narrowly fusiform, acicular, worm-like, or thread-like, -4 μm wide, 2 to 4 celled. Paraph. branched and reticulate bound, ± permanent. Per. black, -0.4 mm. Without algae or the algae only loosely associated.

Leptorhaphis

40* Sp. straight, fusiform to ellipsoid.

41 Sp. 2 celled, ± ellipsoid.

41* Sp. with at least 4 cells.

42 Asci clearly thickened above. Paraph. ± branched, permanent or soon swelling and scarcely recognizable. Sp. ellipsoidal fusiform. Thallus scarcely recognizable or definite. Without algae or with Trentepohlia.

GS Arthopyrenia

42* Asci thin walled, even the apex scarcely thicker. Paraph. approaching unbranched, permanent. Per. 0.2-1 mm. Sp. fusiform, 4-8 celled. Thallus, as a rule, clearly developed, with Trentepohlia.

GS Porina

Genus Key VI: Streak and Fleck Fruiting Lichens

1 Sp. 1 celled, colorless. Thallus with pure green algae

1* Sp. 2 to multicellular, colorless or colored. Thallus usually with Trentepohlia algae, often golden brown to orange yellow at the crevices.


48
2* On wood, rarer on bark . 3

_Ptychographa flexella_

4 Sp. muriform, i.e. with longitudinal and cross walls. On bark .
4* Sp. 2 celled to cross septate multicellular . 5

_Xylographa_

5* Exc., as a rule, definite, black. Sp. I+ violet, as a rule, larger. Ap. indefinite to definite with margin. NW Germany .
6 Graphina Müll.Arg. 7
6* Sp. with more than 2 cells . 9
7 In alpine places on calcareous areas. Ap. angular to elongate, simple, rarely forked, with crevice like disks. Exc. And hyp. Dark red-brown. Sp. 15-23 x 7-12 µm, constricted, for a long time colorless, then the inner layer gray-green to violet-black, with perispore. Asci with K/I+ blue thallus. With coccoid green algae .

_Poetinula cerebrina_ (DC.) Haf. (Encephalophyta e.(DC.) Massal.)

7* With other characteristics. If on calcareous rock, then ap. with sp. otherwise and not with crevice form disks .

_Melaspidea_


_Arthonia_

9* Sp. fan ± rectangular to quadrato .
10 Thallus with fleck soralia, brown, with black prothallus. Ap. rounded, with punctiform disks .

_Enterographe zonata_

10* With other characteristics .
11 Exc. Black to brown-black, clearly developed, as a rule, also extending under the hyp. (producing a U-form receptacle in section). Ap. usually streaked, often branched, rarely rounded, black, with crevice form to broadened disks and elevated margin. Sp. 4 to multicellular .

_Opegrapha_

11* Exc. ± reduced, not carbonaceous. Proper margin lacking or weakly elevated . 12
12 Sp. with a maximum of 4 cells . 13
12* Sp. at least partially 5-9 celled . 14
13 Sp. 24-36 x 2-3.5 µm. Ap. black, 0.3-1.5 x 0.1-0.2 mm, simple to branched, (almost) sunken, with whitish thallloid margin. Hyp. strongly developed, dark red-brown. Thallus whitish .

_Schismatoma graphidioides_

13* Sp. shorter. Arthonia (14)
14 Ap. (almost) completely sunken, black to brown-black, not pruinose, short streak-form to almost rounded. Sp. 6- to 9 celled, (20)24-30(40) x 4-5(6) µm .

_Enterographe_ (Hutch.)

14* Ap. usually not completely sunken, brown to black, red, or red-brown, occasionally pruinose, usually rounded to fleck-form or short lobed, rarely streak-form to branched. Sp. 4-6(7) celled, usually shorter .

_Arthonia_

Genus key VII: Other Crustose Lichens

(above all Disk Fruiting Crustose Lichens)

1 Thallus margins with elongated, radially arranged areoles, appearing lobed, or thallus squamulose .
1* Thallus truly crustose to the margin, not appearing lobed or squamulose .
2 Thallus true yellow, citron yellow, orange, light red, or rust red .
2* Thallus not true yellow, orange, or red .
3* Thallus K-. 4
4 Sp. usually with thick (rarely thin), at least when young with a thin opening penetrating the center of the dividing wall, 2-(rarely 4-) celled. With ap., soralia or isidia, commonly on rock .

_Caloplaca_

4* Sp. without or with thinner, cross wall, 1-2 celled, without soralia, and without isidia. On soil, or mosses .

_Fulgensia_

5 On soil or mosses, squamulose or appearing lobed .
5* On rock, usually rosetted and effigurate .

_Cadalecchia wahlenbergii_


_Candelariella medians_

7* On silicate rock, yellow or rust-red. Almost always with ap., without soralia or isidia. Ap. yellow or red, dark brown, or blackish. Sp. to very many per ascus, small .

49
8 Ap. yellow, disk form. Thallus yellow

Pleopsis dium

8* Ap. blackish to rust colored. Thallus red, or yellow

Acarospora (sinop., smaragd.)

9 Thallus sorediate 10
9* Thallus not sorediate . 20

10 Thallus ± rounded rosettes, appearing lobed
(placoid) at the margin 11
10* Thallus squamulose, not rounded rosettes . 16
11 Thallus C+ red, with fleck soralia, with or without brown cephalodia . 12
11* Thallus C-, always without cephalodia 13
12 Thallus of rounded rosettes, whitish, cream, or light beige, with definite close together marginal lobes, with bordered, often appearing ring-like arranged fleck soralia, without cephalodia or with warty cephalodia protruding in the center, -2 cm wide. Ap. very rare, brown, lecanorine. Sp. 1 celled

Placopsis gelida

12* Only the young thallus rounded, marginally only very weakly effigurate (without clearly bordered marginal lobes), slightly rose tinted, with irregularly ordered irregularly border soralia, always without cephalodia

Trapelia placoidioides

13 Thallus K+ yellow, with definite, close marginal lobes and ± coalescing fleck soralia, gray-white to slightly blue tinted light gray. On calcarious rock, very rarely on bark

Diploicia canescens

13* Thallus K- . 14
14 Thallus with underside with patterned cortex, also a foliose lichen, yet very closely attached to the substrate and scarcely able to be loosened, very thin and delicate, gray-green, gray, or gray-brown, with fleck soralia toward the center, with narrow, smooth, definite lobules at the margin, scarcely over 1.5 cm broad, underside light to dark. On bark, rarer on rock

Hyperphyscia aubluti nata

14* Thallus without patterned underside, entirely crustose, not as easily loosened, underside without cortex. On rock

15 Thallus brown, but often whitish pruinose, small, usually scarcely over 5 mm wide, but often growing together in large numbers, sorediate in the center. On warm silicate rock overhangs

Lecanora (PT 1) dimissa

15* Thallus gray-white, mostly over 5 mm, only weakly lobed at the margin, becoming granular sorediate in the center. Predominantly on walls

Calopla ca teicholyta

16 Squamules C+ red, mostly arranged like shingles and with up-turned sorediate margins, light brown, yellow- to gray-brown, or brown- to gray-olive, 0.8-2.5 mm, mostly at the base of trees, rare on silicate rock. Ap. rare, black, and pruinose

Hypocenomyce scalaris

16* Squamules C- . 17
17 Squamules erect and ± shingle-like arranged, sorediate at the margin (lip soralia), close together, greenish-brown to brown, underside pale brownish, without cortex. Apothecia convex, without margin, brown, very rare. Occurring on charred wood in higher regions

Hypocenomyce

17* With other characteristics; squamules generally without brown tint, if ± shingle like in arrangement, then the underside whitish to yellowish

18 Very rare species with brown to gray margined ap. and light gray-greenish to olive gray squamules with lobed, sorediate eroding margins. Soralia lip-form to almost capitiate. On peat

Trapeliopsis percrenata

18* Ap. lacking

19 Squamules rounded, conchoidal to reniform, flat to concave, with a definite elevated margin, light gray, even with a light blue tint on the often concentric undulating surface, 1-2 mm wide, erupting, scattered to crowded soralia, above all at the margin, R-. On (mossy) bark, rarer on mossy rock. . .

Normandina pulchella

19* Squamules rounded to irregularly entire margined or crenate, gray-green to greenish white, not appearing margined, with cortex, erupting sorediate the margin or on the underside, not undulating on the surface, generally crowded, often erect, P+ red to P-, K+ yellow to K-, on bark, wood, or soil

Cladonia-thallus squamules

20 Thallus on bark or wood 21
20* Not on bark or wood 22
21 Squamules flat closely attached, brown, olive-brown, olive-gray, gray-brown, or gray-green, R-, decumbent to somewhat erect, without a clearly differentiated underside. Ap. black, lecanorine

Hypocenomyce

21* Squamules only attached at the base, greenish-white, gray greenish, yellow greenish, or light gray, erect, crowded, P+ red, yellow or P-, underside clearly differentiated, whitish to yellowish to orange at the base. Always without ap.

Thallus squamules of Cladonia

22 On soil, mosses, or lichens 23
22* Directly on rock 38
23 Lichens ± asteroidal, only about 1 mm wide, consisting of a deeply depressed black-brown ap., which is surrounded by ± triangular “lobules.” Sp. many per ascus, 2 celled, 11-17 x 3-4 μm. On loess

Solorinella astericus

23* Lichens otherwise . 24
24 Thallus with very small blackish punctate squamules (sunken per.). Squamules light to dark brown, gray-brown, olive, or whitish, usually on calcarious soil over mosses

Key V

24* Thallus without per . 25
25 Ap. black, but sometimes whitish pruinose, without thalloid margin, with/without proper margin

25* Ap. not black or a.; lacking . 28
26 Sp. brown, 2-celled

GS Buellia
Toninia

35* Sp. colorless

27 Sp. 2- to multicellular cross- septate, ± fusiform.

GS Lecanora PT 1: Squamarina

31 On acid soils in higher sites. Ap. brown-red, concave, then flat with a thick conspicuously granular margin, 1-6 mm. Sp. 1(2) celled, 16-32 x 5-8 µm. Thallus ochre, gold- to greenish-brown, small squamulose. Squamules -1.5 mm, crenate, coalescing into one crust

Psoroma hypnorum


GS Lecidea PT 1

32 Thallus clearly rosetted, lobed at the margin, the interior of ± continuous, coalescing squamules

32 Thallus squamulose throughout to small lobules, not rosetted and lobed.

33 On lime-poor, acid soils, greenish-gray, sometimes brownish tinted.

Baeomyces placophyllus

33* On lime-rich soil or lime-mosses

34 Thallus P+ red, without ap. Squamules brown to pale greenish, not pruinose

Cladonia pyxidata (pocillum)

34* Thallus P- or medulla P+ yellow, usually with ± brown lecanorine ap. Squamules greenish-white or light yellowish-green, even slightly brown tinted green, usually ± thickly white pruinose

Lecanora PT 1

35 Squamules strongly convex, turgid to almost bladder-like

35* Squamules flat to concave.

36 Squamules, at lease when young, concave, leek- green, white around the margin and inflated, -3(4) mm wide, usually numerous, on turf, peat, moist moss thatch, on acid subsoil, sometimes in association with small fungus caps with lamellae.

Omphalina hudsoniana

36* Squamules otherwise.

37 Squamules firmly attached at the base, ± erect, pale greenish, green yellowish, or gray green, entire margin, crenate, or incised, crowded, often P+ red or yellow, with differentiated, usually whitish underside.

Cladonia

37* Squamules either ± decumbent or P- or other color; see for example Lecidea PT 1, Toninia, or Catapyrenium.

38 Ap. orange-brown to rust colored, K+ deep red, convex biatorine. Thallus squamulose, bright greenish-gray to bright olive, on limestone

Psoroma testacea

38* Ap. not K+ deep red

39 Sp. small (up to about 6µm), spherical to elongate, 1-celled, to very numerous per ascus.

39* Sp. commonly 8 per ascus, larger.

40 Thallus areolate (areoles -0.6 mm), with radiating enlarged marginal areoles, bronze colored to almost black or bright gray to yellowish-ray, C+ red, with black prothallus. Ap. black, sunken, even or uneven, warty-scared to furrowed, lecideine. Sp. spherical. Moist high alpine on silicate rock, or alpine

Sporastatia

40* Thallus squamulose, squamules over 0.6 mm, usually ± brown, or red-brown, with usually sunken to deep seated, red-brown, or brown to dark brown (rarely brown black) ap. Sp. ellipsoidal to elongate.

Acarospora

41 Thallus with a definite yellow tint, yellowish-gray, green-yellowish, or yellowish white.

41* Thallus without yellowish tint.

42 Ap. black, ± sunken and with thalloid margin. Sp. ± brown, 2-celled. Thallus somewhat lobed at the margin, sharply defined areolate in the interior. In higher places on silicate

Dimelaena oreina

42* Ap. usually brown to brown-red, sometimes pruinose, with thalloid margin. Spores colorless, 1-celled.

GS Lecanora PT 1


43* Ap. with thalloid margin, or without definite margin and sunken into the thallus. Thallus usually rosetted and effigurate (placoid), interior areolate to squamulose.


Buellia badia

44* Sp. colorless.

45 Sp. 2- to cross-septate multicellular. Ap. black or sometimes thickly white pruinose, lecideine.

Toninia

45* Sp. 1-celled.

46 On silicate rock. Ap. black or brighter, lecideine or biatorine.

GS Lecidea


47 Squamules whitish, moderately convex to almost flat. Sp. 10-18 x 3.5-5 µm.

Toninia tumidula

47* Squamules ± brown, usually ± flat to uneven. Ap. 12-16 x 5-7 µm (if squamules bloated convex and sp. 10-20 x 3.5-6.5 µm, see Toninia tristis).

Lecidea lurida

48 Sp. 2-celled, 10-18 x 3-4 µm. Thallus white, K- marginal lobes -2.5 mm wide, flat, close to one another. Ap. black (rarely brown), sunken to depressed, -1.5 mm.

Solenopsora candicans
48* Sp. 1-celled. Thallus brownish-gray to dark gray, or greenish-white) almost white (± strongly pruinose), often over 2.5 cm wide, rosetted or squamulose

GS Lecanora PT 1

49 Thallus yellow, orange, or -orange-red. K+ immediately deep red. Sp. 2- rarely 4-celled, commonly with conspicuously thicker dividing wall.

Caloplaca

49* With other characteristics; if thallus yellow to orange-red, then not K+ deep red

50 Sp. one-celled

50* Sp. multicellular

51 Sp. muriiform, i.e. with cross- and longitudinal walls

51* Sp. not muriiform


Phlyctis (agelaea)

52* Ap. not sorus-like, not covered with whitish granules

53 Ap. rose, brown, yellowish, or orange. Thallus with Trentepohlia or true green algae.

GS Gyalecta

53* Ap. blackish, but also gray pruinose

54 Sp. soon clearly brown to green colored.

54* Sp. remaining colorless or (over mature) slightly colored.

55 Ap. disk with sometimes at first a conspicuously deep disk, with a proper margin with at first a narrow opening toward the inside of the bulging thalloid margin, sometimes pruinose. Hyp./Exc. Dark. Paraph. simple. Sp. muriiform, to 4-8. Thallus often very thick, gray to ocher, the native species C+ red. On rock, soil, mosses, and lichens

Diploschistes

55* The ap. disk not clearly depressed, without thalloid margin or with an indefinite whitish thallloid margin. Thallus almost always C-.


Rhizocarpon

56* Sp. without perispore, usually -28 µm long, weakly muriiform (with only 1-2 longitudinal walls), usually with rounded cell lumen. Paraph. simple or with isolated forks. On various substrates.

Buellia

57 Ap. deeply sunken in -2.5 mm wide, hemispherical thallus warts, 1.5(2) mm, at first punctiform, then wider opening, then with an inner wavy margin. Disk blackish, gray pruinose. Sp. 40-140 x 11-25 µm, with lens form to spherical cell lumen. Thallus light gray or yellowish gray, with Trentepohlia, commonly on bark.

Thelotrema lepadinum

57* Ap. not deeply sunken in hemispherical thallus warts, without thalloid margin. Sp. without lens form lumina

58 Paraph. branched and reticulate bound, strongly cemented. Young spores with perispore. Ap. black, sometimes pruinose

Rhizocarpon

58* Paraph. simple, branched here and there. Rare species.


Lopadium disciforme

59* Sp. smaller, usually 4-8 per ascus, mostly weakly muriiform. Hyp./exc. (interior) very light. Ap. concave to flat. Thallus with Trentepohlia or true green algae. On bark or rock

GS Gyalecta

60 Sp. definitely colored, greenish, olive, or dark brown.

60* Sp. colorless (sometimes the older ones slightly colored)

61 Thallus with Trentepohlia algae, when scraped or scratched often orange to golden brown. Sp. commonly at first slowly brownish

61* Thallus with true green (coccoid) algae. Ap. rounded to irregular


Arthonia


Melaspilia

63 Paraph. richly branched and reticulate bound, cemented. Sp. at least when young with perispore, often over 28 µm long, 2-celled, rarely 3-5 celled. Hyp. dark. Thallus usually clearly developed, often areolate. On rock

Rhizocarpon


64 Ap. with thallloid margin (in doubtful cases: always with algae in the margin). Sp. often with unequally thickened wall, 2-celled, in a single moss dwelling species 4-celled. Hyp. colorless to slightly brownish

Rinodina

64* Ap. without thallloid margin (margin without algae) or ap. sunken in the thallus. Sp. wall not unequally thickened. Hyp. usually dark.

Buellia

65 Sp. 2-celled, with conspicuously thickened septum, that at least in the young ones is penetrated by a visible canal (polar diblastic). Ap. yellow, orange, red, or red brown, K+ deep red, or black, sometimes pruinose. Hym. Above generally K+ red to red-violet.

Caloplaca

65* Sp. otherwise. Septum generally thin.
66 Thallus with *Trentepohlia* algae, when scratched or scraped often orange to gold brown (in problem cases check alternatives!).
67* Thallus not with *Trentepohlia*, commonly with true green algae
67 Sp. 2-celled .
67* Sp. with more than 2 cells .
(yellow/orange, dirty gray-blue or blue. Asci thickened above
or I+ blue .
69 Ap. whitish to orange, with concave to flat disks. Hyp. (Exc. ±) colorless. Spores fusiform to
ellipsoidal. Thallus thin, light gray to green, film-like to scurfy, on bark and mosses

**Dimerella**
69* Ap. dark. Hyp and exc. dark or light
70 Sp. at first colorless then brown, cells sometimes unequal in size. Ap. rounded to streaked, black.
70 Thallus indefinite. Asci 1-
70* Sp. remaining colorless, cells equal in size. Ap. rounded, black or dark red-brown. Asci I+ blue at least above.
71* Ap. black, however sometimes pruinose .
72 Sp. to 16 or more per ascus, long fusiform to almost thread-like, -5 μm wide. Ap. brown-red
to orange-brown, -0.6 mm, with concave disk. Asci not thickened at the apex. Epiphym. Brown.
72* Sp. 8 per ascus 73
73 Ap. bordered, with clearly developed exc., disk often concave or deeply sunken. Asci usually
very lax, cylindric-clavate. Sp. long fusiform to ellipsoidal. Ap. yellowish, rose, red, or (dark)
brown. On bark, soil, rock, or plant residue

**Dimerella**
73* Ap. without margin, exc. reduced. Asci broad, wall strongly thickened above .
74 Sp. needle-form, 50-80 x 1.5-2.5 μm, multicellular, disintegrating in short segments. Ap. black. Thallus whitish, almost exclusively
on oak bark
74* Sp. shorter, not disintegrating into small pieces, usually fusiform .
75 Paraph. simple or with scattered branches, in other parts occasionally bound. Sp. 4-celled, with perisporium, 12-28 x 6-9 μm. Asci thin

**Sagiolechia**
75* Paraph. branched and reticulate bound. Asci thick walled, fissitunicate .
76 With strongly developed dark receptacle/exc., without thallloid margin.

76* Receptacle/exc. reduced, with or without thallloid margin .
77 Ap. almost perithecia-like, with narrow punctiform disks. Dark exc. only developed in places, hyp. light. Thallus (dark) brown, with lighter soralia, commonly with a dark prothallus .

**Enteropogon**
77* Ap. with wide open disks. Dark exc. even the underside developed, producing a cup-like
receptacle .
78 Ap. often not uniformly rounded, disks sometimes with an umbo or groves. Receptacle
black, underside often strongly developed. On rock .

**Opegrapha**
78* Ap. usually uniformly rounded, often pruinose, with smooth disk, usually with proper margin.
Receptacle black-brown. On rock and bark .

**Lecanactis**
79 Ap. with a finally inconspicuous, black, rarely pruinose thallloid margin differentiated from the thallus. The fresh thallus slightly reddish, the old (in the herbarium) whitish to cream colored. Sp.
4-celled, fusiform, 25-42 x 2.5-4 μm. Hyp. dark. On bark .

**Schisomatoma**
79* Ap. without thallloid margin, uniformly to irregularly rounded or short lobed, without margin, brown to black, sometimes thickly white
pruinose. Sp. -25 μm long .
80 Ap. margin separated from an at first narrow central star-like ap. opening in 4-8 triangular
lobes. Disk concave, rose, rose-brown, or yellowish. Ap. extensively up to half sunken in calcareous rock. Sp. 4-celled. Thallus indefinite. With Scytomena algae

**Petractis**
80* Ap. margin not set off star-like from the center. Not with Scytomena algae, but with green algae

81 Ap. disk yellow, orange, or brown-orange, K+ immediately deep red. Sp. 2-celled .
81* If ap. disk yellow to orange colored, then not immediately K+ deep red .
82 Ap. margin with algae (in section), externally almost always colored as the thallus
82* Ap. margin without algae, generally colored like the disk, or without a margin .
83 Ap. disk yellow, dirty yellow, or orange, K- to gradually slightly reddish. Sp. 2-celled. Thallus yellow or gray .

**Candelariella**
83* Ap. disk not yellow to orange .
84 Sp. sometimes 30 μm long, fusiform to needle-like, with (1)3-7 cross-septa. Ap. red, K+ dark red or blue, or rarely the ap. brown, non-pruinose, concave to moderately convex. Hyp. ±
colorless .

**GS Haematomma**
84* Sp. shorter, 2-4 celled. Ap. not red
85 On decayed wood, peat, raw humus, or mosses, very rare on acid silicate rock. Ap. rose or rose
beige, at first with whitish margin, 1-3 mm

**Icmadophila** (91)
85* On bark, calcareous rock, manured or mineral rich silicate rock. Ap. brown, red-brown, or rose-brown to blackish, sometimes white pruinose, -1(1.2) mm. Thallloid margin often soon shrinking back (if thallus somewhat squamulose, white, see Solenopsis). **Lecania**


86* Thallus not of distinct squamules, commonly coherent crustose to areolate **87**

87 Lichens on thin branches and needles of conifers **88**

87* On other habitats **91**

88 Ap. light, whitish, beige, or yellow, bordered. Exc. paraplectenchymatous, of spherical to ellipsoidal cells (when exc. not paraplectenchymatous, see Bacidia) **Fellhanera**

88* Ap. dark red-brown to black **89**

89 Ap. bordered. Species dying out **90**

89* Ap. soon margnris . **107**

90 Ap. black, -0.6 mm, margin gray-whitish, hairy-feltly under the lens, made up of loose hyphae coming up from the thallus. Hyp. dark red-brown. Hym. I+ blue. Sp. 10-17 x 3-5 μm, (2-)4 celled. Thallus gray, very thin. **Byssoloma subdiscordans**

90* Ap. dark red-brown to black, -0.3 mm, margin not hairy-feltly. Hyp/exc. colorless at the base. Hym. I- to yellowish. Ascoplasma I+ red. Sp. to 4, rarely 8, 12-19 x 4.5-7 μm, divided by up to 5 cross walls. Thallus gray, very thin **Gyalideopsis piceicola**

91 Ap. rose, rose-beige, or orange-rose, sometimes slightly whitish pruinose, K+ orange (like the thallus), at first with a whitish margin, later convex marginless, sessile or short stalked, 1-3 mm. Thallus pale green, gray-greenish to whitish, ± granular, on decaying wood, peat, raw humus, soil, or acidophylic mosses. Sp. 2-4 celled, 13-24 x 4-6 μm. Hyp. colorless **Icmadophila ericetorum**

91* Ap. other colors; if rose, then on other substrates, not K+ orange, usually smaller **92**

92 Sp. 2-celled, never needle-form to threadlike **93**

92* Sp. multcellular; if sp. needle-like to threadlike, then septa at times indefinite. **99**

93 Ap. concave, small, -0.4mm, yellowish to rose-brown. Asc thickened above, I+ red-brown. Paraph. commonly simple, receptacle and hyp. light. Hym. I-/I+ yellow (at best the tips of the ascii blue). **Absconditella**

(IF ap. dark brown, with triangular appendages, sp. many per ascus; ↑ Solorinella asteriscus, 23)

93* Ap. commonly flat to convex **94**

94 Sp. over 19 x 7 μm in size, the young ones with a perispore. Ap. black, rarely brown-black, at least at first with a margin. Hyp. black to brown. Exc. usually clearly developed. On rock **Rhizocarpon**

94* Sp. up to 19 x 7 μm. Ap. light to black. Hyp. light to dark. On various substrates **95**

95 Paraph. simple to forked. Ap. at least when young commonly with margin, light to black. Exc. clearly developed. Spores without perispore, ellipsoidal to bacillar. Algae not micareoid. Hym. I+ blue **GS Catillaria**

95* Paraph. branched and bound. Ap. bordered or unbordered. Exc. definite to lacking **96**

96 At least the young spores with a perispore, ± ellipsoidal. Ap. at least at first bordered, black, rarely brown-black. Exc. at times clearly developed. Hyp. black to brown. Hym. high. On rock **Rhizocarpon**

96* Sp. with perispore, ellipsoidal to fusiform or elongate. Ap. unbordered, rarely with a light border. Exc. lacking to weakly developed, then of branched paraph.-like hyphae **97**

97 Without hyp. and exc. Hym. without hymenial gelatin. Paraph. almost lacking or ± numerous, branched, netted and closely entwining the asci. Young ap. often hairy (Binocular). Sp. smooth or warty. Short-lived species on mosses, soil, and plant residue **Vezdeae**

97* With other characteristics. Hym. with hymenial gelatin. Paraph. numerous, not entwining the asci. Ap. not hairy **98**

98 Hym. I+ blue. Ap. unbordered or weakly bordered, light or dark (to black). Sp. partitioned ± equal in size. Exc. (almost) lacking, rarely developed, of paraphyses like hyphae. Algae often micareoid. **GS Micarea**


99 Sp. very long, thread-like, 140-180 x 6-8 μm, with 30-40 cross septa.Nearly extinct lichens with dry “urn-form” sunken, black, whitish pruinose disks, at first pore-like, then opening wide, -1 mm. Receptacle carbonaceous. **Conotrema urceolatum**

99* Sp. shorter **100**

100 Fresh thallus gelatinous, membrane-like when dry, with Gloeocystis algae in colonies and thick colorless gelatinous envelope, on mosses and algae. Ap. at first sunken and enclosed (Hym. overlaying the exc.), then pore-like, later opening wide, with a deeply concave, yellowish to rose disk. Sp. 20-30 x 1.5-2 μm, 4-5 celled. **GS Gyalecta: Bryophagus**

100* Thallus not gelatinous, not with Gloeocystis algae with thick gelatin envelopes. Ap. not closed at first, dics not deeply concave **101**

101 Hym. I+ yellow, orange to wine-red. Very rare species **102**

101* Hym. commonly I+ blue, rarely I- **103**

102 Ap. without margin, blue-gray pruinose, exc. reduced **. Arthonia caesia**
102* Ap. with margin, nonpruinose, concave to flat. Exc. developed  
GS Gyalecta: Gyalidea


Vezdaea


104 Sp. ellipsoidal to elongate ellipsoidal, the young ones with perispore. Ap. black (brown-black). Hyp. dark. Exc. clearly developed early. Hym. I+ blue. On rock (when on old trees, sp. very large, 50-120 x 20-35 µm, with thin septa, 8-10(12) celled, hym. I- (excepting the asci), ap. brown, -2.5 mm, thallus mealy, ± greenish ↑ Megalospora pachyacarpa)  
Rhizocarpon

104* Sp. elongate bacillar, (ellipsoidal-) fusiform, needle-like, straight or curved, generally without perispore.

105 Exc. (at least when young) strongly developed. Ap. bordered at least when young. Paraph. simple to isolated branched or only branched above

105* Exc. reduced to (weakly) developed, or paraph.-like hyphae. Ap. without margin or indefinitely margined when young. Paraph. richly branched and bound.


Icamadophila ericetorum

106* Thallus K-; ap. not K+ orange. If ap. rose to orange, then lichen on base-rich bark or on twigs-stems (huckleberry, or Scotch heather). Exc. strongly developed, of actinomorphic hyphae or structural cells (paraplectenchymatous). Ap. almost white, beige, yellowish, rose, brown, red-brown, or dark brown to black, commonly marginated at first.  
GS Baccia

107 Sp. S-form to spirally curved, if ± straight, then thallus green, granular and ap. dark red-brown to black, ± shiny. Exc. definite at least at first. Algae not micareoid  
Scolicosporum

107* Sp. straight to slightly curved. Exc. lacking to ± developed. Algae micareoid (4-7 µm thick).

Micarea

108 Sp. to very many (usually over 50) per ascus, small.

108* Sp. 1-16 (rarely -32) per ascus, usually 8

109 Ap. or thallus warts with ap. with punctiform openings, spherical to egg-shaped, perithecia-like, small, light yellow, or greenish yellow. Thallus very indefinite.  
Thelocarpon

109* Ap. with wide open disks, rarely punctiform openings, then the thallus however definite and not yellow

110 On rock.

110* On bark, wood, soil, plant remains, or resin

111 Ap. disk usually brown, dark brown, or red-brown, ± sunken to hollowed out, with (often indefinite bordered) thallloid margin or sunken in the thallus. Thallus definite, squamulose to areolate, usually ± brown. Paraph. predominately simple. Exc. often weakly developed  
Acarospora

111* Ap. black to dark red-brown, sometimes whitish pruinose, channeled or smooth, with black proper margin, without thallloid margin. Thallus indefinite to definite, not squamulose (if squamulose, then treat it as a parasitic foreign thallus). Paraph. simple or richly branched. Exc. thin to thick, outside dark  
GS Sarcogynae

112 Ap. with definite thallloid margin, blackish, ± flat, -1.2 mm. Thallus light gray to gray-brown, ± granular-warty. Hyp. light, epihym. Dark brown. Sp. 5-6.5 x 2.5-3.5 µm. On bark.

Maronea constans

112* Ap. without thallloid margin, with or without proper margin, whitish, rose-yellow, ochre, brown, or red-brown to blackish, usually soon convex. Hyp. light to brownish.  
GS Biatorella

113 Ap. yellow to orange-red, orange-brown, rust colored, or red, K+ immediately deep red, from the first convex marginless and biatorine. Hyp. light to brown  
Protoblastenia

113* With other characteristics. If thallus or apothecia yellow to red, then not K+ deep red.

114 Sp. very large, usually over 30 µm long, broadly ellipsoidal to spherical. Ap. usually large (over 0.5 mm).

114* Sp. up to 30 µm long, if longer, then narrow.

Mycoblastus

115* Ap. otherwise, with thallloid margin or sunken in thallus warts. Hyp. not blue-green to blue-black above, usually very high, paraph. richly branching and bound


Ochrolechia

116* Ap. otherwise

117 Sp. ± thick walled, usually oval is aspect, 1-8 per ascus. Ap. usually with perithecia-like punctiform opening disk, (often several) sunken in a thallus wart, rarely with wide opening disk and not in thallus warts (then usually blackish).
often with contents and corresponding reactions

Pertusaria

117* Sp. ± thick walled (wall 1-2.5 µm), (4-)8, 30-60 x 20-40 µm, almost spherical to broadly ellipsoid. Ap. sunken deep in -1.5 mm wide thallus warts, disk blackish, at first punctiform, then wider (0.5 mm) opening, thallus margin often also somewhat blackish on the inner side. Thallus on mosses, plant remains, rarely on bark, uneven, whitish, or gray-white. Ch-.

Megaspora verrucosa

118 Ap. spherical to almost shield shaped, on light stout stalks, brown or rose, reminiscent of small fungus fruiting bodies. Thallus crustose to squamulose

GS Baemycetes

118* Ap. not stalked . 119

119 Ap. yellow, citron-yellow, rarely olive-yellow, usually the thallus also yellow. Hy. colorless, hym with a yellow granular covering layer. 120

119* Ap. not pure yellow, citron- or olive-yellow 122

120 Sp. 4-7 x 1-2 µm, up to 8. Thallus finely mealy-dusty, citron- to green-yellow. Ap. convex, marginless, biatorine. Paraph. ± simple, thin. Commonly on vertical and overhanging surfaces of silicate rock

Psilolechia lucida

120* Sp. larger . 121

121 Sp. 8 or 12-32, usually cylindrical with rounded ends or one straight wall, the other convex, often with 2 oil droplets. Ap. flat to convex, usually bordered, lecanorine, rarely biatorine, yellow, olive-yellow, or orange-yellow. Thallus finely granular to areolate, rarely finely sorediate, then on bark. Tholus amyloid only in the lower half, with thick axial mass. With pulvinic acid derivatives

Candelariella

121* Sp. 8, ellipsoid. Ap. lecanorine, pale yellow, pale greenish-yellow, or brown-yellow. Thallus fissured-areolate sorediate. Entire tholus (with the exception of the thick axial mass) amyloid. Without Pulvinic acid derivatives, e.g. with Zeorine, Usnic-, Rhizocarpic-, Rangiformic-acids, or Epinorine, compare with a few species of the genus Lecanora

122 Thallus with Trentepohlia-algae, in the case of abrasions or cracks often ± yellow-orange to golden brown (in case of doubt, check both alternatives!). Paraph. simple to above all branched above and reticulate bound, hyp. (almost) colorless. Ap. biatorine to aspicilioid, disks concave, light to blackish. Calcareaous/silicate rock

Ionapis

122* Thallus not with Trentepohlia, commonly with true green algae . 123

123 Ap. with thalloid margin 124

123* Ap. without thalloid margin, biatorine or lecideine 127

124 Ap. with conspicuous granular-squamulose thalloid margin, brown-red, 1-6 mm. Thallus ochre, green-gray, gold- to olive-brown, green when fresh, large granular to small squamulose,
Key VIIIa: Sterile crustose lichens with conspicuous pycnidia and similar conidia producing organs

1 Pycnidia or pycnidia bearers black
2 Pycnidia(bearers) not black
2* With cylindric, at least in part branching, 50-400 \( \mu \text{m} \) thick pycnidia bearing structures. Pycn. Wall (squash preparation) K-. Pycnosp. 3.5-5 x 1-1.5 \( \mu \text{m} \), often with 2 oil droplets. Thallus scruffy to cracked whitish, pale greenish to dark green. On mosses, bark, or silicate rock .

- **Micarea botryoides**

4 Pycnidia otherwise, not conic, 70-320 \( \mu \text{m} \) high. Squash preparation K+ violet. With true green, 4-7 \( \mu \text{m} \) thick algae. On wood. (See also M. denigrata).

5 Pycnidia 0.2-0.6 mm wide, squash preparation K+ purple. Pycnosp. 3.5-4 \( x \) 1.5-2 \( \mu \text{m} \). Thallus warty areolate yellowish to gray (in the herbarium often ochre), with coccoid green algae (if pycn. 0.1-0.2 mm wide: see C. griffithii). .

- **Clostomum corrugatum**

6 Pycnidia not white, often brown, or rose-brown.

- **Opegrapha**

7 Pycnidia delicate white bordered, flat to convex, -0.3 mm. Pycnosp. 4-6 x 1.2 \( \mu \text{m} \). Thallus P-

- **Arthonia byssacea**

8 Pycnidia not white bordered

9 Thallus KC+ red, P-. Pycnosp. 10-16 \( x \) 0.5-0.7 \( \mu \text{m} \). Arthoniaic acid

8* Thallus KC-, P+ orange. Pycnosp. 4.5-6 \( x \) 0.7-1. Arthoniaic acid

9 Pycnidia brown, rose-brown, or gray-brown, very fine dense hairs (strong lens), 0.1-1.0 mm high, cylindric. Squash preparation K+ violet to violet-brown.

- **Micarea hedlundii**

Key VIIIb: Sterile Crustose Lichens on Rock

10 Thallus with Trentepohlia algae (if scraped often ± orange to golden yellow), gray-white to gray. Pycnidia hemispheric to short peg-form

10* Thallus with true green algae, when scraped not ± orange to golden yellow

11 Heads of the pycnidia C+ red. Pycnosp. 12-17(20) \( x \) 2-3.5 \( \mu \text{m} \). Above all on fir, spruce as well as (above all in the north central Europe) on oak, rare on silicate rock

- **Lecanactis abietina**

11* Heads of the pycnidia C-. Pycnosp. 4-7 \( x \) 1-1.5 \( \mu \text{m} \). Above all on ash, oak or hornbeam in mild sites.

- **Opegrapha vermecillifera**

12 On thin conifer branches and needles and on thin stems of Scotch heather bushes. Thallus greenish to gray, with ± protruding whitish, 0.08-0.20 \( \mu \text{m} \) wide pycnidia. Pycnosp. (3.2)3.7-4.6 \( x \) 1.4-1.7 \( \mu \text{m} \).

- **Fellhanera subtilis**

12* On other habitats

13 On calcareous rock. See **Bacidia arnoldiana**

13* On bark, wood or silicate rock.

14 On silicate rock, thallus gray, white-gray, or gray rose.

- **Key VIIIb/15**

14* On bark or wood

15 Pycnosp. 6.5-9.5 \( x \) 2.3-3 \( \mu \text{m} \). Thallus smooth to scruffy granular, with up to 0.3 \( \mu \text{m} \) wide whitish, cream- to ochre-colored pycnidia, R-. 

- **Micarea adnata**

15* Pycnosp. Over 20 \( \mu \text{m} \) long.

16 Thallus with clearly projecting, 0.1-0.2 \( \mu \text{m} \) wide, -0.2(0.3) mm high brownish, with age often wide open pycnidia, R-. Pycnosp. 1- up to 4 celled, 20-43 \( x \) (0.5)0.8-1(1.2) \( \mu \text{m} \), more narrow at one end (when pycnosp. 6-8 \( x \) 1.8-2.6 \( \mu \text{m} \), elongate, constricted in the middle, with 2 droplets, thallus flowing-smooth, see Dimereilla pinetis).

- **Fellhanera vezdae**

16* With ± sunken, whitish to greenish (rarely red tinted whitish) pycnidia.

17 Thallus gray-green to gray, scuffy to cracked areolate, in case of good development, C+ red. Pycn. with wide open, sunken mouth (almost bowl-shaped), whitish to pale greenish. Pycnosp. Multicellular (septation often indefinite), wavy or strongly curved to S-form

- **Micarea/II**

17* Thallus green, green-gray, even brownish (above all in the herbarium), finely granular (granules usually about 20-50 \( \mu \text{m} \)), R-. Pycn. hemispherical, however with age even bowl-shaped, 0.1-0.2 \( \mu \text{m} \) wide, white, rose-white, rarely even brownish. Pycnosp. Filamentous, curved, 20-50 \( x \) 1-1.5 \( \mu \text{m} \).

- **Bacidina arnoldiana** (-Group)

Key VIIIc: Sterile Crustose Lichens on Bark or Wood Dwellings

18 Thallus with true green algae, when scraped not ± orange to golden yellow

18* Heads of the pycnidia C-. Pycnosp. 4-7 \( x \) 1-1.5 \( \mu \text{m} \). Above all on ash, oak or hornbeam in mild sites.

- **Opegrapha vermecillifera**

19 On thin conifer branches and needles and on thin stems of Scotch heather bushes. Thallus greenish to gray, ± protruding whitish, 0.08-0.20 \( \mu \text{m} \) wide pycnidia. Pycnosp. (3.2)3.7-4.6 \( x \) 1.4-1.7 \( \mu \text{m} \).

- **Fellhanera subtilis**

19* On other habitats

20 On silicate rock.

- **Micarea adnata**

20* Pycnosp. Over 20 \( \mu \text{m} \) long.

21 Thallus with clearly projecting, 0.1-0.2 \( \mu \text{m} \) wide, -0.2(0.3) mm high brownish, with age often wide open pycnidia, R-. Pycnosp. 1- up to 4 celled, 20-43 \( x \) (0.5)0.8-1(1.2) \( \mu \text{m} \), more narrow at one end (when pycnosp. 6-8 \( x \) 1.8-2.6 \( \mu \text{m} \), elongate, constricted in the middle, with 2 droplets, thallus flowing-smooth, see Dimereilla pinetis).

- **Fellhanera vezdae**

21* With ± sunken, whitish to greenish (rarely red tinted whitish) pycnidia.

22 Thallus gray-green to gray, scuffy to cracked areolate, in case of good development, C+ red. Pycn. with wide open, sunken mouth (almost bowl-shaped), whitish to pale greenish. Pycnosp. Multicellular (septation often indefinite), wavy or strongly curved to S-form

- **Micarea/II**

22* Thallus green, green-gray, even brownish (above all in the herbarium), finely granular (granules usually about 20-50 \( \mu \text{m} \)), R-. Pycn. hemispherical, however with age even bowl-shaped, 0.1-0.2 \( \mu \text{m} \) wide, white, rose-white, rarely even brownish. Pycnosp. Filamentous, curved, 20-50 \( x \) 1-1.5 \( \mu \text{m} \).

- **Bacidina arnoldiana** (-Group)
1 Thallus citron yellow, yellow, or orange .  
1* Thallus not definitely yellow or orange .  
2 Thallus K+ promptly deep red .  
2* Thallus K- or very weakly reddish)  
3 Thallus completely mealy disintegrating (“leprose”).  
 (When over mosses and lichens see also Arthrorhaphis)  
3* Thallus only partially sorediate or entirely without soralia .  
4 Thallus C+ yellow to orange, KC+ orange, UV+ orange, with soralia .  
4* Thallus C-, with or without soralia .  
5 Thallus usually thin, fissured to granular, gray, greenish-gray to light yellowish, with small, usually somewhat lighter, often coalescing soralia. P+ yellow, K+ yellow. Soredia 20-40  
 µm.  Atranorin, Arthothelin, and Thuringion .  
5* Thallus strongly developed, fissured to warty, thick, consisting of closely compressed cylindric to coraloid structures, therefore with a very thick, consisting of unbranched isidia or similar coryneform structures.  
P+ yellow, K+ (yellow, then) blue-red .  
6 Without soralia. Thallus yellow, deeply fissured, thick, consisting of closely compressed cylindric to isidiate structures, therefore with a very uneven upper surface.  
On bird rocks  
Candelariella coralliza  
6* With soralia .  
7 Medulla I+ blue. Thallus yellow, of highly convex areoles, which are erupting sorediate.  
Rhizocarpon ridescens  
7* Medulla I- GS Lecanora  
8 thallus with isidia or entirely consisting of very fine isidia-like elongate granules  
9 Thallus with soralia or entirely sorediate disintegrating .  
10 Thallus on calcareous rock, with blue-green algae, gray-brown to black-brown, areolate to appearing squamulose, thickly covered with isidia-like, ± cylindric to coraloid structures, often with a blue-green prothallus at the margin  
Placynthium nigrum  
9* Not on calcareous rock, with true green algae .  
10* Thallus K+ yellow (yellow, then) blue-red  
10 Thallus K- or K+ yellow  
11 Thallus gray to dark green-gray. Isidia in irregular thick groups, partially erupting sorediate  
Aspicilia simoensis  
11* Thallus gray-white. Isidia mostly single, ±0.2  
 mm thick, usually somewhat thickened or browned above, not sorediate .  
Pertusaria pseudocorallina  
12 Thallus gray-brown to brown or dark brown, medulla C+ red (at least in squash preparations) .  
13* Thallus whitish to gray or gray-rose, possibly isidiate with brown points, C-.  
14* Thallus whitish, K+ yellow, thickly covered with cylindric, simple to branching isidia .  
Pertusaria corallina  
14 Thallus K-.  
15 Thallus gray, or gray-rose, with scattered, 0.3-0.5  
 mm thick light gray to light rose colored, unbranched papillae, which bear pycnidia at the tips.  
Pycnop. 4.5-5 x 1-1.5  
 µm. Medulla I- (Gyrophoric acid)  
Koerberiella wimmeriana  
15* Thallus with white-gray to gray, with moderately to very thick standing, -0.5 mm thick unbranched, rarely branched isidia or similar color, with or without pycn.  
Pycnop. 7-10(12) x 0.7-1.2  
 µm. Medulla I+ rose(brown). Fatty acids  
Pertusaria isidioides  
16 With Trentepohlia algae. In the case of cracks or abrasions the thallus often leaves gold-yellow to orange colored traces .  
16* Not with Trentepohlia, with true green algae. .  
17 On limestone or calcareous rocks .  
18* On silicate rock. Thallus gray-brown, brown, brown-red, brick-red or gray, violet-gray .  
18 Thallus whitish to weakly brown tinted, coherent to fissured, irregularly erupting sorediate, C+ red, K-, P-.  
With Erythrin, ± Lecanoric acid.  
Dirina stenhammari  
18 Thallus rose, in the herbarium gray to yellowish, thin, C-: scarcely definable as crustose lichens  
19 Thallus usually thick cushion-like (up to 5 mm thick), mushroom-smooth, gray, violet-gray, often slightly rose tinted, often with wrinkled upper surface.  
Lepraric acid, Roccellic acid .  
Lecanactis latebrarum  
19* Not thick cushion-like and mushroom-like. With other lichen substances  
20 Thallus brown, or dark brown, with bordered rounded, ±0.5 mm gray-whitish fleck soralia, commonly with a black prothallus line.  
R-, UV-.  
With Confluentic acid  
Enterographa zonata  
20 Thallus without small rounded soralia.  
Medulla/soralia UV+ blue-white to light yellow.  
Without Confluentic acid .  
21* Thallus whitish-brown to almost brick-red, in the herbarium usually yellow-brown to brown, upper surface scrawny to mealy, sorediate in
places, very thin, KC+/C+ (transient) red-orange or rarely KC-/C-; sorediate places orange to reddish, in the herbarium gray-white to yellowish. UV+ light yellow to white. Gyrophoric acid or Schizophletic acid or both

Opegrapha gyrocarpa

21* Thallus cocoa-brown, brown, dark brown, with smooth, almost velvety upper surface, in the interior sorediate, ochre-yellowish, rarely brownish, in the herbarium usually yellow-brown, or yellowish, usually thick, KC-/C-, sorediate places/medulla UV+ blue-white. Schizophletic acid

Lecanactis umbrina

22 Thallus upper surface entirely leprous, i.e. mealy or covered with fine granules, whitish, light gray, pale greenish, slightly yellow tinted, or bluish-white.

GS Lepraria

22* Thallus upper surface not entirely leprous. . . 23

23 Thallus K+ red 24

23* Thallus K+ yellow to K- 25

24 Thallus whitish to light gray, with irregular whitish soralia, thin

Phlyctis argena

24* Thallus gray, olive-gray, or olive, fissured to areolate, with bordered soralia.

↑ Aspicilia and Pertusaria excludens

25 Soralia convex, very large, white, KC+ violet.

Thallus gray

Pertusaria amara

25* Soralia KC- or KC+ yellow, orange to red . 26

26 Thallus or soralia C+ red or C+ (at least KC+) (yellow/orange) . . 27

26* Thallus or soralia C- to C+ yellowish 36

27 Thallus C+ yellow-orange to orange 28

27* Thallus or soralia C+ red . . 30

28 Thallus P+ orange-red, K+ (weak) yellowish, strongly developed, usually extensive, fissured to warty, gray- or greenish-yellow, or greenish gray, with irregular, partially coalescing, lighter soralia. Soredia over 35-90 µm. Thiophanic acid, Stictic acid

Pertusaria flavicans

28* Thallus P+ yellow(ish), K+ yellow 29

29 Thallus whitish to gray-white, usually rosetted to rounded, areolate, C+ yellow-orange, UV+ yellow. Areoles convex, sometimes with enlarged marginal areoles, often on a whith prothallus. Soralia rounded, whitish-gray. Sordidon, Roccellic acid, Atranorin

Lecanora lojkaeana

29* Thallus gray, greenish-gray, thin, without enlarged marginal areoles, C+ orange, UV+ orange. Soralia pale yellowish to almost whitish. Atranorin, Arthrothelin, Thuriongin

Lecidella scabra

30 Thallus gray-rose to light (gray) brown, of convex areoles, with dark red-brown, warty cephalodia between them. Soralia whitish to brownish. In montaine to alpine places.

Amrygdalaria panaeola

30* Thallus without cephalodia .

31 Soralia P+ yellow, C+ (fleeting) red, K+ yellow. Thallus gray-brownish to brown, of rounded,

scattered to coalescing areoles, on a black prothallus. Alectorialic acid .

Fuscidea praeruptorum

31* Soralia P- to P+ indefinite yellowish. Gyrophoric or lecanoric acid

32 Thallus with whitish, defined soralia on isidia-like, peg-form to hemispherical outgrowths, soralia likewise standing on outgrowths, -0.5 mm. Thallus areolate, areoles convex, rarely flat, coalescing or ± separated, upon a black prothallus, (cocoa)brown, rose-brown, gray-brown, or yellow-brown, C+ red (Gyrophoric-acid). Isidia-like outgrowths 0.15-0.25 mm wide, -0.5 mm high

Rimularia gibbosa

32* Thallus without isidia-like outgrowths .

33 Thallus warty-areolate, areoles on a black prothallus, with green-whitish (to yellow-whitish), -0.5 mm wide fleck soralia, gray to greenish-gray, K+ yellow, soralia C+ red. Atranorin, Gyrophoric acid

33* Thallus without black prothallus

34 Thallus greenish-gray to gray, warty to coarse granular, with at first delimited, later coalescing, dirty gray-green to dusty blue-green soralia. Gyrophoric acid

GS Trapelia

34* Soralia whitish to pale green-whitish or beige.

35 Thallus thin to moderately thick, whitish to beige, even sometimes with slightly rose tinted, usually relatively small, fissured to fissured areolate, is places erupting sorediate, K-, P-. Above all on rock, or shaded rocks. Gyrophoric acid

GS Trapelia

35* Thallus usually moderately to very thick, whitish to light gray, unevenly fissured to fissured (fissured areolate), extensive. Prothallus sometimes occurring, whitish. Soralia flat or convex. Lecanoric or Gyrophoric acid .

GS Pertusaria

36 Thallus at least in places rust colored ochre to red-brown or almost red.

GS Lecidea

36* Thallus not rust colored 37

37 Soralia blackish to dark gray 38

37* Soralia lighter .

38 In the mountains on light and wind exposed places. Thallus fissured areolate to (warty) areolate, soralia blackish. Medulla I-, P-/P+ yellow. Miriquidic acid, ± Psoromic acid .

Miriiquidica nigroleprosa

38* On more sheltered, often shaded places also on lower sites. Thallus fissured, soralia gray. Medulla K+ blue. Medulla/soralia P-Confluent acid. (If Stictic acid, P+ yellow, medulla I-: P. soredizodes) .

Porpidia tuberculosa

39 Thallus or soralia P+ red to orange. Thallus coherent, white to light gray. . . 40

39* Thallus and soralia P- to P+ yellowish 41

40 Soralia small, -0.5 mm rounded. Thallus often very small, very thin. Stictic acid
Key VIII: Sterile Crustose Lichens on Bark

1. Thallus sorediate.  
2. Thallus not sorediate.  
3. Thallus C+KC+ (yellow)orange or red.  
4. Thallus C- to C+ yellow, not KC+, orange or red (but in the case of Pertusaria amara KC+ violet, in Lepraria eburnea very fleeting reddish).  
5. Thallus usually yellowish, green-yellowish, gray-yellowish, yellowish-green, or ochre, C+ yellow-orange to orange.  
6. Thallus C+ rose to red (orange-red).  
7. Thallus finely isidiate, the isidia sometimes becoming partially sorediate.  
8. Thallus not isidiate.  
10. Upper surface of the thallus generally soon entirely sorediate.  
11. Thallus sorediate ochre, pale yellow to pale yellow-greenish, even pale brownish-green, sometimes with blackish prothallus, K-, C+ orange, UV+ (brown)orange, without crystallizing needles. Soredia -50 µm. Isoarthonellin, Thiophanic acid.  
12. Thallus/soredia ochre, pale yellow to pale yellow-greenish, pale greenish, rarely partially also pale ochre-yellow, sometimes with whitish, rarely bluish prothallus, K+ yellowish, C+ yellow-orange, UV-/UV± violet, in the herbarium often covered with the finest crystallizing needles. Soredia -50 µm.  
13. With Lecanoric acid, C+ (carmine)red reaction above all in the medulla/in the soralia. Thallus with whitish, shiny, often zoned prothallus, smooth to unevenly warty, toward the margin mostly with fissures, fissured to the thallus center, silver-gray, gray-white, or gray. Soralia whitish, convex (to hemispherical), -1.3(1.8) mm wide, also coalescing. Very often in association with Pertusaria coccoides or flavida. Pertusaria hemisphaerica

40* Soralia mostly larger, rounded to irregular, even coalescing. Thallus commonly extensive

41 Thallus K+ yellow with Atraphalin  
41* Thallus K- (possibly soralia K+ yellow).  
42 Medulla I+ blue  
42* Medulla I-  
43 Thallus pale greenish, gray-greenish, slightly yellowish-green even almost gray, KC+ yellow/KC-, of flat to convex areoles or fissured areolate, with defined soralia or in the center soon disintegrating into flat soredia. Usnic acid, Zeorine.  
43* Thallus white to gray, KC-.  
44 Thallus extensive, coherent, ± fissured, with large round soralia, often with clearly defined zones, gray to greenish prothallus.  

44* Thallus without definite prothallus or with black prothallus  

Pertusaria flavida

4* Thallus not isidiate.  
5 Thallus with defined soralia, gray-white to pale yellowish, gray-yellowish to slightly greenish. Soralia pale yellowish. Arthothelin, Hypocenomyce leucococca, Buellia pulverea.  
6 Thallus/soredia ochre, pale yellow to pale yellow-greenish, even pale brownish-green, sometimes with blackish prothallus, K-, C+ orange, UV+ (brown)orange, without crystallizing needles. Soredia -50 µm. Isoarthonellin, Thiophanic acid.  

Pyrrospora quennea

6* Thallus/soredia pale yellow-greenish, pale greenish, rarely partially also pale ochre-yellow, sometimes with whitish, rarely bluish prothallus, K+ yellowish, C+ yellow-orange, UV-/UV± violet, in the herbarium often covered with the finest crystallizing needles. Soredia -50 µm.  

Usnic acid, Thiophanic acid, Zeorine, ± Arthothelin. Lecanora expallens

7 Thallus partially orange, there K+ red, otherwise pale greenish, light gray, greenish-gray, K-, extensive, coarsely granular, with greenish-white, even partially orange colored, at first convex, then fleck like to coalescing soralia, P- Soredia fine, -25 µm. Gyrophoric acid, anthra-quinone

Tranelopsis pseudogranulosa

7* Thallus not flecked orange. K-/K+ slightly yellowish  
8 Thallus permanently finely isidiate in the center, light gray, light greenish-gray to whitish. Isidia delicate, soon disintegrating into whitish to greenish-gray soredia, spherical to mostly cylindrical (to coralloid), -1(0.2) mm thick. Without well defined soralia, often with whitish prothallus. UV+ blue-white. Gyrophoric acid.  

Ochrolechia subviridis

8* Thallus without isidia, clearly sorediate  
9 Thallus P+ yellow/orange, C+ (often fleeting) red, with alectorialic acid  
10 Thallus P-, without Alectorialic acid, with Gyrophoric or Lecanoric acid.  
10 Thallus of mostly scattered, ascending, convex, often indefinite squamules with lip soralia, whitish. Hypocenomyce leucococca

10* Thallus not of ascending squamules

11 Thallus areolate to indefinite (in the substrate), yellowish-gray to slightly ochre or light gray, with diffuse yellowish, pale yellowish-green, yellowish-brown (in the herbarium often rose colored) soralia, K+ yellow. Soredia 20-50 µm. Hypocenomyce sorophora

12 Thallus granular, thin to thick, irregularly finely mealy sorediate disintegrating, dark gray-greenish to dark brown-gray, thin to thick. Soredia 12-22 µm thick. Buellia pulverea

12* Thallus without Lichexanthon, UV±/± white. Soralia ± flat to convex

13 With Lecanoric acid., C+ (carmine)red reaction above all in the medulla/in the soralia. Thallus with whitish, shiny, often zoned prothallus, smooth to unevenly warty, toward the margin mostly with fissures, fissured to the thallus center, silver-gray, gray-white, or gray. Soralia whitish, convex (to hemispherical), 1.3(1.8) mm wide, also coalescing. Very often in association with Pertusaria coecoides or flavida. Pertusaria hemisphaerica

13* With Gyrophoric acid, C+ (rose- to orange)red reaction in the soralia/ in or upon the bark. Thallus without, rarely with whitish prothallus. Soralia flat to convex.
14 Soralia dusty gray-green to dark green or bluish-green, at first separate, -0.4 mm, later sometimes coalescing, mealy to finely granular. Thallus greenish-gray to gray-green, rarely whitish to light gray, coherent granular (0.08-0.25 mm), at the margin the granules often enlarged and flattened, -0.4 mm. Usually on wood, rarely on bark.  *Tragopogon flexuosus*

14* Soralia lighter, whitish, greenish-white, or light green .

15 Thallus uneven-warty to knobby, very thick, also ± wrinkled and thin, with or without a whitish prothallus, with flat to convex soralia. Soralia slightly yellowish, beige, greenish-white, or gray-green, -2 mm, sometimes coalescing. Soredia often very large, reaching over 80 \(\mu\)m. *\(\pm\*\) fatty acids .

15* Thallus granular to areolate, rarely undifferentiated thin crust, without prothallus. Areoles up to about 0.4(0.5) mm, almost spherical to almost flat. Soralia smaller, but also coalescing, soredia up to 80 \(\mu\)m .

16 Thallus not commonly on mosses, but on bark and wood, whitish, beige, slightly rust tinted, gray, greenish-gray, or greenish. Soralia whitish, beige, cream color, greenish, or pale brownish.  *Ochrolechia androdynya*

16* Thallus commonly on mossy bark, not on wood, pale greenish-gray, thin, soon coherent thickly sorediate in the center. Soralia yellowish, yellowish-green, or yellowish-gray. Soredia up to 40 \(\mu\)m. *Biotata chrysantha*

17 Thallus or soralia intensive citron-yellow, yellow, or orange-yellow .

17* Thallus/soralia not intensive citron-yellow to orange-yellow .

18 Thallus and/or soralia K+ deep red Caloplaca

18* Thallus and/or soralia not K+ deep red

19 Thallus of -1 mm large, crenate, yellow-green, greenish-gray, or yellow-gray to yellowish squamules, which erupt sorediate, or of separate, ± convex “soredia heaps.” Soredia citron-yellow to yellow. With pulvinic acid, calycin. As a rule on free standing trees with nitrate-rich bark .

Candelariella

19* Thallus not of sorediate erupting squamules or separated soredia heaps .

20 Thallus of often very equally branching, separated to clasping one another, 0.7-0.15 mm thick, light yellow to slightly orange-yellow granules with a cortex, not sorediate. As a rule on free-standing trees with ± nitrogen-rich bark. Pulvinic acid, calycin, ± pulvinic acid-dilactone. *Candelariella xanthostigma*

20* Thallus coherent, ± regularly mealy-leprose. Rhizocarpic acid or calycin (Chrysothrix cand., Psileochia lucida, Chaenotheca jurf.). Often in bark crevasses or rain-sheltered surfaces  *GS Lepraria*

21 Thallus with completely sorediate upper surface .

21* Thallus upper surface with delimited, regular or irregular sorediate regions, not entirely sorediate

22 Thallus with whitish, fibrous prothallus, pale greenish, yellowish-green or cream colored to (gray)whitish. At times with red pycn. K+ (weak) yellow, P- to P+ yellowish, C-, Atranorin, Zeorin, Porphyric acid, ± Usnic acid.  *Haematomma ochroleucum*

22* Thallus without fibrous prothallus .

23 Very rare lichens of very oceanic regions on old trees in natural forests. Thallus yellow-greenish to pale greenish, thickly powdery, C-, KC+ yellow, K+ yellow, P- to P+ weakly yellow, soredia in places erupting from still visible blue-gray to yellow-gray granules. Usnic acid, Zeorine  *Megalospora pachycarpa*

23* Widespread lichens with permanently uniformly sorediate (powdery to mealy) thallus; if yellow-greenish to pale greenish, then not with these reactions. Usnic acid lacking  *GS Lepraria*

24 Thallus with Trentepohlia algae, in the case of abrasion the thallus often with orange-yellow to golden-yellow/gold/brown trace, R- .

24* Thallus with true green algae, scratch marks ± (often indefinitely) greenish

25 Thallus dirty lilac- to rose-gray, light brownish-gray, ± fissured, with irregularly delimited soralia. UV-. Fatty acids. On fissured bark of old trees on scarcely rain exposed flanks .

Schismatoma decorans

25* Thallus dark brown, or brown, with small rounded soralia and black prothallus. Confluentic acid. On smooth bark trees on very shady sites.  *Enterographa zonata*

26 Thallus K+ red-violet or K+ yellow, then red (in very shady growing conditions reactions delayed) .

26* Thallus K- or K+ yellow to orange or brownish

27 Thallus gray, in places ochre to rust-colored and only here reacting K+ red-violet, coarse granular to warty, partially sorediate, above all on conifers, word, or oaks  *Chaenotheca ferruginea*

27* Thallus not partially ochre to rust-colored. K+ red or violet reactions occurring overall .

28 Thallus whitish, (light)gray, light gray-greenish, K+ yellow, then red (delayed reaction if grown in very shady sites), P+ yellow, then yellow-orange or red (norstictic acid

28* Thallus gray, lead-gray, blue-gray, blue-black, above all marginally with K+ (brown-)violet pigment, P-. On nitrogen-rich or base-rich bark

29 Thallus finely isidiate, in observing of the upper surface and the apparent stunted development of the granular-sorediate isidia, but even (after the
falling off of the isidia) some parts are eroded “sorediate”.

**Pertusaria cocodes**

29* Thallus without isidia, whit-gray to gray, coherent, unorganized to fissured, in places irregularly whitish erupting sorediate and often large areas sorediate, at the margin often whitish.

**Phyllyctis argenta**

30 Thallus areolate to fissured areolate, areoles at the thallus margin often yet separated and rounded to irregular, ± crenate, often somewhat lighter and here having warty to granular-issidiate or sorediate or blasticidiate, even with an entirely granular-sorediate upper surface, sometimes up to 1.2 mm. Soredia/granules/blasticidia often large and up to over 100 µm

**Calopla chlorina**

30* Thallus fissured-areolate to fissured-clumped, with granular-warty to scurfy upper surface, blasticidiate, not of marginal sorediate to isidiate areoles. Areoles even at the thallus margin not individualized, not crenate, not rounded, -0.3 mm. Soredia -60 µm

**Rinodina colobina**

31 Thallus gray, with ochre-yellow to almost rust colored regions, these K+ violet.

**Chaenotheca ferruginea**

31* Thallus not with ochre to rust colored, K+ violet regions.

32 Thallus KC- violet, gray, with usually convex to hemispherical, rarely almost flat white, 1-2(4) mm wide soralia. Prothallus very rarely zoned. Picrolicheninic acid, ± Protocetraric acid, ± Atranorin

**Pertusaria amara**

32* Thallus not KC+ violet

33 Thallus and/or soralia K+ yellow to orange (red-brown) or P+ definite yellow to red.

33* Thallus/soralia K-, P- (or P+ slightly yellowish)

34 Commonly living on wood. Thallus indefinite (usually in the substrate), only soralia conspicuous, C-

34* Commonly living on bark.

35 Soralia whitish, yellow-whitish, gray-whitish, K± dirty brownish-red to K-, P+ (yellow to) red, usually flat, -1 mm. Fumarprotocetraric acid, (Protocetraric acid), rarely traces of Gyrophoric acid

**Pertusaria pupillaris**

35* Soralia often darker. Without Fumarprotocetraric acid

36 Soralia brown, dark gray, gray-bluish, whitish when shaded, K+ yellow, P+ orange, rounded to elliptical -1 mm. Thallus in the stratum. Stictic acid, ± Norstictic acid.

**Xylographa vitiligo**

36* Soralia green-gray, gray, blue-gray, gray-white, green-yellowish, or greenish-white, K+ orange to red-brown, P+ yellow to yellow-orange, -0.4(0.8) mm, occasionally coalescing. Thallus often also developed on the substrate. Atranorin, norstictic acid

**Buellia griseovirens**

37 Thallus and/or soralia P- to P+ yellow.

37* Thallus and/or soralia P+ yellow-orange, orange-red to rust-red.

38 Soralia P+ yellow, K+ orange to red-brown (but at times rather indefinite), -0.4(0.8) mm, usually flat or somewhat concave, often somewhat projecting, not infrequently bordered by one ± frayed “thallus collar”, greenish-white, green-yellowish, gray, green-gray, or gray-blue. Thallus thin, light gray. Atranorin, Norstictic acid.

**Buellia griseovirens**

38* Soralia P- (to yellowish), K- to K+ yellow or brown, without ± frayed “thallus collar”. Thallus P-, K+ yellow.

39 Soralia yellow to yellow-green, with usnic acid, -2.5 mm (also enlarged by soralia coalescing), concave to commonly clearly convex. Thallus of separate to coherent low warts, gray, greenish-gray, color clearly taken from the soralia.

Atranorin, Planica acid. Very rare on acid bark in the mountain regions

**Mycoblastus alpinus**

39* soralia without definite yellow tint, without Usnic acid, smaller

40 Soralia dusty blue-gray, K+ yellowish to brown, -0.3 mm, ± convex, standing upon pale greenish, gray to gray-brown, rounded, flat to somewhat convex, -0.2 mm areoles, sometimes the areoles completely covered over. Soredia -30 µm. Atranorin, Zeorin. On nitrogen-rich bark and mosses.

**Rinodina griseosoralifera**

40* Fresh soralia light greenish-gray to cream colored, whitish in the herbarium, K+ yellow, -0.8 mm, ± round, concave to flat, rarely convex, often coalescing in the center of the thallus. Thallus white to white-gray, coherent, smooth to warty. Soredia -40 µm. Atranorin and others

**Lecanora impudens**

(If thallus conspicuously thick, completely granular sorediate, ap. brown-rose, pruinose, above all on *Pinus mugo* on the moors:

**L. mughosphagneti** Poelt & Veza)

41 Fruiting bodies are contained in the “soralia”, K+ yellow, P+ yellow, then red or K+ yellow, then reddish, P+ orange-red. **Pertusaria trachyphylla** and *P. multipuncta*

41* Soralia without fruiting bodies

42 Thallus and/or soralia P+ orange, with Thamnolic acid or Norstictic acid.

42* Thallus and/or soralia P+ yellow, then red or immediately red or rust-red. With Fumarprotocetraric acid or Argopsin or Pannarin, without Norstictic acid, without Thamnolic acid.

43 Thallus appearing partly large granular, partly finely sorediate (Thallus interior as a rule entirely disintegrating into soredia), at least in the marginal parts warty-lumpy(-knobby), light gray, usually extended. Soralia usually irregularly delimited to coalescing, diffuse, cream colored to light gray-greenish, rarely also separated and convex. Soredia 30-80 µm. Thallus/soralia K+ intensively yellow to orange, C+ yellow, P+ orange. Thamnolic acid, ± elaticin acid,
± (Squamatic acid). Above all on Conifers in the mountains.  

**Loxospora elatina**

43* Thallus thin, light gray, also in the substrate, usually only the soralia conspicuous. Soralia round to elliptical, usually flat or somewhat concave, often somewhat protruding and sharply (almost crater- or collar-like) bordered, -0.4 (06) mm, greenish-white, green-yellowish, gray, green-gray, or green-blue. Soredia -40 µm. Soralia K+ orange to red-brown (but at times rather indefinite), C- or C+ yellowish, P+ yellow-orange. Atranorin, Norstictic acid.  

**Buella griseovirens**

44 With Argospin or Pannarin. Thallus and soralia K-, C-. Soralia pale greenish to yellow-greenish, rarely yellowish  

44* With Fumarprotocetraric acid. Thallus (so far as developed) and soralia P+ yellow, then (orange) red, K- to K+ yellow or dirty brownish-red.  

45 With Argospin. Thallus usually thin, indefinite to thin areolate, with rounded, -0.5 mm in size, but also coalescing, pale greenish to yellow-greenish, usually flat soralia. Soralia P+ rust-red, UV-. In mountain forests above all at the base of the stems.  

**Biatora epixanthoidiza**

45* With Pannarin, ± Zeorin. Thallus of scattered, rarely closing together, gray-brown to greenish-brown, brown-whitish, ± rounded, but also crenate, sometimes appearing squamulose, -05 (0.9) mm wide areoles. Soralia very small, punctiform, at times brownish tinted, -0.4 mm, whitish, pale greenish, greenish-yellow, standing on the areoles or directly on the substrate. Thallus/soralia P+ orange to red, UV+ orange.  

**Rinodina efflorescenes**

46 Thallus greenish, gray-greenish, irregularly sorediate and here ± yellow-greenish, P+ red, K- to weakly yellowish. Fumarprotocetraric acid, ± usnic acid.  

**Lecanora conizaeoides**

46* Thallus gray, whitish or indefinite, soralia whitish, gray, greenish, or bluish to brownish-gray.  

47 Thallus developed upon the substrate, light gray to gray, with or without dark brown to brown-black prothallus lines, unevenly warty or somewhat fissured, with at first small delimited (0.15-0.5 mm wide), ± concave, later larger and often coalescing pale greenish, whitish, bluish- to brownish-gray soralia, K+ yellow. Atranorin, fumarprotocetraric acid. Thallus sometimes with irregular apothecia-like warts, -0.8 mm wide structures of gelatin consistency (+ *Tremella lichenicola* Diederich). **Mycoblastus fucatus**

47* Not sorediate thallus commonly indefinite, ± within the substrate. Prothallus indefinite or whitish  

48 Without Atranorin. Soralia ± concave to flat, rounded to elliptical, single, -0.7 mm, or 2-3 coalescing, producing a non-coherent crust, whitish, slightly yellow- or gray-whitish, K+ dirty brownish-red to K-, P+ (yellow to) red. Soredia 40-60(80) µm. Fumarprotocetraric acid, (Protocetraric acid), rarely (Gyrophoric acid). UV-/+ weakly blue-whitish.  

**Pertusaria pupillaris**

48* With Atranorin. Soralia at first separate, later producing one coherent thick sorediate crust, gray, bluish-gray, yellowish-green, or whitish-gray, K+ yellow, P+ red. Soredia 40-120 µm. Atranorin, Fumarprotocetraric acid, Protocetraric acid, Zeorin.  

**Megalaria pulvrea**

49 Thallus with rounded black soralia, on wood, gray, warty areolate, medulla 1+ blue.  

**Thelomma ocellatum**

49* Soralia not black, if dark, then lichens not on wood. Medulla 1- .  

50 Soralia in the case of good development crater-like encircled by a collar-like, frayed (curved inward) margin, consisting of erupting thallus pustules. On base-rich bark. Ch-.  

50* Soralia otherwise, not encircled by a frayed margin consisting of erupting thallus pustules

51 Soralia gray-green to dusty blue-green, -0.3(0.5) mm. Thallus gray, or bluish-gray.  

**Caloplasca obscurella**

51* Soralia yellowish-green to white-greenish, -0.3 mm. Thallus whitish  

**Caloplasca ulcerosa**

52 Thallus of very fine low-lying to erect, thread-cylindric, branch segments thereby minutely “fruticose”, 50-400 µm thick. Segment (“branchlets”) 12-35 µm thick, pale yellowish to green-yellowish, partially disintegrating into pale yellowish soredia, soredia 15-40 µm. Cortex cells with fine, -1 µm high papillae. Predominantly on elder and maple.  

**Macentina stigonemoides**

52* Thallus not of very fine cylindrical, branched segments. Not commonly on elder and maple.  

53 Thallus very indefinite, commonly moss-dwelling, only the soon extending greenish to yellow-greenish sorediate regions conspicuous, not delimited. R-, Ch-.  

**Mycobilimbia epixanthoides**

53* Thallus with other characteristics, generally not only sorediate regions recognized, if moss-dwelling, then soralia whitish to gray.  

54 Sorediate regions green to yellow-green or brownish. With Usnic acid or Perlatorial acid or Divaricate acid. On nitrogen-poor habitats  

54* Sorediate regions whitish or blue-gray, gray, or greenish-gray. Without those substances. On nitrogen-poor or eutrophic habitats.  

55 Soralia with Usnic acid, -2.5 mm (also coalescing into larger soralia), yellow to yellow-green, concave to generally definitely convex. Thallus often very extensive, of separate to coherent low warts, gray, greenish-gray, color clearly taken
from the soralia. Atranorin, Planaic acid. UV-. Very rare on acid bark in mountain regions

**Mycoblastus alpinus**

* Soralia without usnic acid, smaller, but also coalescing, greenish, yellow-greenish to pale yellowish (if clearly brownish see also in area doubtless dying *Fuscidea lightfooti*). Thallus usually small, 2-2.5 cm, greenish, light greenish, yellow-greenish, warty, in the case of good development with a brownish prothallus, UV+ white .

56 With Diphyseric acid. Thallus usually only -1 cm .

56* With Perlatic acid. Thallus often also larger .

**Fuscidea pusilla**

57 With spheroletic acid. Thallus punctiform, rounded, white- to greenish-gray or brown tinted. Thallus (warty) areolate, gray to brownish, medulla/soralia UV+ white. At the base of trees with acid bark in the mountains

**Lecidea pullata**

57* With other substances.

58 Soralia/soredia dark blue-gray, lead-gray, dark gray to gray (to greenish-gray). On nitrate-rich habitats and base-rich bark.

59 Soralia ± whitish. Thallus whitish to gray.

59* Soralia -0.3 mm, ± convex, sometimes completely covering the areoles. Thallus areoles small, -0.2 mm, pale greenish, gray to gray-brown, rounded, flat to somewhat convex. Soredia -30 µm. Atranorin, Zeorin. On bark and mosses .

**Rhodina griseosoralifera**

59* Soralia not convex. Upper surface entirely or partially granular-sorediate to granular-isdiate. Single ap. are generally to be found in the case of longer searches. Ch- .

60 Thallus with sharply defined, rounded to rarely elliptical, concave to flat, rarely convex, only isolated to coalescing soralia .

60* Thallus at least partially with irregularly defined, diffuse coalescing soralia, which erupt from small warts, light gray, gray-white to cream colored, channeled to smooth, sometimes with whitish prothallus. Soralia whitish, cream colored, yellowish-white, or greenish-white. Soredia 50-90 (120) µm. Ap. very rare. Variolaric acid. (If with fatty acids, see *Pertusaria albsccens*). C± yellow. Sometimes difficult to isolate .

62 Montane species. Thallus cream colored, yellowish-white to gray-white, ± smooth, Prothallus indefinite. Soralia -1(2) mm wide, rounded to elliptical, often surrounded by a “margin”, whitish, slightly yellowish, concave to flat, rarely convex. Soredia -150 µm. Variolaric acid, Lichesterinic acid. Montane species .

**Ochrolechia albiflavescens**

61* Widespread. Thallus gray, often extensive, often with definite, (whitish-green gray) zoned prothallus, clearly darker than the soralia. Soralia -2.4(4) mm wide, rounded, concave to moderately convex, with margin. Soredia large, -200(300) µm. Sterile. Fatty acids. (always allo-Pertusaric acid) .

**Pertusaria albsccens** (if thallus unevenly lumpy, with indefinitely defined granules on the lumps, in part coalescing small soralia: var. corallina)

62 Thallus without lichesterinic acid, with part sharply defined, part diffuse coalescing soralia, rarely finally uniformly sorediate. Above all in lower to central sites .

62* Thallus with Lichesterinic acid, thin, shortly entire surface mealy to granular sorediate. Above all montaine, on acid bark

**Ochrolechia microstictooides**

63 Thallus with isidia or thallus at least partially of elongated, partially of rounded granules .

63* Thallus without isidia, not of such granules .

64 “Isidia” black, cylindrical .

64* Without black isidia .

65 Thallus with *Trentepohlia*-algae, on scraped places often gold-brown to yellow-gold (scratches), “isidia” like the thallus whitish to light gray, hemispherical to short cylindrical, with pycn. Lichens of shades habitats .

65* Thallus with true green algae, on scraped places not gold-brown to orange-yellow. Isidia, if occurring, commonly without pycn .

66 Thallus K+ (yellow, then) blood-red or K+ yellow. Thallus gray-white, light gray, greenish-gray. Isidia relatively delicate, -0.2 mm thick, 0.5(1) mm high, sometimes slightly browned above .

**GS Pertusaria**

66* Thallus K- (Caloplaca herbidella small spots also K+ red)

67 Thallus of very small coraloid to isidiate elongated granules, black-brown to brown, in the shade light greenish-brown, C+ red (usually only to be seen on shaded thalli or microscopically in squash preparations), granules 25-150 x 25-50 µm. On acid substrates

**Saccomorpha icmalea**

67* Thallus not brown .

68 Thallus C+ orange or C+ red .


69 Thallus thin, filmy, blue-green, green (green) gray, smooth to warty, with 0.1 mm long, needle-to thorn-like, gray-green, ± transparent structures .

**Gyalideopsis anastomosans**

69* Thallus of partially elongated to coralloid isidiatia-like granules or 40-120 µm thick or of very finely branched, almost dwarf fruticose segments or 12-35 µm thick .

70 Thallus of very fine decumbent to erect, thread-cylindrical, branched segments, thereby minutely “fruticose”, 50-400 µm thick. Segment (“branchlets”) 12-35 µm thick, pale yellowish to green-yellowish, partially also disintegrating into pale yellowish soredia, soredia 15-40 µm. Cortex cells with fine, -1 µm high papillae. Predominantly on elder, or maple
Macentina stigonemoides

70* Thallus granular isidiate to coralloid isidiate, granules 40-120 µm thick, not erupting sorediate 71

71 Thallus white-gray, yellowish-gray, pale greenish-gray, thickly covered with mostly cylindric to clearly coralloid isidia (to coarse granular), sometimes in places with orange-yellow, K+ deep-red pycnidia and isidia points. In high rainfall, oceanic sites, in regions occurring on bark or oak or sycamore

. Caloplaca herbidella

71* Thallus pale gray-greenish to pale greenish, in the herbarium bleaching and light gray to beige, of rounded to elongated and weakly coralloid, in part also somewhat flattened granules. On longer studies usually isolated light brown or dark brown to blackish ap. are to be found. Above all on oak, or ash .

72 Thallus granules/isidia not browned. Sometimes brown to rose-brown ap. initial stages are to be found. Above all on oak, ash, maple, or Norway maple . Bacidia rubella

72* Thallus granules/isidia often somewhat browned on the upper side. Sometimes dark brown to blackish ap. initials are to be found. Above all on oak Bacidia biatorina

73 Thallus yellow 74

73* Thallus not yellow. 75

74 Thallus green-yellow to citron yellow, of ± convex, -0.5 mm wide areoles or granules, on trees with acid bark on ± rain protected sites, above all on oak, or alder

Chaenotheca chrysocephala

74* Thallus yellow to slightly orange-yellow, of about 0.07-0.15 mm thick, often uniformly ordered, separate to coalescing granules (C. xanthostigma) or of flattened to convex, 0.3-1 mm wide areoles (C. vitellina). ↑ Candeliarella

75 Thallus warty-large granular, gray, in places orange to rust-brown, there K+ red

Chaenotheca ferruginea

75* Thallus appearing squamulose, not orange to rust-brown in places 76

76 Squamules convex to vesicular or unevenly deformed, in places flattened, gray-green, yellow-brown, or dark brown, variously colored according to the exposure to light, dull to weakly shiny Hypocenomyce caradocensis

76* Squamules concave, flat to convex or uneven, with entire, lobed or crenate margin, gray-green to dark brown, shiny Hypocenomyce friesii (for additional squamulose species see Agonimia tristicula, or Lapadium disciforme)

Key VIII: Sterile Crustose Lichens on soil, Raw Humus or Plant Remains

1 Thallus citron yellow, or light yellow 2

1* Thallus not citron yellow 3

2 Thallus entirely finely mealy. Colonizing rain protected sites (overhanging scarp, under root hollows (Psilolechia, Chaenothea turf.)  GS Lepraria

2* Thallus granular to squamulose. On rainy habitats . Arthrorhaphis

3 Thallus black-brown to brown, in the shade light greenish-brown, warty (C-) or of very small elongated to coralloid granules (C+ red, usually only seen on abraded thalli or in microscopic squashed preparations), granules 25-150 x 25-50 µm. On acid substrates . Saccomorpha

3* Thallus otherwise, not brown 4

4 Thallus of fresh shiny, dark green plump globules with Coccomyxa-algae, R-, on moist moss covered, plant remains, or peat Omphalina umbellifera

very widespread species

4* Thallus not of such globules . 5

5 Thallus flesh-wise orange to rust colored, there K+ violet-red, extensive, light gray, light greenish-gray, or gray green, producing a single coherent, granular to warty crust (granules about 0.05-0.2 mm), in places with greenish-white to light greenish, convex, soon coalescing soralia, C+ red, P-. Soralia 18-25 µm. Gyrophoric acid

Trapeliopsis pseudogranulosa

5* Thallus not flesh-wise orange to rust colored . 6

6 Thallus with entirely fine granular to mealy upper surface or from beginning to end granular to mealy 7

6* Thallus not entirely granular or mealy 9

7 Thallus C- to C+ yellowish, whitish, gray, blue-green tinted whitish, or pale greenish, commonly on non rain exposed sites GS Lepraria

7* Thallus C+ red, on rainy sites, commonly on mosses . 8

8 Thallus medium gray to blue-gray, C+ red, P red, consisting of 0.1-0.4 mm thick granules, with argopsin, and gyrophoric acid. Algae micareoid, about 4-7 µm thick . Micarea

8* Thallus white to whit-gray, often darker in the center, (mostly non persistent) C+ red-orange, P+ citron-yellow, often rounded rosetted, 0.08-0.2 mm thick granules, with Alectorialic acid, Angardianic acid. Algae larger . Lepraria neglecta

9 Thallus C+ orange to red 10

9* Thallus C+ C- red-yellowish 11

10 Thallus granular to warty areolate or appearing squamulose, areoles -0.5 mm. Soralia whitish, slightly greenish or dull green-gray to blue-gray GS Trapelia

10* Thallus very thick, uneven, not granular or granular-warty, gray-white to light gray. Soralia pale yellow-greenish to whitish. Usually in the high mountains GS Pertusaria

11 Thallus thin, indefinite, coherent, dirty loam colored to greenish-gray, when fresh somewhat

65
slimy. Soralia pale greenish, soon irregular to
coalescing

**Trapeliopsis gelatinosa**

11* Thallus definite .

12 Thallus light greenish-brown to greenish, of
spherical to elongated or coralloid granules,
granules 25-150 (200) x 25-50 µm, C+ (at least
in squash preparations) red, K-.

**Saccomorpha icmalea**

12* Thallus not of such fine, elongated to coraloid
granules, K+ yellow, C-.

13 Thallus of convex (-hemispherical) areoles,
whitish to light gray, often extensive on acid soil
banks, or open slopes, P+ yellow. Atranorin,
Baeomycesic acid, ± Squamatic acid, Barbatic
acid .

**Dibaeis baemycyes**

13* Thallus gray, gray-green, or brownish gray, when
moist light green, P+ orange

14 Thallus rosetted, at the margin with definite,
elongated, crenate, -5 mm wide lobes, interior ±
squamulose. On the upper surface are cut off
about 0.2 mm flat to convex schizidia, which
leave behind concave scars. Stictic acid .

**Baeomyces placophyllus**

14* Thallus without such marginal lobes, truly
crustose to small squamulose, squamules -1 mm,
not sorediate or with diffuse greenish to whitish
soralia, at times with small, up to 0.2 mm wide
blastidia (bursting out or the upper surface part of
the cortex). Stictic acid, ± Norstictic acid, ±
Gyrophoric acid .

**Baeomyces rufus**

The keys are not often lacking, they are there
for ease in keying the species of the genera
treated and identifying them from one another in
a related or similar genus. In these cases, the
genus names and the corresponding keys are
indicated (“Determination ↑ Genus xy”).

Absence of such an indication – which is the rule
only in the instance of solely a species extensive
genus – keying out the species to a genus key
I-VIII on pages 66-99.

Species, which are supplied with author names
in the key, are described further only in the
ecology and distribution. Those which are, in the
main, not found in Baden-Württemberg, in the
same way as all species, are provided in brief
with ecological/chronological descriptions.

If not otherwise mentioned, the spores are
colorless and are developed eight per ascus.

Conidia and spermatia are designated generally
as pycnosporous (pycnidiospores). With them are
the many still unknown functions of the slow to
be recognized structures. Pycnosporous are, if not
otherwise mentioned, colorless and single celled.

Color production may give only one detail of
the breadth of variation of the species.

**Absconditella Vézda**

**Introduction**

The species of *Absconditella* are very
inconspicuous crustose lichens with
gray-greenish thallus and very small, whitish,
pale yellow, rose or red-brown colored apothecia
with concave disks and proper margin. They
grow on dead or dying mosses, thus they live
above all on peat mosses *A. sphagnorum*, or on
small stones (silicate rock) on long time dew
moistened sites, as *A. delutula*, others live on
humus and soil. The area of *A. delutula* extends
over central Europe (up to the southern part of
Scandinavia). *A. sphagnorum* occurs in southern
and central Scandinavia as well as the foothills of
the Alps; quite recently these species were
reported from the moors of south Black Forest.
Further species of the approximately 10 species
included in the genus are not known in Germany.

**Genus Characteristics and Keys**
Thallus crustose, thin, usually gray-yellow, gray, or greenish, when moist often ± gelatinous, with coccoid green algae. Apothecia with sunken, concave disks, light colored with a proper margin. Exciple paraplectenchymatous or of parallel hyphae, colored or colorless. Hypothecia often indefinite. Hymenium I-/I+ yellowish, K/I-. Paraphyses simple, rarely branching above, thin, slightly thickened above. Thallus very thin, grayish to blackish, R-. Spores elongate ellipsoidal, fusiform or almost needle-like, 2- to multicellular, cross-septate.

1 Sp. 4-celled, fusiform, 20-28 x 5-6 µm. 1  On sandy humus soils. Ap. -0.4 mm, whitish, pale yellowish, pale brownish, sunken. Thallus very thin, grayish to blackish, R-.

A. trivialis

1* Sp. 2-celled. Lichens on peatmoss or rock.

2 On peatmoss. Ap. 0.1-0.4 mm, whitish to yellowish, when moist light rose. Sp. 10-12 x 4-5 µm.

A. sphagnorum

2* On rock. Ap. -0.2 mm, whitish, yellowish to rose-brown, depressed. Sp. 8-15 x 3-5 µm.

A. delutula

Ecology and Distribution of the Species

Absconditella delutula (Nyl.) Coppins & Kilias

(A. modesta (Hegetschw.) Vézda m. (Hegetswch.) Grumm.) In the foothills up to montane regions on silicate rocks, on rocks over base-rich soils, on road banks, scarps, on shady, wind-protected, cool substrates, subneutroph.,-m. acidoph., m. photoph.-v.skioph., anitroph.centr – rare, probably often overlooked; süHü, O, SFW

Absconditella sphagnorum Vézda & Poelt

In montane and high montane, heavy rainfall regions in the high moors on dead, for the most part on blue-green algae overgrowing peatmosses (Sphagnum) on hummocks, above all in the late autumn, very to extreme acidophytic, very photophytic, v.-e.acidoph., v.photoph., substrathygroph., in the Spagnion magell. Bor-mieur – v.rare (2); süSch, Av

Absconditella trivialis (Willey ex Tuck.) Vézda

On acid, sandy humus, foist soils on open sites, often with blue-green algae, pioneer ephemeral habitats – mieur – rare; Westf. Alps

Acarospora Massal.

Introduction

The genus Acarospora includes lichens with squamulose to purely crustose, commonly areolate, sometimes marginally lobed thallus with sessile to usually sunken, apothecia with thalloid margins. The thallus and apothecia are as a rule light to dark brown or red-brown, rarely yellowish or rust-red colored. From time to time the true thallus color is covered over by a whitish pruinosity. The very small, single-celled colorless spores sit in a large number (usually over a hundred) in the ascus. In Germany the genus numbers ca. 30 to 35 species (partially unsatisfactorily known). Concerning the species validity numerous species have still indefinite descriptions. As a result of taxonomic and diagnostic problems, but also as a result of the frequently scarcely possible procurement of vouchers of the species, the principal occurrence on anthropogenic substrates (tombstones, monuments, and mural crowns), the distribution of Acarospora species also in the region is still entirely unsatisfactorily known.

Of the Acarospora species growing on rock; the most of them prefer light-rich sites. A. macrospora, A. heppii, A. glaucocarpa and the closely related A. cervina occur on lime-rich rocks, the remaining indigenous species are silicate dwellers. A. sinopica lives only on heavy metal or iron sulfide-rich silicate rock, e.g. on processed ore. A. smaragdula is found likewise occasionally on heavy metal-, e.g. copper-rich substrate, preferring however in contrast to the acidophilic A. sinopica so-called neutral and basic silicate rock. Many indigenous species have their strong point on rocks with weakly acid to weakly basic weathered rind, above all on slightly calcareous (or even dust impregnated) sandstone (shell-sandstone, or clay- red marl sandstone), thus A. gallica, A. oligospora, A. paupera, A. tongletii, A. umbilicata, A. versicolor and A. nitrophila. Since that kind of sandstone with base-rich upper surface is scarcely contiguous, on the other hand it is rather often used in the region as building stone (e.g. for walls), these species occur predominantly or almost exclusively on anthropogenic habitats. A. heppii, which also commonly occurs on lime-rich...
substrates, is found especially on rock on shady sites, e.g. in forests.

A. fuscata, A. glauccarpura, A. heppii, A. macrospora, A. nitrophila, A. veronensis as well as A. sinopica are widespread throughout Europe. A. peliscypha is arctic alpine; it is known in Germany from the high Black Forest and the Harz. A southern distribution picture is shown by A. cervina, A. gallica, A. oligospora, A. umbilicata and A. versicolor, whose northern distribution boundary lies through Central Europe or Southern Scandinavia. A. paupera and A. tongletii have their presumptive distribution strong point in the summer-green deciduous forest region.

Genus Characteristics and Keys

Thallus crustose, commonly clearly developed and areolate to almost squamulose, sometimes with enlarged areoles at the margin and ± placoid, usually light to dark brown, red-brown, black-brown, rarely rust color or yellowish, sometimes pruinose, with paraplectenchymatous upper cortex, underside without cortex. With coccoid green algae. Apothecia single to usually many, thin, stuck together, simple to very numerous, thin, stuck together, simple to bound. Asci with usually more than 100 sp., clavate, with tholus (I-, KI-, very rarely ± blue). Sp. 1-celled, spherical to more than 100 sp., clavate, with tholus (I-, KI-, very rarely ± blue). Epihym. usually brown to brown-black disk and indefinite to indefinite to indefinite, rarely crowded sessile, with brown red-brown to reddish-brown, with ± same colored margin, regularly round. Sp. 3-6 x 1.5-2.5 µm. Thallus indefinite, very thin to almost lacking, pale brown to light gray A. heppii

5* Ap. definitely larger, 0.7-2(3) mm, mostly whitish pruinose, flat, raised margin, round or flattened on opposite sides. ↑ A. glauccarpura

6 Sp. 7-12 x 3-6 µm, less than 100 per ascus. Ap. -1 mm. Thallus usually red-brown to light brown, rarely ochre, greenish-brown, squamules areolate to almost cracked areolate, areoles 0.5-5 mm, running together, mostly sterile at the thallus margin. Ap. to 1-3(8), ± sunken, red-brown to dark brown, darker than the thallus, without margin or with definite thallloid margin. Algae layer ± uniformly coherent. A. macrospora

7* Thallus scattered to grouped, ± rounded areoles, not placoid. Ap. dark brown to black-brown, commonly punctiform, rarely distended. Areoles/squamules smooth to wrinkled, flat, -1.5(2) mm. K+ red ↑ A. smaragdula

3 On limestone, R-, Ch-. 4

3* On silicate rock . 8

4 Thallus only developed as clearly margined ap., otherwise lacking or indefinite. Ap. ± round, single, scattered to rarely 2-3 grouped

5* Thallus clearly developed, squamulose to areolate. Areoles with at times 1 to several ap. 6

5 Ap. 0.2-0.4(0.5) mm, definitely scattered, rarely 2-3 grouped, wartly projecting, with concave disk, pale brown to reddish-brown, with ± same colored margin, regularly round. Sp. 3-6 x 1.5-2.5 µm. Thallus indefinite, very thin to almost lacking, pale brown to light gray A. heppii

2* Thallus scattered to grouped, ± rounded areoles, not placoid. Ap. dark brown to black-brown, commonly punctiform, rarely distended. Areoles/squamules smooth to wrinkled, flat, -1.5(2) mm. K+ red ↑ A. smaragdula

2 Thallus coherent, areolate, radiate lobed at the margin with enlarged areoles (placoid), usually ± round, -4(6) cm, but also often growing together, in the interior thickly covered with ap., sometimes sterile. Ap. yellow, -1.5 mm. K-

↑ Pleopsidium

1 Thallus yellow to greenish-yellow . 2

1* Thallus brown, gray-brown, red-brown, ochre, or rust-red 3

2 Thallus coherent, areolate, radiate lobed at the margin with enlarged areoles (placoid), usually ± round, -4(6) cm, but also often growing together, in the interior thickly covered with ap., sometimes sterile. Ap. yellow, -1.5 mm. K-

A. smaragdula var. lesdainii (harm.) H.Magn.: Ap. usually

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larger, thallus not radiate- rosetted with enlarged marginal areoles, rust-brown to ochre)

8* Thallus not rust-red to rust brown

9 Thallus or ap. K+ red (crystals), C-. Norstictic Acid

9* Thallus and ap. K-, C- or C+/KC+ red .

10 Thallus light gray-brown to light red-brown, areolate to almost squamulose, areoles for the most part taken up by ap., rounded to angular, -1 mm. Ap. K+ red, single, rarely to 2-5, flat or concave, light margined, -4.0 mm. Sp. 4-6 x 1.5-2 µm. * A. paupera

10* Thallus yellowish-brown, light brown, beige, rarely red-brown or rust colored or greenish-yellow, squamulose, K+ red or K-. Squamules scattered or in small groups, rounded to irregular and crenate, often with uneven upper surface, mostly 0.5-2 mm, only a small part taken up by ap. Ap. mostly 3-7, brown-black, punctiform, rarely with disk opened out (mostly -0.8 mm). Sp. 3-5 x 1-1.5(2) µm. * A. smaragdula

11 Thallus KC+ red. Gyrophoric acid

11* Thallus KC-

12 Thallus pruinose .

12* Thallus not pruinose .

13 Ap. 0.3-1.8 mm, disk brown to black-brown, very uneven to umbilicate. With enlarged marginal areoles, therefore appearing lobed. Areoles 0.4-2.2 mm, convex, brown, often pruinose. Sp. 3-5 x 1.5-2 µm. * On calcareous or neutral/basic silicate rock - mieur; MRh A. bullata Anzi

13* Ap. -0.4 mm, often only punctiform, hollowed out, without recognizable margin, disk not conspicuously uneven. Thallus squamulose to areolate, dark brown to black-brown, squamules 0.5-3 mm, mostly in a commonly pruinose, brown, very variable in size, thallus. Marginal areoles often sterile, enlarged or not, sometimes appearing lobed. Sp. 3-5 x 1.5-2 µm . * A. umbilicata auct. (In contrast to occasionally pruinose forms of A. fuscata ap. smaller. Species concept unclear at this time. The forms found in the region probably not belonging to A. umbilicata Bagl.)

14 Ap. disk commonly smooth or very slightly rough, not wrinkled, not umbilicate, ap. -1 mm, hollowed out to level with the thallus upper surface, mostly angular or irregular, often darker than the thallus, red-brown to black-brown. Thallus squamulose to (in the interior) areolate, light to dark brown, or red-brown, usually ± shiny, concave, flat or uneven, 0.5-1.5(3) mm. Sp. 4-6 x 1-1.5 µm. Hym. 70-120 µm. * A. fuscata

14* Ap. disk wrinkled uneven or with umbilicus. Hym. 80-100 µm. Very rare species

15 Ap. -0.3 (0.8) mm, mostly to 3-6, dark brown, clearly margined, ± circular, hollowed out, disk often with an umbilicus. squamules pale yellow-

brown, from flat, close standing to scattered, 0.4-1.4 mm wide, ± pale underside squamules. * A. gallica

15* Ap. -1.4 mm, dark red-brown, finally projecting to sitting up, with erect thalloid margin and wrinkled to often umbilicate disk, often close standing. Thallus squamulose, squamules often appearing lobed, shiny, light- to dark brown, convex to uneven, 0.5-3 mm. Sp. 4-6 x 1.5-2 µm. * A. peliscypha

16 Sp. 9-13 x 5-6 µm, only to ca. 16-64 per ascus. Areoles olive-to dark brown, underdies pale, usually scattered and rounded, ± convex, 0.5-1 (1.5) mm. Ap. single, -0.6(1) mm, round, black-brown . A. oligospora

16* Sp. clearly smaller, to more than 64 per ascus .

17 Thallus pruinose

17* Thallus not pruinose

18 Thallus ± thickly pruinose, under the pruinosity light brown to light red-brown, squamulose areolate, squamules flat to convex, rounded to angular, 0.5-2 mm. Ap. ± hollowed, commonly without projecting thalloid margin, usually black-brown, 0.2-0.5 mm. Sp. 4-7 x 1.5-2 µm. Paraph. ca. 1.5 µm thick. Hym. 90-130 µm

A. versicolor

18* Thallus weakly to thickly pruinose, pruinosity mostly truly variable in each thallus and only occurring in the case of lime influence. Ap. often with raised thalloid margin .

19 Ap. -1.5(2) mm, red-brown to black-black, definite (usually raised) margin, to 1 (2-3) per squamule, finally often clearly projecting and ± sessile, rounded to distorted. squamules scattered to running together, moderate to dark brown, rounded, flat to convex. Hym. low, -75 µm high, paraphyses -3.5 µm (above -5 µm) thick. sp. 3-6 x 1.5-2.5 µm . A. nitrophila (31)

19* Ap. rarely over 0.8 mm. Hym higher. Paraph. -2µm

20 Ap. commonly with warty rough disk, red-brown thin margined, -0.8(1.4)mm. Hym. (120)140-170 µm. Squamules 1-5 mm, yellow-brown, light- to dark-brown, dull, usually uneven, underside ± pale, usually scattered to in small groups, often appearing lobed. Sp. 3.5-5.5 x 1.5-2 µm . A. diafusca

20* Ap. disk usually not warty rough .

21 Thallus of single, ± rounded, -2 mm large, weakly convex areoles or flowing together warty areolate, yellow-brown, light brown, beige, often with uneven upper surface, usually 0.5-2 mm, underside ± blackish. Hym. (60)125-140(250) µm. Ap. usually to 3-7, punctiform or rarely with opened up disk (up to 0.8 mm), with or without margin. Paraph. 1-15 µm thick. Sp. 2.5-5 x 1-1.5(2) µm. Norstictic acid A. smaragdula
21* With other characteristics (ap. usually not punctiform. Hym. rarely over 120 µm, exception: A. pyrenopsoides). Without Norstictic acid .

22 Thallus only clearly developed as an ap. margin, otherwise lacking or indefinite. Ap. ± round, single, scattered to rarely 2-3 in a group, 0.2-0.4(0.5) mm. Paraph. -1 µm. On calcareous or basic silicates .

22* Thallus clearly developed, squamulose to areolate. Ap. with from time to time 1 up to several ap. Paraph. thicker. Lichen not limited to calcareous or basic silicates .

23 Ap. often irregularly formed, angular or elongated, rarely round. Disk sunken, margin scarcely raised or indefinite. Hym. ca 60-80 µm (rarely up to 100 µm). Sp. 3-5 x (1.5)2-2.5 µm.

A. impressula s.l. .

23* Ap. as a rule ± rounded .

24 Thallus cracked-areolate. Ap. mostly angular, closely flowing into one another, dark brown to black-brown, underside dark, 0.4-1.5 mm, from time to time without ap. Ap. 1-5 per areole, hallowed out, -0.4 mm, concave to flat, rounded to angular. Paraph. 1.5-2 µm .

A. impressula

24* Thallus not consisting throughout of cracked areolate crust. Squamules single to mostly only a few grouped between/in other lichens, convex, red-brown to gray-brown, shiny, -1.8 mm. Ap. 0.1-1.5 mm, irregularly formed, often elongate, of a color similar to the thallus. Often parasitic .

25 Squamules red-brown. ap. to 2-5 per squamule. Medulla granular because of crystals. E.g. on Aspicilia species A. hospitans .


A. insolata

26 Thallus very pale brown to pale yellowish, very thin, cracked areolate, areoles flat to slightly concave, -0.8 mm. Ap. to 1-2, red-brown, sunken. Sp. 3-6 x 1-2 µm A. tongletii .

26* Thallus definitely darker .

27 Thallus cracked areolate. Ap. angular, closely flowing into one another, flat, dark brown to black-brown, underside dark, 0.4-0.7 (1.0) mm, from time to time without ap. Ap. 1-5 per areole, -0.4 mm, concave to flat .

A. impressula (24)

27* Thallus otherwise .

28 Parasitic. Ap. mostly up to 2-10 per squamule

28* Not parasitic

29 Sp. 3-5 x 2-3 µm. Squamules convex, shiny, red-brown, gray-brown .

A. insolata (25)

29* Sp. 3-6 x 1.5-2 µm. Squamules strongly convex, dark brown to black-brown .

A. pyrenopsoides (31)

30 Ap. 0.1-0.5 mm, without margin, concave (hallowed out), to 1-3 red-brown to dark brown. areoles red-brown, dark red-brown, 0.2-1.4 mm, scattered or several to a group, rounded to angular. Sp. 3-5 x 1.4-2 µm. Hym. 60-100 µm A. veronensis

30* Ap. usually at least partially with raised margin. Areoles appearing squamulose. Sp. 3-6 x 1.5-2 µm .

31 Squamules mostly dark brown, 0.4-2.5 mm, mostly convex (also light brown to brown, even to uneven, -4mm, almost squamulose, often crenate-lobed: v. praeruptorum), ap. -1.2 mm, often with somewhat rough disk. Hym. 70-130 µm. Paraph. 1.5-2(2.5) µm, above -5(6) µm. Very form rich A. nitrophila

31* Squamules dark brown to black brown, strongly convex. Ap. -0.7 mm, sunken, colored similar to the thallus. Hym. 70-150 µm. Paraph. 1.3-1.7 µm, above -3 µm A. pyrenopsoides

Ecology and Distribution of the Species

Acarospora badiofusca (Nyl.) Th.Fr.

In high montane and alpine sites (rarely lower, as well as above all in dry-warm, continental sites: dealpin) on basic or calcareous or lime dust impregnated silicate rock and lime removed limestone, on very rain sheltered to rained upon surfaces, also on moderately dunged bird roosts, subneutrophitic-neutrophitic, extreme to very photrophitic, moderately nitrophitic, on lower sites e.g. in Lecanoretum demissae, in higher in Aspicilion mastr. – arct-alp(pralp) – very rare (1); Vog, Ju

Acarospora cervina Massal.

Up to the montane zone on limestone on discreet places, like Placocarpus schaer. (7), Char. Placocarpetum schaeri – mieu (subco)-med – rare (3); Ju, FrJu, Sju, O+, Ne, Mn, Th

Acarospora fuscata (Nyl.) Th.Fr.

Euryöke species, up to the alpine zone, above all on acid lime-free silicate rock, above all on sunny completely rain exposed places on ± hard rock, also as a apophyte in limestone frequent on wall crowns, tombstones etc. of lime- free natural stone, (subneutrophitic-) moderate- extreme acidephyte, moderate-very phototrophic, antrophitic to extremely nitrophitic, predominantly in crustose lichen stands, in pioneer habitats and permanent regions, Char. Rhizocarpetea geotr. – bor-med(mo) – rather(moderately) frequent

Acarospora gallica H. Magn.
Similar to *A. umbilicata* (†), *Lecidella carp.* (†) – mieur-med – O (Heidelberg), Th

**Acarospora glaucocarpa** (Ach.) Körber

Very euryöke species, up to the alpine zone on lime poor to above all lime-rich rock, on very small boulders, rocks on round heads, steep, and overhanging surfaces of rock, rarely also on walls, even on nitrogen rich sites (dust, bird dunged), on moderate to very light rich, rainy to extremely rain sheltered habitats, basiphytic, (a-) to moderate nitrophytic, e.g. in the *Aspicilion calc.* – bor-med (mo) -- very rare; Sju, Ju, FrJu and Al very rare, besides (v.) rare (Mn, Ne, Hû, süRh, Vog, Eif, He, Th)

**Acarospora heppii** (Naegeli ex Hepp) Naegeli ex Körber

Up to the montane zone on lime-rich to lime-poor rock (e.g. weakly calcareous silicate rock marly or sandy carbonate rock, lime-containing artificial stone), above all on the rocks lying on soil on road borders, scarps, in abandoned gravel pits, scree slopes, subneutrophic - basiphytic, (v. skiophi.-) mon. extremely phototrophic, e.g. with *Arthonia lap.* -- bor - bor-smed (?-med) – very rare, overlooked; SJu, Ju, FrJu, süHû-HRh, Ne, Mn, He, Th, süRh, O, Eif, Mi

**Acarospora hospitans** H.Magn. (A. impressula Th.Fr. v. hospitans (H.Magn.) Clauz. & Roux)

Similar to *A. insolata* (†) - bor-med-mo - rare; süSch, Al

**Acarospora impressula** Th.Fr. (A. atrata Hue)

Up into the high montane zone on lime free, often heavy metal-, at least iron-rich silicate rock on sunny surfaces, extremely acidophytic, extremely to very photophytic, ombroph., anitrophytic, e.g. in *Acarosporion sin, Parmelion conspersae* – s’bor-mieur – rare; süSch, O, Eif

**Acarospora insolata** H.Magn.

Above all in montane and alpine, extremely high precipitation regions on lime-free, mineral rich or slightly calcareous silicate rock and flat topped lime deficient limestone, mostly on sunny surfaces parasitic on crustose lichens, above all *Aspicilia*-species and *Rhizocarpon geogr*, often also on iron-rich rock, (subneutrophic.-) moderate (extremely) acidophytic, extremely to very photophytic, a-/m nitrophytic, above all in the *Asciiletum cin.*, *Um bilicarion cyl.* – (bor-) mieur-smed – rare; süSch, Vog, Rhôn, Al

**Acarospora macrospora** (Hepp.) Massal. ex Bagl. (incl. ssp. murorum (Massal.) Clauz. & Roux, A. murorum Massal.)

Up to alpine zone on mostly lime-rich rock predominantly on steep slopeing and vertical surfaces as well as overhanging rocks on fissured or earth encrusted sites, on rain sheltered sites also on from time to time moistened cliffs, on m.- ex. (v.) light rich habitats, basiphytic, extremely xerophytic, m. nitrophytic, e.g. in the *Caloplacetum cirr.*, but mostly on anomalous small habitats – bor-med -- Sju, Ju, FrJu, Th, Al, besides very rare: Ne, Eif

**Acarospora nitrophila** H.Magn

var. **nitrophila**

Up into the alpine zone on silicate rock, above all on basic to neutral or dust impregnated or slightly eutrophic silicate rock, a pioneer on hard magmatic silicates, often a snyanthrop on wall crowns, tombstones, old roof tile, above all on rain exposed, light-rich habitats, often on horizontal/sloping surfaces, subneutrophic, extremely to very photophytic, m.- to rather nitrophytic – arct-med – moderately frequent; very rare natural occurrence

var. **praeruptorum** (H.Magn.) Clauz. & Roux (A. praeruptorum H.Magn.)

On extremely rain sheltered vertical- and overhanging surfaces on crystalline magmatic or metamorphic, mineral rich silicate rock, extremely acidophytic, -subneutrophytic, m. to ex. photophytic, mostly only in association with few lichens. – mieur-med – rare; e.g. Sch, Mos, Eif, O

**Acarospora oligospora** (Nyl.) Arnold

In hilly and submontane, mostly very warm regions on basic or slightly lime impregnated silicate rock, often on sandstone, on wall crowns, on rock over base-rich soil, often on eutrophic sites and then also on acid silicate rock, subneutroph. - neutroph., rather to very photoph., m. nitroph., in the *Lecidellatum carp.* -- mieur-smed – rare (2); Pf, Ne, Bo, Vgb, Fr, FrJu, Westf, Al

**Acarospora paupers** H. Magn. (A. tongletii var. p. (H. Magn.) Clauz. & Roux)

Like. *Lecidella carp.* (†), above all snyanthrop on sandstone – Ne, Ju, Fr, FrJu, Th

**Acarospora peliscypha** Th.Fr.

In alpine, rarely high montane, high rainfall sites on wind and radiation exposed silicate rock,
especially in region of bird roosts, m.-ext. acidoph., v.photoph., m.(-rather) nitroph., in the Umbilicarion cylon, in contact with the Ramalinetum cap. – arct-alp – v.rare (R); süSch, Hz

Acarospora pyrenopsoides H.Magn.
On silicate rock on steep faces and on overhanging ± light-rich sites – v.rare (R); süSch

Acarospora scabrida Hedl. ex H.Magn.
In montane region on usually weathered, fragmented, dust impregnated silicate rock, e.g. on vertical faces and overhangs – bor-mieur - v.rare (1); süSch

Acarospora sinopica (Wahlenb.) Körber
Up into the alpine zone on lime-rich, heavy-metal-rich, at least FeS₂-rich silicate rock, especially in (formerly) ore mining regions, also on ore dumps and waste, often on rust colored to black (MnO) oxidized substrate, on horizontal- to (in high rainfall regions) overhanging surfaces, on sunny sites above all on often dew moistened surfaces near soil, places with high heavy metal content, edaphic stenök, but r.euryök, r.-v.acidoph., m-s.potoph., anitroph., Char. Acarosporetalia sin. – arct-smed-mo – rare (3); süSch, Vog, BayW, Ts, Sauerl, Erz, Hz

Acarospora smaragdula (Wahlenb.) Massal.
A. undata Clauz., Roux & Wirth)
Up into the alpine zone on calcareous or basic to neutral or ± eutrophic silicate rock, the principal form largely in high places is cracks of rock walls of mineral rich rock (above all on vertical surfaces) and on bird roosts, var. lesdainii v. subochracea H.Magn. and other forms on heavy metal-rich, lime-free rock (like A. sinopica ↑). Principal form subneutroph. -m.acidoph., m.-r.(v) photoph., often in initial stages -arct-mieur-mo/alp-med-mo/alp – v.rare (1); Vog. süSch, Ne, Ju, BayW, Ts, Hz

Like Lecidella carp (↑), A. oligospora (↑), above all synanthrop on sandstone, especially wall crowns – mieur – rare (3); Eif, Fr, o

Acarospora umbilicata auct.
In hilly-submontane, warm to rather warm, usually rather precipitation poor region on calcareous or lime impregnated or basic silicate rock, primarily on sandstone, often synanthrop on walls, on sunny, often dust impregnated habitats, subneutroph., thermoph., m.(-r.)nitroph., above all in the Lecidelleatum carp., also in the Caloplacetum teich. –mieur(subatl?)-med – rare (3); Rh, Hü, Ne, Ju, Sch, O, Mn, Sp, Pf, Eif

Acarospora veronensis Massal.
Up into the alpine sites on acid to basic, as well as also on calcareous silicate rock (and upper surfaces of de-limed limestone), often on somewhat eutrophic sites, thus on walls, on bird roosts, on soil lying rocks (e.g. on roadways), also on artificial rock (roof tiles), pioneer on hard rock, subneutroph.-m.acidoph., r.-v.photoph., (a-)m.nitroph., in the Lecidelleatum carp., Aspicilietum cin., Buellio-Rhizocarpetum etc. – bor-med – v.rare; e.g. Sch, Vog, O, Eif, He, Th

Acarospora versicolor Bagl. & Carestia
On mineral rich silicate rock, like A. umbilicata (↑) – mieur-med – rare; süSch, süRh-HRh, O, Pf, Mos, Eif


Acrocordia Massal.
(Determined ↑ Arthopyrenia)

Introduction

The Acrocordia species have a little differentiated crust, often scarcely visible thallus with Trentepohlia algae and relatively large, black perithecia with two to four celled, ellipsoidal spores in cylindrical asci. The four species occurring in Germany also occur in Baden-Württemberg. A. conoidea and A. salweyi live on limestone on shaded rock (above all on steep surfaces) and are distributed from the Mediterranean region to southern Scandinavia. A. gemmata and A. cavata reside on deciduous tree bark; they prefer oak and ash in oak-hornbeam and ash stands in mild-winter places. Both occur in the zone of summer-green deciduous forests and in the Mediterranean region and have western tendencies.

Genus Characteristics
Thallus crustose, little differentiated, thin or in the substrate, with *Trentepohlia*. Per. largely sunken to sessile, black, among the non indigenous species also light colored. Exc. spherical, colorless to brownish, surrounded by an entire or hemispherical brown-black involucrellum. Paraphysoids thin, sparsely branched or reticulate bound. Without periphyses. Asci 8-, rarely 4-spored, cylindric, K/I-, fissitunicate, with definite tholus and ocular chamber. Sp. one series, ellipsoid to elongate ellipsoid, with usually rounded ends, 2- rarely 4-celled, with thick septum and with finely ornamented upper surface, not shrunk at the septum. Pycnosp. (narrow) ellipsoid. Ch-.

Ecology and Distribution of the Species

**Acrocordia cavata** (Ach.) R.Harris
Like *A. gemmata* (↑), mostly on relatively smooth bark, predominantly on Ash, like *Anisomeridium nyss.* (↑) – mieur-(atl)-med – v.rare; süRh, HRh, Ju

**Acrocordia conoidea** (Fr.) Körber
(Arthopyrenia c. (Fr.) Zahlbr.)
Above all in submontane and montane regions on carbonate rock (Above all limestone and dolomite), usually on relatively smooth, unweathered, compact or fine pored rock on m.rainy to rather rain-sheltered, often slightly moist, shaded steep sloping to vertical faces, on m.warm to rather cool, humid, wind sheltered habitats in forests, valleys, on shaded slopes, basiph., m.photoph.-r.skioph., anitroph., Char. Acrocordion con. – mieur-med – rare; Ju, Sju, FrJu, Al, otherwise v.rare (HRh-süSch, Bo, Bit, Th)

**Acrocordia gemmata** (Ach.) Massal. (A. alba (Schrader) B. de Lesd., Arthopyrenia a. (Schrader) Zahlbr., A. gemmata (Ach.) Massal., A. Sphaeroides (Wollr.) Zahlbr.)
Up into the montane zone, above all in (r.)mild winter places, on subneutral-m.(r.).acid, cracked, also slightly decayed bark of deciduous trees (middle of the stem), above all on Oak, Ash in Oak-Hornbeam and Ash-w. on m.light-rich, mild, wind protected habitats, often in pastures and hanging valleys, basiph., m.photoph.-r.skioph., anitroph., Char. Acrocordion con. – mieur-med – rare; Ju, Sju, FrJu, Al, otherwise v.rare (HRh-süSch, Bo, Bit, Th)

**Acrocordia salweyi** (Leighton ex Nyl.) A.L.Sm. (Arthopyrenia s. (Leighton ex Nyl) Zahlbr.)
On limestone on shaded habitats, often on porous substrate (tufa, mortar) – mieur-subatl-med – v.rare (R); Ne (Jagst)


Introduction

There are at present two species of *Adelolecia* known. *A. pilati* has an indefinite, rarely definite crustose thallus and black apothecia with lecideine proper margin. It differs from *Lecidea* in the construction of the asci among others. The lichen usually sits on vertical faces of fragmented silicate rocks, especially on sloping, iron-rich rock. It is arctic-alpine distributed and is known in outer alpine central Europe from southern Black Forest, the Bohemian Forest and the South.

Genus Characteristics


Ecology and Distribution of the Species

**Adelolecia pilati** (Hepp) Hertel & Haf. (Lecidea pilati (Hepp) Körber)
In high montane and alpine, very high precipitation sits on lime-free, usually upper surface friable, weathered, micaceous and rather iron-rich silicate rock on rather rain protected to moderately rain exposed sloping surfaces, r.acidoph., anitroph., usually only with very few
companions, also in the Acarosporion sin. – 
arct-h’mo/alp – v.rare (3); süSch, BayW

Lit.: Hafellner 1984*, Vaino 1934

Agonimia Zahlbr.

Introduction

Of the three species in the extensively distributed
genus, one is in Germany. The thallus consists of
greenish squamules bearing black perithecia,
which in the case of A. tristicula show a conic or
barrel-like form and a warty-folded upper
surface. The large spores are multicellular
muriform.

A. tristicula grows on mosses over base-rich
substrates, e.g. over calcareous rocks, rarely on
old, mossy deciduous tree trunks. The species
occurring in western Europe from the
Mediterranean region to the high north is rarely
found up to now in central Europe, however it
has certainly been overlooked.

Genus Characteristics

Thallus of very small squamules, in non
indigenous species also coarse granular, light
green-gray or blue gray to brownish. Squamules
rounded to elongated, often incised, with
paraplectenchymatous cortex, cells on the upper
surface with short papillae. Photobiont coccoid
green algae. Per. spherical to keg-form or
irregularly conical. Exc. outside brown, interior
light to colorless. Per. in the upper part with
numerous simple to sparsely branched
periphyses. Paraphyses lacking. Asci thin-
walled, scarcely thickened above, I-, Sp. to 1, 2
or 8, colorless to pale brown, ellipsoidal,
muriform multicellular. Ch-

Ecology and Distribution of the Species

Agonimia tristicula (Nyl.) Zahlbr.
Predominantly in hilly to montane, mild climate,
often oceanic sites on bark and on mosses on old
tree trunks, on mosses over rock, commonly in
half-shaded habitats in light forests, near brooks,
as a rule on subneutral (to moderately acid).
often somewhat decayed bark, e.g. on Ash, or
Oak, e.g. with Normandina, Candelaria reflexa,
in the Lobarion, Acrocordietum gemm.,
subneutroph., r.hygroph., anitroph. – bor-med,
subatl – (r.)rare, easy to overlook, since often
sterile; Sch, Ne, Ju, SJu

Lit: Coppins & James 1978, James in Poelt & Vezda
1981.

Alectoria Ach.

Introduction

Alectoria includes yellow to pale greenish-yellow
or even blackish fruticose lichens of bushy erect
to beard-like pendant growth forms with rounded
stalks to slightly flattened segments. The
apothecia have brown disks with a thalloid
margin, the species remain however commonly
sterile. After removal of the greater part of the
species as the genus Bryoria the genus contains
eight species mainly distributed in the boreal
zone, of which two are indigenous to Germany.

A. sarmentosa lives in oceanic, rainfall and
snow-rich mountain sites in predominately near
natural pine thickets, Fir- and Spruce forests on
the branches of the trees. Because of air
pollution, however even given intensified
forestry science the species has regressed in the
last ten years, and still appears mostly in a
meager form and is strongly threatened. Its area
stretches over the boreal pine forest zone and the
mountain sites of central Europe and the
Mediterranean region. A. ochroleuca, an arctic-
alpine species of the dwarf shrubby heath and
turf above the tree line, occurs in the neighboring
Allgäu, very rare relics in the Vogesen, in the
Bohemian Forest and a few other central
European central mountains (here extremely
threatened).

Genus Characteristics and Determination

Thallus shrubby erect to beard-form pendant,
light green-yellow or (not in Germany) brown-
black, with rounded stalk to weakly flattened,
sometimes streaked on the axles of the branches,
with whitish, fusiform pseudocyphellae. Without
isidia or soralia. Thallus sections ± radially
symmetrical, cortex of periclinal, elongate,
packed hyphae, which are imbedded in richly
developed, thick (usually over 40 µm),
cartilaginous substance. Medulla commonly of

1 Thallus gray-black to dark brown, base rose-gray to light gray-brown, shrubby erect, branch up to 1.5 mm thick, stem round, base somewhat flattened. Medulla K+ yellow, C+ red, P+ yellow. Aleotoriadic acid, Barbatolic acid. – arct-alp – Alps, Sudenten A. nigricans (Ach.) Nyl

2 Thallus without pseudocyphellae, delicate, with small punctiform soralia on the short tips, often curved back side branches. (Usnic acid)

2* Thallus pale yellow to light yellow-green. (Usnic acid)

3 Thallus almost exclusively on trees, ± long pendent, -30 cm, isotonic-dichotomously branching. Principal axis flattened and long streaked. Soralia rarely appearing. Ap. rare, disk ochre, brown to almost black. Medulla KC- or KC+ rose, UV+ bluish-white. ± Aleotoromic acid, Squamatic acid. * A. sarmentosa


Ecology and Distribution of the Species

*Alectoria ochroleuca* (Hoffm.) Massal
In open to the wind alpine and subalpine places on acid soil on sites snow-free relatively early, on habitats with strongly fluctuating moisture conditions, rarely descending below the tree line, then on light-rich, but shaded surfaces of silicate rock or on mosses between boulders, m.-r.(v.)acidoph., (r.skioph.-)m.-r.photoph., anitroph., in the Usneion, but scarce in the Evernietum dir. – bor-smed-mo(-med-mo) – rare (2); süSch (above 900m), nöSch (v.rare), Vog, Al, ThW+


*Amandinea* Choisy ex Scheideg. & Mayrhofer

(Determined ↑ Buellia)

Introduction

This segregation of the *Buellia* genus includes the crustose lichens with two-celled brown spores, but deviates in the form of the pycno-spores, *A. punctata* very widely distributed in Europe, principally on bark, but also occurring on silicate rock.

Genus Characteristics


Ecology and Distribution of the Species

*Amandinea punctata* (Hoffm.) Coppins & Scheideg. (*Buellia* p. (Hoffm.) Massal., B. punctiformis (Hoffm.) Massal., B. myriocarpa (DC.) De Not.)
Up into the high montane (subalpine) places; rather substrate vague, on trunks of Deciduous and conifers, on tough decaying wood (fence posts etc.), rare on silicate rock, commonly on r.-m.acid, ± eutrophic bark, also on rather rain sheltered sites, avoiding trees with primarily subneutral bark or only residing in a secondary acidification (by emissions), commonly on freestanding trees, on wall surfaces, in
settlements, m.-v.acidoph., m.-r.(s.)photoph., a-to r.nitroph., r.toxitol., above all in the Parmelietum cap. and (air polluted regions) in the Buellietum punctatae – (arct-bor-med – frequent to very frequent throughout the entire region, in the south (above all in calcareous regions) rarer.


Amygdalaria Norman

(Determined ↑ Lecidea PT 5/PT 6)

Introduction

The Amygdalaria species are crustose lichens with sunken black, lecideine apothecia, green algae as symbionts and in addition blue-green algae in brown cephalodia. Of the up till now, eight species exclusively living on silicates, which are very closely related to the Porpidia genus, three occur in Germany, A. consentiens (very rare in the Bavarian Alps), A. pelobotryon (very rare in the Rhön) and A. panaeola, an arctic-alpine lichen, which is known from the high Black Forest, Bohemian Forest and from the Rhön and grows on sites that are relatively long snow-covered, cool moist on low rocks.

Genus Characteristics

Thallus crustose, clearly developed, of flat to convex areoles, beige, gray, or brown, often rose tinted, with brown-red (to gray) cephalodia between the areoles, sometimes with soralia. Photobiont Trebouxia-like green algae, Stigonema in the cephalodia. Ap. sunken, Aspicilia-like with thalloid margin, rarely sitting up, black to brown-black, flat to concave, sometimes with a navel, without definite, rarely with proper margin. Exc. commonly weakly developed and then, rarely (not in the species occurring in Germany) clearly developed, brown. Hyp. black-brown. Hym. I+ blue, of paraphysoid-like, branched and reticulate, hyphae shrunk toward the ends and at the septae. Epithym. brown to brown-black. Asc narrow clavate, of the Porpidia-type. Sp. 1-celled, ellipsoidal, when young surrounded by a slime halo. Pycnosp. bacillar. Ch: often with Gyrophoric acid.

Ecology and Distribution of the Species

Amygdalaria panaeola (Ach.) Hertel & Brodo (Lecidea p. (Ach.) Ach.

In high montane to alpine, rarely montane places on moist neutral to basic silicate rock (mineral-rich Gneiss, Slate, basalt etc.) on high precipitation, longtime snow covered, cool, rather light-rich, usually away from the sun habitats, e.g. in boulder slopes, maritime boulders, single boulders in thin turfs, subneutroph.-m.acidoph., m.-r.photoph., nitroph., e.g. in the Porpidion tub. – arct-mieur-h’mo/alp – (v.)rare, because of removal of stones (2); süSch, Vog, He (Meissner, Rhön, je lx), BayW

Amygdalaria pelobotryon (Wahlenb.) Norman (Aspicilia p. (Wahlenb.) Th.Fr.)

Rather like A. panaeola – arct-bor(-mieur-h’mo) – very rare; Rhön (1x)

LIT.: Brodo & Hertel 1987

Anaptychia Körber

(Determined ↑ Physcia)

Introduction

The perhaps 10 species of the genus are gray or brown, narrow lobed fruticose and foliose lichens with flat lecanorine apothecia with dark brown to black disk and greenish to brown-black two-celled spores. In a few species – as in the case of A. ciliaris – the ends of the thallus lobes are conspicuously bristly ciliate.

Only A. ciliaris has been recorded in the region. It lives on mineral-rich, often slightly dust impregnated bark of deciduous trees on light-rich habitats, often on avenue trees. The lichen is as a result of developing air pollution strongly in decline. Formerly distributed over the entire Baden-Württemberg region, it is today disappearing in the north and northwest. The European area stretches from the Mediterranean area up to southern Scandinavia.

Genus Characteristics

Thallus fruticose, segments branched, dorsiventrally flattened, upper side gray to
brown, sometimes (as in *A. ciliaris*) velvety hairy because of hyphae extending from the upper cortex, with one of the thick walled packed, pericinal oriented hyphae making up the cortex, underside without cortex and without rhizines or (non indigenous species) with cortex and with rhizines. With green algae. Ap. ± stalked, with permanent thallloid margin and darker, sometimes pruinose disk. Hyp. colorless to yellow-brown. Eiphym. brown. Paraphyses branching above and ± thickened, scarcely cemented. Ascii of the *Lecanora*-type. Sp. dark brown, 2-celled, ellipsoidal, some narrowed at the septum, uniformly thin-walled, with finely areolate or warty upper surface. Pycn. in small warts, pycnosp. short fusiform. Ch: ± Atranorin, Zeorin (non indigenous species e.g. also without lichen substances).

Ecology and Distribution of the Species

**Anaptychia ciliaris** (L.) Körber ex Massal.
In the high montane zone, in lower places though strongly in regression only yet partially, above all on old freestanding deciduous trees on cracked, mineral-rich, also (lime) dust impregnated bark, overgrowing moss, mostly on avenue and field trees (above all ash, linden, maple), sometimes also in illuminated mountain forests, very rare on rock, optimal today on moderate- to rather- high precipitation, rather open to the wind sites, subneutroph., mesoph., (a-)m.(-r)nitroph. (yet sensitive to ammonium), Char. Parmelietum ac., also in the Lobaria – s’bor-med-mo – rare (3); in not reduced specimens almost only still in SJu, Ju, süSch, Av, Al, besides SFW, Bo, Ne; Mn, Rhôn, Eif. O and süRh almost +; formerly in the entire region, e.g. in Th, frequent.

Lit.: Lyng 1935

**Anema** Nyl. ex Forss.
(Determined ↑ Phylliscum)

Introduction

The *Anema*-species are blue-green algae lichens with thalli of small, few millimeter wide, blackish, mostly slightly organized squamules or rosettes, which are attached to the substrate with a navel. In the moist state they swell up gelatin-like. The lecanorine margined apothecia are sunken. The three species recorded in Germany of the rather small genus occur on calcareous rock on surfaces occasionally flooded by seeping water on warm habitats. *A. tumidulum* is until now known from dry-warm valleys in Moravia, lower Austria, south Germany and south Norway. *A. decipiens* occurs from the Mediterranean region up to the warm region of central Europe and into Norway.

Genus Characteristics

Thallus clod-like, squamulose to shield-form and then umbilicate and often appearing lobed, black, sometimes pruinose, of a somewhat gelatin consistency, unstratified, of one ± thick hyphal net with embedded blue-green algae with yellow-brown colored gelatin enveloped (*Gloeocapsa*) at the thallus margin. Ap. sunken, with punctiform opening, later opening wide, lecanorine. Exc. not developed. Hyp. light. Hym. I+ blue. Paraphyses unbranched, septate. Ascii clavate, often regenerated at the tips, with a very thick gelatin envelop in the upper part. Sp. to 8 or less, 1-celled, ellipsoidoidal. Ch-.

Ecology and Distribution of the Species

**Anema decipiens** (Massal.) Forss.
On limestone, rarely calcareous silicate rock, on sunny, from time to time seep moistened rocks like *Thyrea* (↑), e.g. in the Psorothchion schaer. – (s’bor-)mieur-med – rare; SJu, Ju, FrJu, Ne, süHü

**Anena tumidulum** Henssen ined. (A. moedlingense auct.)
On calcareous or basic silicate rock (e.g. basalt, green stone), rarely calcareous sedimentary rock, on sporadically seep moistened surfaces on warm habitats, like *Peltula* (↑) – mieur-med? -- very rare (1); süSch (1x), Ju (1x), Lahn (1x)


**Anisomeridium** (Müll.Arg.) Choisy
(Determined ↑ Arthopyrenia)
Introduction

The genus *Anisomeridium* with its thin or embedded in the substrate crustose thallus, the black perithecia and the two- to many-celled spores is reminiscent of *Arthopyrenia*, however it is distinguished by a series of anatomical characters, e.g. in ascus structure. They include above all species occurring in the subtropics and mild temperate regions. Two lichenized species occur in Germany. *A. nyssaegenum* lives in mild places on subneutral deciduous tree bark and is distributed in western Europe up into central Scandinavia.

Genus Characteristics

Thallus crustose, thin to in the substrate, whitish to gray, with *Trentepohlia*. Per. sunken to sessile, hemispherical to globose. Exc. ± dark, light toward the base, with or without involucrellum. Involucrellum without incorporated tissue of the tree bark. Hym. I-. Pseudoparaphyses thin, branched and bound, periphyses lacking. Asci cylindric-clavate, K/I-, fissitunicate, with tholus and indefinite or shorter and wider ocular chamber. Sp. 1- to 2 series, 2- to 4-celled, egg shaped to clavate-fusiform, the middle septum often somewhat shifted toward the end of the spore, smooth, without perispore. Pycn. sunken to sessile and globose to conic protruding, black. Pycnosp. in two types, almost spherical, ellipsoidal, egg- shaped to short cylindric, sometimes – embedded in a gelatinous substance – becoming free as packets. Ch-.

Ecology and Distribution of the Species

**Anisomeridium biforme** (Borrer) R.Harris (Arthopyrenia biformis (Borrer) Massal.) In hilly and submontane, winter mild, rather oceanic places on smooth to cracked bark, above all on trunks of older deciduous trees in light forests (e.g. Oak-Hornbeam forests), m.acidoph., m.photoph., r.-s.hygroph., anitroph., Char. Acrocordietum gemm. – mieu-atl-smed – v.rare (+++); Eif

**Anisomeridium nyssaegenum** (Ellis & Everh.) R.Harris (Thelidium juistense Erichsen) In hilly and submontane, rather winter mild places on humid habitats in pasture trees, Ash stands along brooks, oak-hornbeam forests, on subneutral bark above all on ash, similar to *Acrocordia gemm.* (†), *Arthonia cinn.* (†), but usually more basal on the trunk of cracked bark, (r.skioph.-m.(-r.) photoph., hygroph., anitroph., in the Acrocordium gemm. – mieu-subat-med – r.rare (-m.frequent), overlooked; e.g. Rh, O, Sch, Ne, SFW, Eif


**Arthonia** Ach.

Introduction

*Arthonia*, with several hundred species of one of the most significant lichen genera, including crustose lichens with mostly thin, undifferentiated often scarcely visible or living in the substrate, whitish, gray to brownish thallus and rounded to irregularly formed, lobed, branching or star-formed, brown to black or cinnabar red fruiting bodies without definite margins and with cross-septate spores. Symbionts are *Trentepohlia*-, rarely coccoid green algae. Some species are lichen dwelling fungi, as *A. clemens*, *A. fuscopurpurea* and *A. glaucomaria*.

The indigenous lichenized species (ca. 27 of the 34 are recorded in Germany) live entirely preferably on bark in forests and tree stands along brooks on radiation protected, rather humid sites. *A. cinnabarina*, *A. dispersa*, *A. elegans*, *A. galactites*, *A. patellulata*, *A. punctiformis*, *A. radiata*, *A. reniformis*, *A. stellaris* and *A. zwackii* “prefer” smooth bark of deciduous trees and sometimes also fir, *A. patellulata* and *A. galactites* especially poplar, the remainder hornbeam and ash. Here is often also found *A. spadicea*, which however also occurs on smooth bark – almost always at the base. *A. leucopellaea* and *A. vinosa* usually sit on older fir and spruce.

The few indigenous rock-dwelling live on more or less rain- and wind-protected overhangs of silicate rock and boulders, e.g. maritime boulders and in narrow valleys, like *A. arthonioides*, *A. endlicheri* and *A. insulata*. *A. lapidicola* grows on calcareous rock, especially on small stones lying on soil.

Almost all indigenous species (differing behavior usually reflects ecology) avoid dust impregnation or manuring of the habitat. One
such progressive eutrophication of the habitat by nutrient-rich dust has likely substantially contributed to the pronounced regression of Arthonia species. Numerous species are in recent years no longer to be found; almost all were limited to lower sites, the especially strongly altered clean-air species, however also have been subject to other human engagements (e.g. development, forestry and farming).

By far the most of the indigenous species of the genus represented principally in tropical regions, prefer mild to moderately cool regions and fail to break into the boreal zone.

Numbering in this group of species with principal regions, prefer mild to moderately cool regions and fail to break into the boreal zone.

Numbering in this group of species with principal area in central European, summer-green deciduous forest region to partially in the Mediterranean region are deciduous forest region to partially in the area in central European, summer-green deciduous forest region to partially in the Mediterranean region up into central Europe. For example, Quercus robur (toward the north up to perhaps the distribution boundary in the region is reached), A. byssacea, A. caesia, A. cinnabarina, A. elegans, A. endlicheri, A. fuliginosa, A. insulata (where the northernmost boundary in the region is reached), A. medusula, A. byssacea and A. spadicea; with exception of the latter, which penetrate toward the north up to perhaps the distribution boundary of pedunculate oak (Quercus robur), not reaching Scandinavia or only in the extreme south or southwest (A. arthonioides, A. cinnabarina, A. pruinata, A. stellaris). A. punctiformis and A. vinosa are distributed from the Mediterranean region up into central Fennoscandia, whereby finally advancing further toward the north. Many Arthonias presumably avoid (north-) western Europe and the extensive mediterranean zone, thus A. byssacea, A. caesia, A. cinereoprunosa, A. insulata and the central Sweden occurring A. helvola. A. galactites is distributed from the Mediterranean region over western Europe to south England and central Germany. A. leucopellaea is native from southern Scandinavia and from Great Britain to the north German lowlands as well as in central European mountains (Black Forest, Vogesen, Bohemian Forest, Alps, Tatra, et al.). The area of A. radiata, A. dispersa, presumably also A. patellulata and A. lapidicola, reaches over the greatest part of Europe.

**Genus Characteristics and Determination**

Thallus crustose, undifferentiated, thin or into the substrate, with Trentepohlia, rarely coccoid green algae, lacking in the case of saprophytic or parasitic species. Ap. very variously formed, rounded to elongate or branched to star-form, red-brown to black, sometimes whitish or red pruinose, without thalloid- and without proper margin. Exc. lacking or reduced. Hyp. indefinite to definite, colorless to dark. Epiphym. colorless to red-brown or dark brown. Hym. colorless to yellowish, brownish or reddish, I+ orange, red or blue. K/I+ blue. Paraphyses richly branching and reticulate bound, ends often thickened and with pigmented cap. Asc. clavate, bulging to almost spherical, with thick tholus, often with definite ocular chamber. Sp. usually colorless, 2- to 8-celled, cross-septate, usually egg-shaped to fusiform. Pycnospor. as a rule short cylindric to ellipsoidal. Frequently Ch-.

**Key Part 1:** Lichenized, with thallus

**Key Part 2:** Not lichenized, living on the thallus or in the apothecium of lichens

### **Key Part 1: Lichenized Species**

1. Thallus on rock
2. Thallus on bark, rarely on wood
3. On lime-rich rock. Thallus with pure green algae, indefinite to scurfy-warty, gray to brownish. Ap. black, almost sunken to protruding, rounded to irregularly angular, flat to convex, -0.5 mm. Epiphym. red-brown, Hyp. ± dark brown, also olive tinged. Sp. 2-celled, 11-18 x 4-7 µ, shrunken at the septum, cells unequal. Thallus R-

#### A. lapidicola

2*. On silicate rock. Thallus with Trentepohlia algae (when scratched, gold-brown to orange)


3*. Hyp. light. Ap. pruinose, flat, thallus yellowish-white, C+/KC+ red, K± yellowish, P-

4. Sp. 2-celled, 10-16(19) x 4-6 µ, colorless, finally pale brownish, warty. Ap. rounded to shortly elliptical, flat, ± margined, -0.35 mm, with clearly developed exc. Hym. pale brown. Thallus very thin, yellowish to brownish.

#### Melaspilea granitophila

4*. Sp. (3-)4-celled, ± wedge-form (cells unequal in size), 12-16 x 4-6 µ. Ap. rounded to rarely elliptical, almost flat to convex, -0.8(1) x 0.5 mm. Thallus rose, whitish in the herbarium, yellowish-white to pale greenish, thin to thick, pliable, scurfy to mealy

#### A. Arthonioides

5. Thallus of scattered, not coherent granules. Ap. often rare, light blue pruinose, rounded to lobed, -0.6 mm. Sp. usually 4-celled, 12-18 x 6-7 µ.

#### A. insulata

5*. Thallus coherent, moderately to rather thick, very uneven, tubercular, almost lobed at the margin, dull, often finely uneven, pale rose, brownish-gray in the herbarium, usually partially sorediate. Ap. very rare, thickly grayish pruinose, irregularly angular to boxed, -0.8 mm. Sp. 4-
6-celled, 14-20 x 5-7 µm. Pycn. numerous, 0.1-0.2 mm wide, sunken to wart-like, pycnospor. 15-25 x 1 µm. Lecanoric acid A. endlicheri

6 Sp. 2-celled. Ap. dark brown, brown-black, or black, oftentimes pruinose...

7* Sp. at least 3-celled.

7 Ap. elongate, linear to winding, simple of branched, -1 mm long, 0.2 mm wide, blackish. Hym. and sp. often weakly developed (relatively ephemeral lichens), epihym. olive-green, olive-brown, or black-brown, hyp. colorless. Sp. mostly (10)12-14(15) x 3-5 µm. Thallus very thin, with Trentepohlia A. dispersa (Sp. 15-18 x 5-7 µm, epihym. light brown or olive, at the side a dark brown exc.-like zone developed, atl: A. excipiend (Nyl.) Leighton)

7* Ap. rounded to fleck form.

8 Hym. K+ red, purple or violet.

8* Hym. without this reaction.

9 Ap. black, round, rarely elliptical, -0.8 mm, flat. Thallus without algae (algae possibly occurring very isolated), whitish, K+ yellowish, without prothallus. Epiph. black-brown, hym. ± yellowish or brown. Sp. 11.5-15 x 3.5-5 µm, egg-shaped, surface often somewhat irregular. Pycnosp. 11-16 x 0.7 µm, strongly curved.

A. galactites

9* Ap. at least not black when moist, but with a reddish tone. Thallus with Trentepohlia-algae

10 Sp. 7-10 x 3-4 µm, colorless, cells often somewhat unequal in size. Ap. red-black to blackish, deep red-brown when moist, compressed, usually scarcely convex, mostly rounded, -1(1.5) mm. Hym. usually brownish to orange-brown, K+ indefinite purple (pigment not soluble in K). Hym. brown-red, Sp. 3-celled, 8-12 x 3-5 µm. Thallus without cortex and indefinite of thin, greenish to olive (never orange), often smooth, R-.

A. spadicea

10* Sp. larger, colorless, often brown and warty when older.

11 Ap. sunken (often not projecting above the thallus), irregularly rounded to mostly short lobed, elongate distorted, fleck- to almost star-form (branched), ± flat, red-brown to brown-black, -0.5 mm. Sp. 12-18 x 5-7 µm, cells slightly to definitely unequal, with warty upper surface, brown when old. Hyp. red-brown to black-brown, K- or K+ olive or red. Epiphym. almost colorless, yellowish, even red-brown. Hym. ± colorless and K- or K+ olive-green or hym. brownish and K+ violet-red. Thallus very thin, yellowish-white to gray-olive or brownish, R-. Pycnosp. 3.5-4 x 0.7 µm

A. didyma

11* Ap. sessile, mostly rounded, convex, red-brown to dark brown to almost black (when moist ± brown-red), more rarely red-orange, -0.8 mm. Sp. 10-17 x 4-7 µm, cells mostly equal size, with finely warty upper surface, sometimes brown with age. Hyp. ± brown-red. Epiphym. scarcely developed, hym. reddish-yellow to brownish, K+ purple. Thallus mostly ochre to orange (K+ red), more rarely yellowish to yellowish-gray. Pycn. frequent, pycnospor. 4-6 x 1 µm. ?Anthraquinone.

A. vinosa

12 Thallus with Trentepohlia-algae. Ap. red-brown to black-brown, rounded to appearing boxed, fleck-form, ± flat, mostly not projecting above the thallus. Sp. 12-18 x 5-7 µm

A. didyma

12* Thallus with true green (protoccoid) algae, sp. narrower, with unequal sized cells. Ap. black, round. R-


A. patellulata

13* Paraph. ends with brown walls and bending away from the hym. upper surface. Paraph. very thin. Hyp. yellow-brown to brown-red. Ap. flattened to hemispherical, -0.4 mm. Thallus gray-green to olive green.

14 Ap. sessile to depressed, flat to convex, rounded to irregular in outline, -0.4 mm. Paraph. ends with a brown cap, sp. (9)11-16 x (2.7)3.5-5(6) µm. Hyp. colorless to yellow-brown. Thallus smooth to granular.

A. apatletica

14* Ap. sessile narrowed at the base, convex, ± marginless, -0.25 mm. Paraph. ends without brown cap, epihym, greenish-brown or reddish-brown. Sp. 8-12 x 2.3-3.8 µm. Hym. pale olive or colorless. Hyp. brown-red, K-/K+ dark olive-brown. Thallus granular A. muscigena

15 Ap. (mostly only at the margin of the disk) red cinnamon brown to purple-brown. (epi-) hym. K+ purple, purple-violet, red. With Trentepohlia-algae.

15* Ap. dark brown, brown-black, or black, sometimes whitish pruinose. Hym. K- or K+ olive

16 Sp. 3-celled, 8-12 x 3-5 µm. Ap. rust-red, strongly red-orange when moistened, rounded to elongate, flat, depressed to almost sunken, -0.8 mm, often coalescing. Hym. yellow-orange to red, K+ purple to violet.

A. helvola

16* Sp. 4-6(7)-celled. Ap. numerous, rounded, streaked to star-form branching, epiphym. ± red-brown, K+ red to purple. Thallus whitish to ochre. Anthraquinone.

A. elegans

17 Ap. cinnamon brown to dark purple-brown, nonpruinose, -0.8(1.0) x 0.2 mm, streaked, with pointed ends, often branching to star-form (then larger). Hyp. -45 µm, colorless to pale yellow-reddish. Sp. 12-17(19) x 4-6(7) µm, 4-5(6)-celled, often weakly developed.

A. elegans

17* Ap. brown-red, at the margin shiny cinnabar-red pruinose, in the center usually whitish pruinose, -1(1.5) x 0.7 mm, four angled, lobed, rarely streaked. Hym. 60-70 µm. Epiphym. K+ red to
21* Thallus with true (protococcoid) algae, whitish to gray-greenish, granular-scurfy to mealy, herbarium specimens covered with fine needle crystals. Ap. rather rare, bluish-gray pruinose, ± rounded, sitting up, ± flat, -0.6 mm. Epiphym. and hyp. dark red-brown. Sp. 4-celled, shrunken at crystals. Ap. rather rare, bluish-gray pruinose, -0.3 mm. Pycn. numerous, ± sunken to depressed sessile.

19* Thallus with *Trentepohlia*-algae, whitish, gray-to yellowish-white, not granular-leprose

19 Thallus of *Lecanactis amylacea* (When sp. longer, thallus with whitish pycnidia, see *L. abietina*)


18 Ap. pruinose, underneath blackish or brown

17 Thallus of *Lecanactis amylacea* (When sp. longer, thallus with whitish pycnidia, see *L. abietina*)

16* Ap. round, sessile, often with whitish cob webby margin, often uneven, -2 mm, always occurring. Sp. 4-5 celled, (9)12-17(19) x (3)4-4.5(5) µm, upper sp. cell not enlarged. Without pycn. Thallus whitish, cream colored, cobweb-like to scuffy or indefinite. Unknown lichen substances

15* Ap. black, thick white pruinose, ± sunken to closely depressed sessile. Sp. 4-celled, 14-27 x 2-3 µm. Unknown lichen substances. Thallus with hyp. dark red-brown. Sp. 4-celled, shrunken at crystals. Ap. rather rare, bluish-gray pruinose, -0.3 mm. Pycn. numerous, ± sunken to depressed sessile. Pycnosp. 5-6 x 1.2 µm

14-27 x 2-3

14 Thallus cracked, strongly developed, gray-to yellowish-white, K-, C+/-KC+ red, P-. Ap. brown, thickly bluish-white pruinose, numerous, ± crowded, rounded, angular or lobed, -0.6 mm. Epiphym. red-brown. Sp. 4-5 celled, upper cell not enlarged, 13-24 x 4.5-7 µm. Pycn. rare, pale to red-brown, pycnosp. 10-16 x 0.5-0.7 µm. (Aronia acid)

13 Thallus C-/KC-, K- or K+ yellow/red. Yet insufficiently clarified group

12* Ap. pruinata

12 Thallus C-/KC-, K+ or K+ yellow/red. Yet insufficiently clarified group

11* Thallus C-/KC-, K- or K+ yellow/red. Yet insufficiently clarified group

11 Epiphym. blue-black (dark olive-brown), K+ greenish. Sp. 9-18 x 2-3 µm, usually 4-5 celled, uppermost cell not enlarged. Ap. often sparse, blackish, sometimes dark gray pruinose, elongate to richly star-form branched, flat, sunken, -2 mm. Thallus P-, K-/+ yellowish. Pycn. frequent, blackish, often white pruinose, somewhat protruding. Pycnosp. 5-6 x 1.2 µm

10* Ap. round, sessile. *Lecidea*-like, flat to moderately convex, black, 0.2-0.5 mm. Paraph. ends slightly thickened, in gelatin, with definite brown caps. Hyp. colorless to red-brown. Sp. (11)13-16(18) x 3.5-5 µm, 4(5) celled. Thallus thin, membranous, light yellowish to whitish.

9* Ap. irregularly rounded to lobed, brown to brown-black, flat to uneven, often over 0.5 mm. Paraph. ends not thickened, often free, without definite caps. Sp. (9)12-17(19) x (3)4-4.5(5) µm, 4-5 celled

8 Thallus of *Lecanactis amylacea* (When sp. longer, thallus with whitish pycnidia, see *L. abietina*)

7* Ap. without margin

7 Ap. black, thick white pruinose, rounded to elliptical, convex, -1 mm, often lacking. Sp. 4-6 celled, 13-23 x 5.8 µm, one of the end cells usually definitely larger. Pycn. numerous, blackish, usually white margined, -0.3 mm. Pycnosp. 5-6 x 1.2 µm, often with apparent two part content. Thallus white, definitely developed, coherent

6* Ap. dark brown to black, weakly pruinose (then ± gray) to nonpruinose, irregularly rounded to lobed, often with whitish cob webby margin, often uneven, -2 mm, always occurring. Sp. 4-5 celled, (9)12-17(19) x (3)4-4.5(5) µm, upper sp. cell not enlarged. Without pycn. Thallus whitish, cream colored, cobweb-like to scuffy or indefinite. Unknown lichen substances

5* Thallus cracked, strongly developed, gray- to yellowish-white, K-, C+/-KC+ red, P-. Ap. brown, thickly bluish-white pruinose, numerous, ± crowded, rounded, angular or lobed, -0.6 mm. Epiphym. red-brown. Sp. 4-5 celled, upper cell not enlarged, 13-24 x 4.5-7 µm. Pycn. rare, pale to red-brown, pycnosp. 10-16 x 0.5-0.7 µm. (Aronia acid).

4 Thallus C-/KC-, K- or K+ yellow/red. Yet insufficiently clarified group

3 Epiphym. blue-black (dark olive-brown), K+ greenish. Sp. 9-18 x 2-3 µm, usually 4-5 celled, uppermost cell not enlarged. Ap. often sparse, blackish, sometimes dark gray pruinose, elongate to richly star-form branched, flat, sunken, -2 mm. Thallus P-, K-/+ yellowish. Pycn. frequent, blackish, often white pruinose, somewhat protruding. Pycnosp. 5-6 x 1.2 µm

2* Thallus of *Lecanactis amylacea* (When sp. longer, thallus with whitish pycnidia, see *L. abietina*)

1 Ap. round, sessile. *Lecidea*-like, flat to moderately convex, black, 0.2-0.5 mm. Paraph. ends slightly thickened, in gelatin, with definite brown caps. Hyp. colorless to red-brown. Sp. (11)13-16(18) x 3.5-5 µm, 4(5) celled. Thallus thin, membranous, light yellowish to whitish.

0 Thallus of *Lecanactis amylacea* (When sp. longer, thallus with whitish pycnidia, see *L. abietina*)
linear, sunken, ± flat, -2 mm.  epiphy. dark red-brown.  K+ greenish, hyp. ± light.  Thallus
whitish to ochre-yellowish, coherent, often with brown prothallus. With center running lichens
substances A: 2-3. Very rare oceanic lichen

A. stellaris

30* Uppermost cell not noticeably enlarged.  Ap. black, flat to moderately convex, commonly not
repeatedly branched.  Epiphy. black to dark brown or greenish

31 Thallus under the bark, scarcely visible, without algae.  Ap. rounded, elliptical to elongate-streak
form, rarely branched, often with apparent margin of tree bark tissue, -0.8(1.4) x 0.4 mm, in
section 40-60 µm high.  Hym. 25-50 µm, µm, ± blue.  Sp. 4(5) celled, 13-23 x 4-7(8)
µm.  Hym. and sp. often poorly developed.  Ch.-

A. punctiformis

31* Thallus over the bark, clearly visible, thin, membranous, usually whitish to greenish, rarely
ochre-yellow, with Trentepohlia-algae .  32

32 Sp. 6-7 celled, 13-20 x 4-5 µm.  Ap. -1(1-5) mm,
only crowded and coalescing, fleck like, rounded to irregular, often unevenly wrinkled.
Hym. ± orange.  Epiphy. blackish.  Thallus strongly wrinkled, somewhat shiny

A. reniformis

32* Sp. 4-, rarely to 5 celled, 15-20 x 4.5-6 µm, sometimes slightly wedge-form.  Ap. -1.5 mm,
usually lobed or branched or irregularly angular, rarely rounded to elongate, brown to black,
sunken, ± flat.  Hym. colorless or slightly brownish, 1+ blue, epiphy. brownish or greenish, K+
epiphy. colorless.  Thallus rather variable

A. radiata

Key Part 2: Species living on Lichens
(selection)

1 Sp. 2 celled .  2
1* Sp. 3-4 celled, elongate-egg shaped
2 Ap. developed in the hym. of lichens of the
Lecanora dispersa group and blackens the ap.
disk of that species, 0.1-0.4 mm, black, rounded,
flat to moderately convex.  Sp. 9-15 x 3-5 µm,
colorless  A. elemens  (Tul.) Th.Fr.
2* Ap. develops on the thallus of foliose lichens
3 On Peltigera (lactucifolia).  Ap. 0.5-1.5 mm,
red-brown to brown-black, rounded, flat to convex,
often surrounded by light dying host tissue.
Epiphy. orange- to red-brown, hym. pale orange-
to red-brown variegated.  Paraph. 1.5-2.5 µm.
Sp. 9-15 x 3-5 µm.  With red-brown pycn. (in
groups or at the margin of the ap.) .  A. fuscopurpurea  (Tul) R.Sant.
0.1-0.35 mm, often crowded, rounded, convex.
Epiphy. brown, hyp. colorless to dark red-
brown.  Paraph. 1.4-2.5 µm.  Sp. 10-14 x 3.5-5
µm, colorless.  Without Pycn.  A. epiphyscia Nyl.
4 Ap. in the hym. of Lecanora rupicola and
blackening their disk, 0.3-1 mm, black, with the
upper surface of the host disk breaking open or
vaulting over it.  Epiphy. brown to olive-brown,
K+ greenish, hyp. colorless.  Paraph. 1.5-2 µm.
Sp. 11-17 x 5-6.5 µm, (2)3-4 celled .  A. glaucomaria Nyl.

4* No distinct ap. developed.  Asci and paraph of
the fungus between those of the host.  Paraph.
1.5-3 µm thick, thickened above by olive-brown
pigment up to 5.5 µm.  Sp. 12-17(20) x 3.5-5(6)
µm, colorless  A. intesa Almq.

Ecology and Distribution of the Species

Arthonia arthonioides  (Massal.) Th.Fr. (?A.
exilis auct., Allarthonia e. auct.)
Above all only (high)montane zone on cracked
bark of deciduous trees, e.g. oak, in
oak-hornbeam forests. – (s‘bor-)mieur-sméd –
süHü, at this time. insufficiently known

Arthonia arthonioides  (Ach.) A.L.Sm. (A.
xylophila V.Wirth & P. James, A. aspersa
Leighton)
Up to montane sites on radiation- and wind
protected overhanging surfaces on silicate rock,
favoring sandstone, commonly also on bark of fir
(and wood) in old near natural forests, on cool-oceanic, very humid or high rainfall habitats,
readily on maritime boulders, rather acidoph.,
anombroph., (m.potoph.-)r.skioph., anitroph., in
community of the Chrysotrichetalia chlor. –
mieur- (sub)atl(-med-subatl) – v.rare (R); nöSch,
O, ThW, Lux

Arthonia byssacea  (Weigel) Almq.
In hilly and submontane sites in deciduous forest,
especially pasture forests, cool oak-Hornbeam
forests, almost only on old oak with deeply
cracked bark on rain sheltered places in the lower
stem region in species-poor habitats, r.acidoph.,
ąnombroph., (m.potoph.-)r.skioph., anitroph., in
community of the Chrysotrichetalia chlor. –
mieur- (sub)atl(-med-subatl) – v.rare (R); nöSch,
O, ThW, Lux

Arthonia caesia  (Flotow) Arnold (Allarthonia c.
(Flotow) Zahlbr.)
In hilly and submontane sites in deciduous
forests, especially Hornbeam, m.acidoph., in
Graphidetalia-community – mieur – v.rare (?,
only rarely fruiting and overlooked or confused with Lepraria species; O, HRh

Arthonia cinereopruinosa Schaerer
In hilly to (high)montane sites in mild winter regions on deciduous and conifer trees, especially on mineral-poor bark, such as oak, spruce and fir, in the interior of forests (e.g. oak-hornbeam forests), on rather- to very shady, rather humid, rather rain-sheltered habitats, r.acidoph., anitroph., in the community of the Leprarian inc. – s’bor-mieur – v.rare (0); süHü-HRh (around Lörrach)m süRh (Freiburg). It is questionable whether the records from the region under this name really belong to this repeatedly falsely understood species Arthonia cinnabarina (DC.) Wallr. (A. tumidula (Ach.) Ach., A. Gregaria (Weigel) Körber) In foothills and submontane, warm to moderately cool sites in cool oak-hornbeam forests and in oak-pasture forests (Pruno-Fraxinetum, Carici-Fraxinetum), often in brookside ash stands, also in linden-maple forests, preferably on softer, base-rich bark, above all on ash, rare on other deciduous trees and spruce, on moderately light rich to rather light-poor, rather to very humid habitats, m.acidoph.-subneutroph., ombroph., anitroph., penetrating into many regions through algae-covered dark and dust influence, Char. Opegraphetum ruf. – mieur(atl)-med – v.rare (0); süSch (Haslach), nöSch (Baden-B), SJu, MI, Bo (Konstanz), SFW, FrJu, O (Heidelberg), Sp?, Rh-Mn-T, Eif

Arthonia endlicheri (Garov.) Oxner (A. lobata (Flörke) Massal.) In hilly, rather warm, mild winter sites on rain sheltered overhanging and vertical surfaces of silicate rocks (e.g. maritime boulders), in the region like A. insulata (↑), yet probably on warmer habitats, often on hard rock – s’ mieur(subatl)-med – v.rare (0); süSch (Wieladingen, Kinzigtal), O (Heidelberg), MRh-Ts (Lorch), Eif

Arthonia fuliginosa (Turner & Borrer) Flotow Penetrating into montane, high rainfall, oceanic influenced sites in the interior thinned out spruce-fir and spruce-beech forests on spruce-fir on moderately well lighted, very humid, mild to cool habitats, preferring old near natural stands, dying out in lower sites, r.acidoph., r.ombroph., anitroph., e.g. in forests with Lobariion-fir or in the Parmelinion perl. – mieur-subatl-med(subatl), oc – v.rare (0); Ne(Trillfingen, probably +) Fr +, Al, MI

Arthonia galactites (DC.) Duf.
In warm summer and rather mild winter, hilly sites in thinned out forests, especially pasture forests and on ± free standing deciduous trees, preferring smooth bark, most frequent on poplar, subneutroph., m.-r.photoph., r.xeroph., anitroph., e.g. in pioneer stages of the Xanthorion – s’mieur(atl)-med – v.rare, also easily overlooked (0); süRh, nöRh (around Karlsruhe)

Arthonia helvola (Nyl.) Nyl.

Arthonia didyma Körber
Up into the (high)montane zone on mostly smooth bark deciduous and conifer (shrubs, hornbeam, spruce et al.) in the interior of near natural forests, m.-r.acidoph., r.skioph., r.hygroph., m.-r.ombroph., anitroph., in the Graphidion, usually with Graphis scripta, Opegrapha atra – s’bor-smed(-med) – r.rare, probably often overlooked; Sch (up to 1350 m), süHü-HRh, süRh, SJu, additionally rare Ju, Ne, O, Rhön, Th, Al

Arthonia dispersa (Schrader) Nyl.
Up into the montane zone on smooth bark of deciduous-, rarer on conifers, above all on young stems and branches, soon disappearing on the bark becoming cracked, probably the most frequent on ash, weakly competitive pioneer, also on rather open to the wind habitats, subneutroph. -r.acidoph., m.-r.photoph., m.-r.hygroph., ombroph., anitroph., e.g. in the Lecanoretum subf., e.g. with A. radiata, Arthopyrenia punctif. – bor-med – r.rare; e.g. Ne, Hü, Sch, O, Ju, Rh, Mos

Arthonia elegans (Ach.) Almq.
In winter mild, foothills and submontane sites on smooth bark of deciduous trees (above all ash and hornbeam) and on spruce in the interior of forests, above all ash stands (e.g. Carici-Fraxinetum) and cool spruce shrub forests, on rather light poor to moderately light rich, very humid, sheltered habitats, m.acidoph., anitroph., e.g. in the Opegraphetum ruf. – mieur(atl)-med – v.rare (0); süSch (Haslach), nöSch (Baden-B), SJu, MI, Bo (Konstanz), SFW, FrJu, O (Heidelberg), Sp?, Rh-Mn-T, Eif

Arthonia endlicheri (Garov.) Oxner (A. lobata (Flörke) Massal.)
In hilly, rather warm, mild winter sites on rain sheltered overhanging and vertical surfaces of silicate rocks (e.g. maritime boulders), in the region like A. insulata (↑), yet probably on warmer habitats, often on hard rock – s’mieur(subatl)-med – v.rare (0); süSch (Wieladingen, Kinzigtal), O (Heidelberg), MRh-Ts (Lorch), Eif

Arthonia fuliginosa (Turner & Borrer) Flotow
Penetrating into montane, high rainfall, oceanic influenced sites in the interior thinned out spruce-fir and spruce-beech forests on spruce-fir on moderately well lighted, very humid, mild to cool habitats, preferring old near natural stands, dying out in lower sites, r.acidoph., r.ombroph., anitroph., e.g. in forests with Lobariion-fir or in the Parmelinion perl. – mieur-subatl-med(subatl), oc – v.rare (0); Ne(Trillfingen, probably +) Fr +, Al, MI

Arthonia galactites (DC.) Duf.
In warm summer and rather mild winter, hilly sites in thinned out forests, especially pasture forests and on ± free standing deciduous trees, preferring smooth bark, most frequent on poplar, subneutroph., m.-r.photoph., r.xeroph., anitroph., e.g. in pioneer stages of the Xanthorion – s’mieur(atl)-med – v.rare, also easily overlooked (0); süRh, nöRh (around Karlsruhe)
In the hilly and submontane zone on smooth to flat-cracked bark of deciduous and conifer trees in forests, e.g. alder-ash forests in mild winter sites, probably r.acidoph., (r.)v.hygroph., anitroph. – s’bor-mieur – v.rare (0); O (Heidelberg), MI (Frauental in Zug)

**Arthonia insula** (B. de Lesd.) Redinger

In hilly, mild winter places on rain sheltered overhangs, on rocks and boulders of silicate rock, on mild- to cool oceanic, very humid, r.-v.light-poor habitats, e.g. on maritime boulders, r.acidoph., anombroph., anitroph., in a community of the Chrysotrichetalia chlor. – s’mieur-atl-smed – v.rare (0); O (Heidelberg)

**Arthonia lapidicola** (Taylor) Branth & Rostrup (Allarthonia l. (Taylor) Zahlbr.)

Up into the alpine zone above all on lime-rich rock, but also on lime impregnated silicate rock, frequent on rocks lying on soil, rarer on boulders, cliffs, also tiles, walls, basiph.-subneutroph., ombroph., r.xeroph., r.photoph., euryöké, but competitively weak pioneer – bor-smed – r.rare; probably wide-spread, but often overlooked, above all Rh, Hù, Ne, besides e.g. SJu, Ju, Mn, Rhön, Eif

**Arthonia leucopellaea** (Ach.) Almq.

In montane and above all high montane, high rainfall, rather oceanic places on very humid cool (to cold), r.(-v)light-poor habitats above all on spruce and fir, rarer e.g. on beech or birch, often in high valleys, basins, r.(-v)acidoph., r.anombroph., anitroph., Char. Lecanactidetum ab., usually with *Thelotrema* – s’bor(atl)-zentr-mo – rare (3); Sch, Vog, Al, besides BayW

**Arthonia mediella** Nyl.

In montane to high montane sites in near natural spruce-beech and spruce-fir forests on spruce and fir, more rarely on deciduous trees or on wood, on r.shaded, cool to cold, very humid habitats, r.-v.acidoph., anitroph. – bor-mieur-mo – rare; süSch, Fr (probably +), Th

**Arthonia medusula** (Pers.) Nyl

In hilly to montane sites on mostly smooth, subneutral bark or free-standing deciduous trees (e.g. ash, walnut, Norway maple), on branches of elder, also over mosses, also in open forests, subneutroph., r.photoph., anitroph., in the Lecanorion subfuscae – mieur-smed – r.rare ?; e.g. süRh, süHù-HRh, Ne, Ju, SJu, Sch, Al

**Arthonia muscigena** Th.Fr. (A. leucodontis (Döbb. & Poelt) Coppins, Bryostigma l. Döbb & Poelt)

In hilly to montane sites on smooth bark of deciduous trees, almost only on *Populus tremula*, subneutrophytic pioneer – bor-mieur(-med) – v.rare, probably also overlooked; nöRh, Fr, Al

**Arthonia pruinata** (Pers.) A.L.Sm. (A. impolita (Hoffm.) Borrer)

In hilly, mild winter sites in deciduous forests almost only on older oak on deep-cracked bark, like *Lecanactis amyl.* (†), Char. Arthonietum pruinatae (e.g. with *Lecanactis amyl.*, *Chrysothrix cand.*, probably also *A. byssacea*) – mieur-atl-med – v.rare (0); süHù, nöRh, Rh-Mn-T +, MRh-Ts, ?Eif

**Arthonia punctiformis** Ach.

Up into the high montane zone on smooth bark of deciduous trees, very rarely on conifers, above all on thinner twigs of young stems, disappearing from cracked bark, competitively weak pioneer lichen, above all on ash, mostly on moderate to rather light-rich habitats, subneutroph.-r.acidoph., ombroph., anitroph., in the Lecanorion subf., also in the Graphidion, often with *Arthopyrenia punctif.* – s’bor-med – r.rare (3); above all Sch, Vog, almost lacking in dry-warm regions

**Arthonia radiata** (Pers.) Ach.

Up to the tree-line on smooth to slightly cracked bark (i.e. smooth paths ) of deciduous trees and spruce, preferably on ash, elder, beech, *Sorbus*, above all on young stems and on branches, in the interior shady forest as well as on free-standing trees, with regard to climate euryöké species, high point on subneutral and moderately acid bark on rather to very humid habitats, subneutroph.-r.acidoph., r.(v.)skioph.-r.photoph., m.-r.ombroph., a-(m.)nitroph., also still in rather epiphyte-poor regions, Char. Graphidetalia – (s’)bor-med – moderately frequent; widespread
in the region, yet lacking in regions of strong air pollution

**Arthonia reniformis** (Pers.) Nyl.
Up into submontane sites on smooth bark deciduous trees, above all on the trunk of elder, rarer on beech, hazel-bush etc., similar to *Strigula glabra* (†) – meur-(zentr)-med – v.rare (0), very easily overlooked; süSch. O, Fr

**Arthonia spadicea** Leighton
In the hilly and submontane, more rarely in the montane zone, on bark on the trunk and above all on the base of the trunk of deciduous and conifer trees, often on somewhat rotting, on rain moistened bark on oak, in the interior of forests, e.g. oak-hornbeam forests, m.-r.acidoph., r.-v.hygroph., r.anombroph., r.skioph., anitroph., r.toxiol., in the Graphidion, also in contact with Caliccion-community – s`bor-smed-mo – r.rare; e.g. süRh, Hū, HRh, Sch (Tieflagen), Ne, SFW, SJu, Ju, Av, O, Rh-Mn-T, Th

**Arthonia stellaris** Krempelh.
In hilly and submontane, rarely montane sites in mild winter, oceanic influenced regions on smooth bark trunks of deciduous and spruce forests (e.g. spruce-beech forests) on very humid, moderately light-rich, mild (to cool) oceanic habitats, m.-r.acidoph., anitroph., in the Graphidion – meur-atl-smed(atl), oc – v.rare (0); Sch (Baden-Baden, Haslach)

**Arthonia vinosa** Leighton (A. lurida auct.)
Above all in the montane zone on deciduous and conifer trees, on (often also somewhat decaying) bark and on wood of 'debarked' trees, predominantly on fir, spruce and oak, especially on the central trunk and on the base of the trunk o older trees in closed near natural forests, r.-v.acidoph., anitroph., r.-v.hygroph., m.-r.anombroph., anitroph., in the Calicion vir. in very species poor stands, Char. Arthonietaum vin., rare in the Opegraphetum verm. – s`bor-smed(-med) – rare; above all Sch. Vog, Sp. Al, additionally SFW, Ne, nōRh, Rh-Mn-T, Mn, Fr, Ju, O, Ts, He, ThW, Eif

**Arthonia Zwackhii** Sandst.
In hilly, mild winter sites in the interior of cool forests, e.g. oak-hornbeam forests, on smooth, moderate to rather base-rich bark of deciduous trees, above all hornbeam, ash; m.acidoph., in the community of Graphidion – meur-atl-smed(atl) – v.rare (0); nōRh (Karlsruhe)

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**Arthopyrenia** Massal.
(Keys incl. Acrocordia, Anisomeridium, Strigula)

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**Introduction**

The *Arthopyrenia*-species are crustose lichens with generally indefinite, thallus scarcely setoff from the substrate by color, small, hemispherical projecting perithecia with black top and mostly two to six-celled spores in asci with often conspicuously regenerated ends. Many species of the genus are not lichens. In the case of a few species it questionable whether they are found to be constantly lichenized. The symbionts of the lichenized species belong to the genus *Trentepohlia*. The genus is still insufficiently known, the species have been little observed. The Arthopyrenias occur as a rule as first residents on smooth bark of branches and young stems of deciduous trees, especially on hazel, mountain ash, mulberry, cherry, willow, popular, birch and ash. They prefer humid habitats as e.g. stream meadows.

*A. lapponina*, *A. punctiformis*, *A. rhyponta*, are distributed over the greater part of Europe, somewhat less wide is *A. cerasi*, while *A. antecellens*, *A. fraxini*, *A. grisea* and *A. cinereopruinosa* from southern Europe to southern Scandinavia, recently with the high point in the west.

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**Genus Characteristics and Determination**

Thallus indefinite, in the tree bark, whose upper surface is colored ± whitish to pale brown, rarely blackish, when fresh sometimes rose, with *Trentepohlia*-algae, many species not lichenized. Per. rounded to elliptical in aspect, with black top. Exc. commonly colorless, from the top side appearing covered over by a dark roof-like protruding involucre, that incorporates the tree bark cells. Pseudoparaphyses branched and reticulate, rarely lacking; sometimes with downwards growing periphysoids. Asci pear shaped, clavate with regenerating ends, rarely cylindric, I-, fissitunicate. Sp. elongate to

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The determination of Arthopyrenia species is difficult. All species of the key R.-Ch.-

1 On clay soil. Per. sunken, light yellowish to brownish. Sp. 4-celled, 14-28 x 4-9 µm. Thallus thin, with protococcoid algae.

2* On bark or on mosses.

3 Sp. 12-19 x 6-9 µm, 2-celled, with perispore, 1 series in cylindrical ascus (?). Paraph. rigid, permanent. Per. 0.6-0.8 mm, hemispherical projecting. Thallus indefinite to mostly shrubby-cracked, rose-gray, gray, greenish-gray, or brownish.

4* On limestone

5 Sp. 25-35 x 5-8 µm, with (5-)6-7(9) septa, fusiform. Per. rounded, ±0.45 mm, usually moderately convex, half sunken, at first covered with a thin gray thallus layer, later black. Thallus thin, gray. Pycn. ±0.1 mm. Macroconidia 20-30 x 4-6 µm. On mosses and bark.

6* On bark or on mosses, Thallus whitish to indefinite (if sp. 11-16 x 5.5-9 µm, per. 0.3-0.6 mm; Acrocordia cavata)

7* Sp. 12-19 x 6-9 µm, 2-celled, with perispore, 1 series in cylindrical ascus. Per. ±0.45 mm.

8* Sp. 25-40 x 8-13 µm, 2-celled, with age 4-celled and browned, rounded on the ends, without perispore, ± 2 series to unorderd in bulging-clavate asci. Per. 0.3(0.4) mm. Paraph. richly branched. Thallus indefinite, probably not lichenized.

9 Thallus indefinite or whitish to greenish, with pointed, conical black, -0.2 mm high, 0.1-0.15 mm thick pycn. with bent pycnosp. extruded in large packets in gelatin-like substance (single 3.5-4.5 x 1.8-2 µm). Per. rare, -0.25 µm ± sunken to sessile. Sp. 2(4) celled, 12-23 x 3-5 µm, cells strongly unequal, one up to twice as long as the other.

10 Sp. with (3)5-7 cross-septa. On bark or mosses.

11* On bark or on mosses.

12* Sp. with best 3 cross-septa. On bark


14* Paraph. richly branched or soon slimy and scarcely recognizable. Asci ventricose. Sp. ± 2 series to irregularly in the asci. With or without contingent algae. Thallus indefinite, rarely dark. Sp. 12-23(26) x 4-8 µm, 4-6(8) celled. Per. ±0.2 mm. Hym. (asci) 1+ red-brown. To A. grisea?

15* Sp. 20-27 x 3-5 µm, with 6-7 septa. Per. usually elliptic to elongate, ±0.6 mm. Thallus very thin, whitish. Often with macroconidia in pycn. of similar size as the per. Macroconidia 20-30 x 3-4.5 µm, rounded at the ends. On bark

16* Strigula glabra

17* Sp. 25-35 x 5-8 µm, with (5-)6-7(9) septa, fusiform. Per. rounded, ±0.45 mm, usually moderately convex, half sunken, at first covered with a thin gray thallus layer, later black. Thallus thin, gray. Pycn. ±0.1 mm. Macroconidia 20-30 x 4-6 µm. On mosses and bark. Strigula stigmatella

18* Sp. with ± thicker, finer whitish perispore (only in the case definitely stronger enlarging) and thick septum, 2-celled, 15-27(30) x 8-13 µm, not shrunked at the septum, with rounded ends, 1 series ( ). Ascus cylindrical, paraph. rigid erect. Per. mostly 0.5-1 mm, hemispherical projecting

A. personii

19* Sp. 25-40 x 8-13 µm, 2-celled, with age 4-celled and browned, rounded on the ends, without perispore, ± 2 series to unorderd in bulging-clavate asci. Per. 0.3(0.4) mm. Paraph. richly branched. Thallus indefinite, probably not lichenized.

A. antecellens

20* Sp. 13-19 x 3-5 µm, 2-celled, a few old ones ± shrunken at the septa, fuseiform. Thallus whitish to indefinite, under the bark.

Strigula affinis

21* Sp. 20-27 x 3-5 µm, with 6-7 septa. Per. usually elliptic to elongate, ±0.6 mm. Thallus very thin, whitish. Often with macroconidia in pycn. of similar size as the per. Macroconidia 20-30 x 3-4.5 µm, rounded at the ends. On bark

A. gemmata

22* Sp. 25-35 x 5-8 µm, with (5-)6-7(9) septa, fusiform. Per. rounded, ±0.45 mm, usually moderately convex, half sunken, at first covered with a thin gray thallus layer, later black. Thallus thin, gray. Pycn. ±0.1 mm. Macroconidia 20-30 x 4-6 µm. On mosses and bark

Strigula stigmatella

23* Sp. with ± thicker, finer whitish perispore (only in the case definitely stronger enlarging) and thick septum, 2-celled, 15-27(30) x 8-13 µm, not shrunked at the septum, with rounded ends, 1 series ( ). Ascus cylindrical, paraph. rigid erect. Per. mostly 0.5-1 mm, hemispherical projecting

A. microspila Körber

24* Not on Graphis scripta

25* Sp. soon 4-celled. Hym. 1-4. Probably not lichenized

86
Thallus gray- to brown-black. Sp. 14-20 x 4.5-6 µm, with definite perispore. Per. usually dull. 

A. grisea

15* Thallus ± lacking or implied by a light fleck. Sp. 15-22 x 5-7 µm. Mostly on birch. Closely related to A. punctiformis.

A. grisea

16 Sp. with at least 2 µm thick perispore (in K). Per. wall greenish in K. Probably not lichenized, but sometimes associated with single algae.

16* Sp. without perispore of envelop -1.5 µm thick (in K).

17 Young per. sometimes whitish (by covering periderm of the tree bark), later black, -0.4 mm. Sp. 15-22 x 5-8 µm, in the center of the cells often somewhat indented (“fitted to the waist”). Paraph. often with very definite, elongate shining oil incorporated bodies (in the case of A. lapponina rarer and less definite), -1.5 µm thick. Thallus producing light gray to yellowish flecks.

A. cinereopruinosa

17* Per. all black, -0.5(0.6) mm. Sp. 2-celled (also 4-celled with age) 13-24 x 5.5-9 µm, the cells commonly unequal in size, not indented in the center of the cells not “fitted to the waist” (or at best implied in one cell). Paraph. 1.5-2 µm thick. Thallus indefinite.

A. cinereopruinosa


A. punctiformis

18* Thallus ± lacking or implied by a light (rarely darker) fleck.

19 Paraph. lacking or very soon deliquescing. Per. -0.3 mm, black, per. wall brownish in K. Asci 33-45 x 14-20 µm. Sp. (12-)14-17(21) x 4-4.5 µm, without perispore, shrunken at the septum, each cell with 2 oil droplets, one or both cells indented (waist-like). Thallus indefinite to implied by mostly light flecks. Commonly lichenized, with Trentepohlia. Above all on hazel. In this region, at this time, insufficiently known, ecology similar to A. punctif., e.g. Sch.

A. salicis Massal.

19* Paraph. occurring.

20 Sp. “waist-like” in the center, 14-22 x 5-7 µm, 2-celled, at best a few of the old 4-celled, with definite, ca. 2 µm thick perispore. Per. wall greenish in K. Paraph. mostly rather distinct. Young per. commonly appearing light gray. Ascii clavate. Thallus light gray to yellowish-white

A. punctiformis

Ecology and Distribution of the Species

Arthopyrenia antecellens (Nyl.) Arnold

Up to high montane sites, especially in mild winter regions, on smooth, thin bark of deciduous, rarely conifer trees, e.g. Corylus, avoiding base-rich bark, m.-r.acidoph, m.-r.photoph., anitroph. – mieur – rare; Eif, SJu, Vog, PfW, O

Arthopyrenia cerasi (Schrader) Massal.

Up to the montane zone on smooth, thin bark with less water capacity, above all on young branches, almost only on Prunus (mostly cherry trees), rarely on hazel, weakly competitive pioneer lichen, m.-r.acidoph. – mieur-med – v.rare (?) throughout the entire region, yet collections mostly old

Arthopyrenia cinereopruinosa (Schaerer) Massal. (A. pinicola (Hepp) Massal.)

Up to the montane zone on smooth and flat-cracked bark of deciduous trees, especially on popular (above all aspen) and ash, rarer on oak, mostly on young stems or on branches in the forest, especially ash forests, etc. (Alno-Padion) in valleys and stream pastures, above all in undisturbed old forests, m.(r).acidoph.

Arthopyrenia fraxini Massal

Like A. punctiformis, on smooth bark of trees, especially on Fraxinus – s’bor-med – at this time insufficiently known, Rh, Sch
Arthopyrenia grisea (Schleicher ex Schaerer) Körber
On thin, smooth bark of lower water capacity, predominantly on birch, facultatively lichenized, r.(v.)acidoph. – mieur – erratically collected from Bo, Al, Rh-Mn-T

Arthopyrenia lapponina Anzi (A. fallax (Nyl.) Arnold)
Up into high montane sites on smooth, thin bark with lower water capacity, on branches and young stems of deciduous trees and shrubs (e.g. hazel, oak, ash, hawthorn, Sorbus), rarely on conifers, e.g. Pinus-twig, in forests as well as free-standing trees, weakly competitive pioneer lichen, facultatively lichenized, r.-m.acidoph. (subneutroph.) – bor-smed – scattered, (?); Sch, Vog, süHü-HRh, süRh, Ne, O, Eif, SJu, Al

Arthopyrenia persoonii auct. (to A. grisea ?, A. pluriseptata auct.)
Probably rather like A. punctiformis (†), but avoiding cooler sites, on smooth bark deciduous trees -- mieur-med – e.g. süSch

Arthopyrenia punctiformis (Pers.) Massal.
Up into the high montane zone on smooth, thin bark, on almost all species of deciduous trees and shrubs, predominantly on young branches of ash, Sorbus, oak, hazel, in forests and in freer sites (then usually on humid sites), weakly competitive pioneer, r.acidoph.-subneutroph., r.photoph., climate r.euryök, on algae-covered branches (eutrophic above in intensively agricultural regions, clustered spaces) vanishing, e.g. with Lecanora carpinea in the Lecanorion subf., also in the stages of dark Graphidion – bor-med – r.rare (-m.frequent); distributed through the entire region, regionally frequent (e.g. süSch.), rarer in dry-warm regions

Arthopyrenia rhyponta (Ach.) Massal.
On subneutral and m.acid, smooth bark of deciduous trees, especially on branches of popular, besides e.g. on hornbeam, oak, Norway maple, walnut – bor-med – rare (?); süRh-süHü, O, nöRh, SJu, Al, only individually found

LIT.: COPPINS 1988, KEISSLER 1936-37, VAINIO 1921

Arthothelium Massal.

Introduction

The Arthothelium-species have a thin crustose thallus and sunken, rounded to usually fleck form irregular or branched, not bordered, blackish apothecia. They call to mind Arthonia-species, differing however in having muriform multicellular spores. The principally tropic distributed genus has ca. 10 species in Europe and two species in Germany. Both indigenous species grow predominantly on the smooth bark of hornbeam and oak in humid forests, e.g. often in the hardwood meadow of the river and in brook bordering stands. In the north A. ruanum thrusts up into the border o the oak area in southern Scandinavia, while the apparently rarer A. spectabile reaches only the more north German lowlands. Both have a subatlantic area. They are rare in southern Europe and on the British Isles

Genus Characteristics and Determination

Very like Arthonia, distinguished by the muriform divided, egg-shaped to ellipsoidal spores. The indigenous species are lichenized (Trentepohlia) and distinguished by irregularly bordered (“fleck-form”), sunken, flat, brown-black to black, nonpruinose ap.

I  Sp. 26-36 x 12-15µm, with 5-7 cross septae; mostly cross-celled with at least one long septum. Hym. red-brown throughout. Ap. -2 mm, black to dark brown, rounded, angular to lobed. Thallus well developed, whitish, pale greenish

A. spectabile

I* Sp. 15-26 x 7-11 µm, with 5-7 cross-septa; (2)3-7 cross-cells with at least one long septum. Hym. red-brown, epihym. dark brown. Ap. irregularly bordered, fleck-form, -2 mm, not raised. Thallus olive, olive-brown to yellowish olive or rarely whitish(gray)

A. ruanum

Ecology and Distribution of the Species

Arthothelium ruanum (Massal.) Körber
(A. ruanideum (Nyl.) Arnold, A. dispersum auct.)
Up into the submontane sites on smooth to flat-cracked bark of deciduous trees, above all on lower and central trunk region of hornbeam, hazel or ash, in cool deciduous forests and undergrowth on humid, rather light poor habitats, especially in oak-hornbeam and ash
forests. (Pruno-Fraxinetum), m.acidoph., r.ombroph., antroph., Char Graphidion, above all Opegraphetum ruf., Pyrenuletum nit., Graphidetum – mieur-subatl-med-mo – r.rare-m.frequent (3); scattered in SW-Germany in correspondingly high sites, today probably clearly rarer, m.-r.toxitol.

Arthothelium spectabile Flotow ex Massal.

In mild winter hilly, rarely submontane sites on smooth to flat-cracked bark of deciduous trees (preferably hornbeam or ash) in meadow forests and brook-side ash stands (above all in cool oak-hornbeam-, alder-ash forests), on humid, rather light poor habitats, especially in larger, little disturbed forests, m.acidoph., r.ombroph., antroph., in the Opegraphetum ruf., Pyrenuletum nit. – mieur-subatl-smed – v.rare (1); süRh, süHü-HRh, SJu, nöRh, o, Av

LIT.: COPPINS & JAMES 1979, REDINGER 1937

Arthrorhaphis Th.Fr.

Introduction

The thallus of Arthrorhaphis is purely crustose to squamulose and commonly colored citron-yellow. In the case of lichen dwelling species it is indefinite or over lying the host tissue. The apothecia are black, the spores cross septate and needle-like to bacillar. Most of the species live at first as parasites on the thallus of lichens, as on Baeomyces-species, however later mostly standing alone.

Of the perhaps nine species distributed principally in the temperate and cold zones, four occur in Germany and two to three in the region. They live on acid mineral soils in lacunae of thin turfs, on cool slopes and road sides, A. citrinella often also on mosses and silicate rocks. While A. grisea lives upon Baeomyces, A. citrinella and A. alpina later become autonomous. They are distributed principally in north and central Europe.

Genus Characteristics and Determination

Thallus crustose, granular, warty or squamulose, usually citron-yellow to yellow-green, sometimes disintegrating sorediate, or living in the host lichen and appearing ± gray to gray-green, with coccoid green algae. Ap. black, lecideine, with hollowed out to convex disks. Exc. weakly developed, dark. Hyp. colorless to pigmented. Hym. often with oil droplets, I not blue. Epiphyllum. blackish to greenish. Paraphyses thin, sparsely branched and reticulate bound, not or weakly thickened above. Asci clavate, K/I-, thin-walled, only weakly thickened above. Sp. 4- to many celled, cross-septate, fusiform to needle-like. Ch: yellow species with Rhizocarpic acid.

1 Thallus citron-yellow to yellow-green, with Rhizocarpic acid. Sp. 8-12 celled
1* Thallus gray-greenish, on Baeomyces species with Stictic acid, ± Norstictic acid, darker than the host thallus and changing it. Ap. at first often projecting top-like, first with a deep sunken, later with a flattened disk, usually with a permanent thick margin, -0.5 mm, ± sessile. Epiphym. brownish. Hym. inspersed. Sp. 8- up to 16 cells, 20-70 x 2.5-3.5 µm  A. grisea
2 Thallus at least partially of compact areoles
2* Thallus extensively sorediate
3 In the high mountains, usually over weakly Ca-influenced substrate. Thallus with clearly set off white to weakly yellowish medulla with numerous Ca-oxalate crystals (insoluble in acetone), of scattered to coalescing, mostly convex areoles, which sometimes also break out crater-form (if areoles elongated at the margin, see Catolechia). Ap. often lacking, epiphyllum. black-brown to blue-green. Sp. (20)25-45(60) x 3-4.5 µm, over one another (multi-storey) in the ascus. * A. alpina
3* Widely distributed, on acid substrate. Thallus without white, Ca-oxalate rich medulla (if crystals occur, then acetone soluble). Areoles flat to high convex and then often hollow within, see relatively rare non-sorediate form of A. citrinella (4)
4 In the high mountains over Ca-influenced substrate. Areoles breaking out crater-form or thallus entirely sorediate on whitish Ca-oxalate under layer (Crystals not soluble in acetone) A. alpina (3)
4* Widely distributed on acid substrates. Thallus of sorediate erupting areoles or entirely sorediate, not on whitish Ca-oxalate under layer, without crystals or crystals soluble in acetone, often at first parasitising Baeomyces, later autonomous. Ap. soon flat, margined or not, -1 mm. Sp. 8-12 celled, (45)55-80(100) x 2.5-3.5 µm, beside one another in the ascus. * A. citrinella

Ecology and Distribution of the Species

Arthrorhaphis alpina (Schaerer) R.Sant.  
(Bacidia flavovirescens v. alpina (Schaerer) A.L.Sm.)
In high montane-alpine sites, rarely lower, on open sites on cool, weakly calcareous soils – arct-mieur-alp – v.rare; Fr, Opf, Obay, Al

Arthrorhaphis citrinella (Ach.) Poelt (Bacidia flavovirescens (Dickson) Anzi)
From the submontane up into the alpine zone on naked soil, on soil dwelling mosses, mossy silicate rock, e.g. on road ways, maritime boulders, on shaded cliffs, often on or with Baeomyces rufus (especially over soil), usually on cool-humid or cool substrate habitats, in high precipitation sites often in lacunae of thin turfs on acid humus, sandy stony clay soils (Nardion), also on rather long snow-covered sites, pioneer in road grades, r.-acidoph., r.hygroph., substrate hygroph., r.skioph., s.photoph., anitroph., in the Lecideetum ulig., in moss community., Leproloma membr.

Arthrorhaphis grisea Th.Fr. (Lahmia fueistigii Körber, Gongylia viridis A.L.Sm.)
In montane-high montane sites on Baeomyces rufus (? and (v.rare) placoph. – bor-mieur-mo – rare; süSch, O, Fr, BayW, ThW


Arthrosporum Massal.
(Determination ↑ Bacidia)

Introduction

A. populorum, the single species of the genus, is characterized by a crustose thallus, black apothecia with proper margin, sparsely branched paraphyses and four-celled, bean shaped curved, colorless spores. The lichen grows on mineral-rich bark on free-standing trees from the central mediterranean region up to central Scandinavia. It is rare and declining.

Genus Characteristics


Ephym. brown to slightly greenish or purple. Paraphyses sparsely branched, ends thickened with pigment layer

Ecology and Distribution of the Species

Arthrosporum populorum Massal. (A. accline (Flotow ex Massal.) Massal., Bacidia acclinis (Flotow ex Massal.) Zahlbr., B. Populorum (Massal.) Trevisan)
Up into the montane zone on light or free standing deciduous trees, predominantly on base rich bark, above all popular, walnut, oak, and willow, subneutroph. (-m.acidoph.), r.(-v.)photoph., a-/m.nitroph., e.g. in the Xanthorion, often with Caloplaca holoc. – s’bor-med-mo – rare (2); e.g. süHü, nöHü, nöRh, SJu, Ju, FrJu, Mfr, Ne, süSch, MI, Th

LIT.: HAFELLNER 1984* VAINIO 1922

Aspicilia Massal.

(Lecanora sect. Aspicilia, Key including Bellemerea, Eiglera, Hymenelia, Lobothallia, Megaspora, et al.)

Introduction

The Aspicilia-species are crustose lichens with mostly strongly developed, smooth, cracked or cracked-areolate, (in the case of nonindigenous species) sometimes marginally lobed, whitish, gray, green-gray or brownish thallus and sunken to depressed sessile apothecia with flat or concave, black or brown, disks surrounded by a margin. The thallus of many species grows relatively rapidly and often reaches a large diameter. In recent time several natural groups (once more) have been described as their own genera, thus Clauzadeana, Hymenelia, Koerberiella, Lobothallia and Pinacisca, from the former broad composite genus Aspicilia. A large part of the species remaining in Aspicilia, an always and yet heterogeneous genus are diagnostically difficult to characterize and taxonomically not yet satisfactorily clarified. Several discovered species may not be considered here.

The Aspicilia-species are almost altogether rock-dwellers. A. calcarea, A. contorta, A. candida, A. moenium reside on carbonate rock,
the remaining indigenous epilithic species commonly on lime-free rock. *A. caesiocinerea* tolerates dunging and often grows on bird roosts and on boulders in brooks. *A. cinerea, A. gibbosa, A. recedens* and *A. simoensis* are found mostly on light-rich sites on mineral-rich silicate rocks. *A. aquatica* lives amphibiously in cool, clear brooks, *A. laevata* above all on humid sites in valleys and forests.

*A. aquatica, A. cinerea* and *A. laevata* are indigenous of the north upper central Europe up into the mountains of the Mediterranean region. Also *A. moenium* might be distributed over the greater part of Europe, mostly on anthropogenic substrates. The area of *A. simoensis* and *A. recedens* culminates in central Scandinavia, stretching into moderately warm to cool sites of the Mediterranean regions; up into north Scandinavia reaching the area of *A. caesiocinerea*. The lime species *A. calcarea* and *A. contorta* are distributed over the greatest part of Europe (with the exception of the northern boreal zone and the Arctic).

**Genus Characteristics and Determination**

Thallus crustose, weakly cracked to areolate, sometimes placoid, often very large, white, gray, greenish, brownish, sometimes isidiate or with soralia, with paraplectenchymatous upper cortex. Photobionts coccoid green algae. Ap. aspicilioid, sunken with concave to flat, black-brown to black disk and weakly developed to aspicilioid, sunken with concave to flat, blackish proper margin, -1(1.5) mm. Ch-

**Megaspora verrucosa**

3 Thallus rounded, rosetted, clearly narrowly-lobed (placoid) at the margin, brown- to white-gray, cracked areolate toward the center and often dark gray. Marginal lobes close together, uniting, ± pruinose. K- to K+ red. Ap. -1.5 mm, dark brown to blackish, numerous. Epithym. brown. Sp. 11-15 x 6-8 μm. On limestone, rarely mineral-rich eutrophic silicate rock. Norstictic acid, ± (Atranorin), rarely Stictic acid or Ch-

**Lobothallia radiosa**

5* Thallus without soralia, with ap. 6

**Hymenelia coerulea**

(if thallus light gray, ap. often irregularly curved: *H. homalomorpha* (Nyl.) Poelt, alpine)

**Eiglera flavida**

8 Ap. brown-rose to yellowish-rose, oval or elongated or with irregular outline, concave, -0.5 mm, sunken (into substrate), separated by a crack in the thallus. Epithym. colorless to pale brown. Thallus uniformly crustose, ± endolithic, gray-whitish. Sp. ellipsoidal to spherical, 10-24 x 7-17 μm (if thallus definite, on moist rock, see *H. lacastris*, 16). Ch-..

**Hymenelia prevostii**

8* Ap. black, but occasionally whitish pruinose. Epithym. dark green. Sp. wide ellipsoidal to almost spherical, 20-30 x 15-25 μm, to (2-)4(6) per ascus. Difficult group, many forms are not
reliably assigned (Pachyospora-group). R.-

Aspicilin 9

9* Thallus clod-like to areolate, gray to olive, often ± whitish pruinose, generally not with chalky-mealy upper surface. Prothallus indefinite. Ap. mostly rounded, sunken to with a definitely raised, often radially striated thallloid margin, to usually 1-3 per areole. Very variable species. *; ssp. hoffmanniana: thallus gray to brown-gray, cracked areolate, areoles ± coalescing and angular, usually 1 ap. per areole: ssp. contorta: areoles above all on periphery of the thallus scattered and there ± convex, rounded, with rounded corners, white to gray, mostly 1-3 ap. per areole

A. contorta s.l. (A. coronata (Massal.) B.de Lesd. is distinguished by endolithic or semi-endolithic, yellow-gray to gray-white unorganized thallus, only cracked areolate in the vicinity of the ap.; ap. -0.4 mm, often deformed, disk always strongly pruinose: e.g. Ju, Hū)

10 Thallus with soredia or isidia or ± hemispherical to short cylindrical papillae, often sterile . 11

10* Thallus without that kind of structures 15

11 Thallus (medulla) or soralia K+ red, with soredia or isidia-like, papilliaform to coraloid outgrowths. Norstictic acid. In the region several difficult to address, partially unclassified species, among others the following two . 12

11* Thallus K- 13

12 Thallus center gray, dark gray to greenish-gray, cracked areolate, strongly developed, with isolated rough, coraloid, sometimes erupting sorediate isidia groups. Stictic acid and/or Norstictic acid A. simoensis

12* Thallus light to dark gray, cracked areolate, warty or smooth, thin, with whitish fleck soralia, *; e.g. siSch

A. grisea

13 Thallus gray-rose to gray, cracked areolate to areolate, with regular dispersed, short cylindric, 0.3-0.5 mm thick, whitish to light rose isidia. Isidia one per areole, with a sunken pycn. at the tip, leaving a concave scar behind after breaking off. Prothallus dark, ± definite. C-, KC-. Pycnosp. 3.5-5 x 1-1.5 μm. Ap. very rare, light to dark red-brown. (Gyrophoric acid) .

Koerberiella wimmeriana

13* Thallus yellow-brown, brown-gray to dark brown, medulla C+/KC+ red, cracked- or warty-areolate, areoles dispersed or dominating with short cylindric isidia-like outgrowths.

Outgrowths without pycnidia, often erupting sorediate. Prothallus black. Gyrophoric acid . 14

13* Thallus gray, with soredia . (not treated)

14 Thallus areolate, moderately thick, areoles mostly convex, coalescing to scattered on black prothallus, sometimes with isidia-like, cylindric, -0.25 mm thick, -0.5 mm high outgrowths or with whitish (sometimes originating on the outgrowths) soralia. Outgrowths/soralia sparse to lacking on fruiting specimens. Ap. -1.2 mm, disks black, furrowed.

* ↑ Rimularia gibbosa

14* Thallus cracked areolate, thin, areoles flat, with small, hemispherical to short cylindric, -0.1(0.15) mm thick, -0.2 mm high outgrowths and ca. 0.1 mm large soralia. Ap. very rare.

* ↑ Rimularia intercedens

15 Ap. rose, rose-yellowish, flesh colored, light brown(red), beige. Ch-

16* Ap. blackish, dark brown-red to dark brown, sometimes whitish to bluish pruinose .

16 On occasionally flooded or irrigated surfaces. Thallus coherent to finely cracked, with smooth upper surface, whitish, pale yellowish, yellow-reddish, ochre. Ap. concave, permanent sunken, as a rule appearing marginless, -0.5 mm, often heaped. Hym. 85-100 μm. Sp. 13-24 x 6-11 μm

Hymenelia lacustris

16* On ± dry rock. Thallus very thin, dirty yellowish to light ochre, often indefinite. Ap. at first strongly concave and sunken, later flattened and somewhat projecting. -0.3 mm. Hym. 70-85 μm. Sp. 10-15 x 6-8 μm

Hymenelia ceracea

17 Medulla I+ violet. With black prothallus. Alpine .

17* Medulla I-. Epihym. olive to verdigris green, rarely brownish

18 Ap. (even moist) black. Thallus whitish, gray-yellow, in the herbarium also ochre colored, warty- or cracked areolate, thick, K+ yellow, then red. Epihym. green-black, blue-black, olive. Sp. 11-20 x 7-11 μm, wall I-. Norstictic acid, – arct-alp – e.g. Al A. myrini (Fr.) Stein


19 Thallus K+ yellow, then red, warty areolate (to cracked areolate), gray to whitish, also somewhat red tinted, areoles coherent to often scattered. Ap. flat, -1.5 mm. Sp. 8-15(23) μm. Norstictic acid Bellemerea alpina (if crater-form blue-gray to blackish soralia start up from the ap.: Bellemerea subsorediza (Lynge) R.Sant.)

19* Thallus K-, cracked areolate to warty, coherent with scattered areoles, gray (if rust colored: B. diamartha (Ach.) Haf. & Roux), prothallus often indefinite. Ap. -1 mm, but often punctiform. Sp. 7-18(24) x 5-10 μm .

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**Bellemerea cinereorufescens**

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<td>20</td>
<td>Thallus (medulla) K+ blue-red. Norstictic acid.</td>
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<tr>
<td>21</td>
<td>Thallus (medulla) K-, K+ yellow, rarely ± dirty red-brown</td>
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<tr>
<td>22</td>
<td>Thallus cracked areolate (to almost cracked), gray, brownish-gray, light gray, on blackish prothallus. Ap. concave, then flat, smooth, with thick, permanent thalloid margin, black, -1.5 mm. Sp. 12-22(25) x 6-13 μm. Hym. -115 μm. Pycnosp. 11-22 x 1 μm.</td>
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<tr>
<td>23</td>
<td>Thallus cracked areolate, dark gray, brownish-gray. Ap. -0.8(1.5) mm, sunken, with wrinkled, rounded to angular disk, black. Hym. ca. 150 μm. Sp. 20-25 x 12-15 μm. Pycnosp. 15-28 x 1 μm.</td>
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<tr>
<td>24</td>
<td>Hym. carboneous black above, hyp. dark brown. Thallus warty (to cracked) areolate, cocoa-brown, gray-brown to dark brown, in the shade also brown-beige, dull. Areoles ± coalescing to scattered, on a black prothallus, -0.4 mm, medulla C+/KC+ red. Ap. (warts) -1.4 mm, disk black, at first ± punctiform, then widening, tuberculate, furrowed, swollen margin. Sp. 15-25(30) x 9-12.5(14) μm.</td>
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<td>25</td>
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**Note:** The above text includes a table with page numbers and descriptions of various species, with some common species highlighted in blue. The table is structured to facilitate easy reading and comprehension of the different species and their characteristics.
Ecology and Distribution of the Species

Aspicilia aquatica Körber (Lecanora a. (Körber) Hepp)
Like Hymenelia lacustris (↑), but scarcely below the montane zone – (arct-)bor-med-alp – rare: Sch, Eif, ThW

Aspicilia caesiocinerea (Nyl.) ex Malbr. (Lecanora c. Nyl)
Form rich euryöke species, above all in the submontane-montane, rarely high montane sites on rain exposed surfaces on silicate rock, predominately on rather to very light rich, moderately to very dunged horizontal- and sloping surfaces, e.g. on the cap of bird roosts, on occasionally flooded boulders in the uppermost amphibious zone on brook, on ± irrigated as well as dry (not secondarily moistened) surfaces, e.g. on boulder scree slopes on sunny surfaces, also as a pioneer, avoiding cold sites, (subneutroph., m.-r.acidoph., M.-v.photoph., (a-)m.-v.nitroph., Char. Aspicilietea gibb. – bor-med-mo – m.frequent-r.rare; above all Sch. Vog, RhSch, Pf, ThW, lacking or syanthrope in lime regions

Aspicilia calcarea (L.) Mudd (Lecanora c. (L.) Sommerf., Pachyospora c. (l) Massal.)
Up into the alpine zone on lime-rich to rather lime-poor rocks (also lime impregnated sandstone) on rather to very open to light, according to the rain rather rapidly drying horizontal and sloping surfaces, on stones in dry turfs, isolated also on natural rock walls, avoiding extremely dry-warm sites, basiph., r.xeroph., a-/m.nitroph., Char. Aspicilietum calc. – s’bor-med – v.rare; SJu, JU and FrJu m.frequent additionally e.g. Th, Mn, Ne, suHü, Rh. Saar, Bit

Aspicilia cinerea (l.) Körber (Lecanora c. (L.) Sommerf.)
Up into the subalpine zone above all on lime-free, hard, crystalline rock on rain exposed, often ± sunny surfaces, often on boulders in scree slopes, in meadows, on dry walls, above all on moderately nutrient-rich sites, m.-r.acidoph., r.xeroph., r.-v.photoph., Char. Aspicilietum cin., in the community of Aspicilietalia gibb. – bor-med-mo – v.rare; above all Sch, Vog, additionally E.G. O, Pf, RhSch, He, ThW, Erz, Al, also as an isolated syanthrope in lime regions (Tomb stones etc.)

Aspicilia contorta (Hoffm.) Krempelh. (Lecanora c. (Hoffm.) Steiner, Pachyospora c. (Hoffm.) Massal.)
ssp. contorta
Primarily on the hilly up into the montane zone on limestone, rarely on lime-poor or lime impregnated silicate rock (often sandstone), above all as a pioneer on stones and lower boulders, in stone piles, on gravel, often on anthropogenic habitats (walls etc.) and therefore also migrating to artificial rock, such as e.g. laundry concrete, but above all in dry trufs, usually on dust impregnated, often dew moistened in the mornings, but relatively dry warm habitats exposed to rain, basiph.-neutroph., m.nitroph., Char. Aspicillietum cont. – (s’bor)mieur-med – r.rare-moderately frequent; above all lime region ssp. hoffmanniana Ekman & Fröberg (A. hoffmannii auct., Lecanora h. auct.)
Like ssp. contorta (↑), but frequently on lime-poor, lime-impregnated or basic silicate rock – s’bor-med – rare; throughout the whole region, above all on anthropogenic habitats

Aspicilia epiglypta (Norrlin ex Nyl.) Hue
On mineral-rich or basic silicate rock on light rich habitats – (s’bor-)mieur – v.rare; Rhön

Aspicilia gibbosa (Ach.) Körber (Lecanora g. (Ach.) Nyl.)
Up into the montane sites on sunny silicate boulders and cliffs, like Lasallia (↑), Parmelia conspersa (↑), sometimes syanthrope on wall crowns (above all sandstone), Char. Aspicilietea gibb. – mieur – r.rare; e.g. Sch

Aspicilia grisea Arnold
In montane-high montane sites on silicate rock, above at near soil, often dew moistened cliff surfaces or on stones – s’bor-mieur – rare; Sch, Vog

Aspicilia laevata (Ach.) Arnold (Lecanora l. (Ach.) Nyl., A. sylvatica Arnold)
In sub- to high montane sites on silicate rock on shady, humid habitats, usually in forests and valleys, readily on brooks and on from time to time moist cliffs, m.-r.acidoph., substrate hygroph., r.skioph.-m.photoph., e.g. in the
Porpidion tub. – bor-med-mo – r.rare; Sch, Vog. O, He, Th, ThW, Eif, Al

Aspicilia moenium (Vainio) Thor & Timdal (A. excavata Thor & Timdal)
In hilly and submontane, precipitation poor to m.precipitation rich sites as a rule synanthrop on anthropogenic substrates, above all concrete walls, cement, in the first line on vertical surfaces on rather to very light-rich habitats, like e.g. Caloplaca teicholyta – (s’)bor-mieur – rare; Ne

Aspicilia obscurata (Fr.) Arnold (Lecanora o. (Fr) Nyl.)
In montane, high precipitation sites on silicate rocks, on open to moderately open lying boulders and rocks – bor-mieur – rare; Sch

Aspicilia recedens (Taylor) Arnold (A. bohemica Körber)
In submontane and montane, high precipitation sites on silicate rock, like Lasallia (↑) in the Lasallietum, Parmelietum consp., Ephebetum -- bor-mieur – rare (2); süSch, HRh, nöSch, Vog, O, Sp

Aspicilia simoesis Räsänen
Predominantly in montane, high precipitation sites on silicate rock on sunny habitats, like Umbilicaria deustae, Parmelium consp. – mieur-smed(-med) – rare (3); süSch, Ju, He, Alpine


Bacidia De Not.

Introduction

The genus Bacidia includes crustose lichens with little differentiation to almost squamulose or coralline-isidiate, usually gray or pale greenish thallus and whitish, rose, orange, brown or black apothecia with proper margin and cross-septate spores. Species with relatively thick, fusiform spores and variant ascus structure were recently removed from the genus and placed in Mycob limbium and Biatora. Species with very thin, needle-like to filamentous spores and filamentous pycnospores in usually whitish pycnidia and with an often conspicuous finely granular thallus were given autonomy in the genus Bacidina.

The Bacidias are dwellers on rock, bark, mosses and plant detritus. They prefer weakly acid, subneutral and weakly basic, mineral-rich substrates. Subneutral bark, thus on Norway maple and maple, elm, willow, ash, walnut or black elder, are colonized by e.g. B. rubella, B. roSELLa, B. fraxinea, B. polychroa, B. incompta, B. arceutina, B. beckhausii, B. assulata and B. naegelii. Prerequisite pH conditions may be totally avoided by bark being enriched by dusting with nutrient materials, B. rubella frequently occurs exclusively in this sort of relationship. Therefore, these species are predominantly in forests and brook accompanying, and to be found on willows adjoining thickets. B. subincompta, B. globulosa, B. laurocerase, B. hegetschweileri and B. subacerina grow on moderately to even rather acid bark, lastly especially on beech and spruce in moist mountain forests, the others e.g. on ash and oak.

B. trachna and the south and central Europe distributed B. fuscoviridis requires as a rule lime-containing rock on sunny sites. B. bagliettoana and B. herbarum grow over dying mosses and other plant detritus over lime rock or lime-rich soils; both occur throughout Europe almost exclusively in the high mountains.

The area of many Bacidia-species covers the north largely with the common beech or the pedunculate oak and chestnut oak (Quercus robar and petraea) and ends in southern Scandinavia, including the greatest part of west- and central-Europe (partially also southeast Europe) as well as the mountain sites of the sub-Mediterranean regions, occupying also the zone of the summer-green deciduous forest; often -- with the exception of B. fraxinea – a subatlantic tendency is recognized. To these species are numbered the also for the most part ecologically resembling epiphytes B. arceutina, B. assulata, B. biatorina, B. friesiana, B. polychroa, and B. roSELLa. Advancing further toward the north, up into the southern boreal zone, B. rubella, B. circumspecta, B. subacerina and B. trachna.

In Baden-Württemberg one recognizes perhaps 20 of the ca 29 species of Bacidia occurring in Germany. Almost all of the epiphytic Bacidias are becoming rarer and threatened. The causes of this repression are the acidification and eutrophication of the bark and the removal suitable carrier trees, such as Norway maple and common maple. Only B.
rubella is still relatively widespread; from the northwest however it is also disappearing.

**Genus Characteristics and Determination**

Thallus crustose, unorganized and thin to cracked, warty, or granular-coralloid, whitish, pale greenish, light gray, or pale brownish, with spherical to broadly ellipsoidal green algae. Ap. ± sessile, flat to convex, with proper margin. Exc. of coherent, radial hyphae. Hyp. colorless or colored. Epiphym. colorless, brown, red-brown, olive, green etc. Hyp. colorless, I+ blue. Paraphyses simple, rarely branching, often thickened above. Asci clavate to narrowly clavate-cylindric, of the *Bacidia*-type, with thick, K/I+ blue tholus, below which is embedded a narrow-cone like, I+ pale blue central plug, with a very small ocular chamber, wall I-, with a thin outer I+ blue gelatin envelop. Spores cross-septate, mostly 4-12 celled, elongate, fusiform, needle-like or worm-like. Ch: almost always without lichen substances, always R-.

Remarks: Unless otherwise stated in the key, thallus R- (in most cases then presumably also CH-)

**Overview of the Parts of the Key**

- **On rock** .
- **On mosses and soil**  .
- **On bark or wood**  .

**Bacidia PT 1: Rock Dwelling Species**

   *Scoliciosporum umbrinum*  
2. Sp. straight or only weakly curved .  
3. Sp. needle-like, long pointed, mostly ± indefinitely septate  
4. Sp. fusiform to bacillar  
6. Hyp. colorless to yellow-brownish .  
7. Epiphym. yellowish to colorless. Sp. 27-45(55) x 1-2 µm, 2-4(8) celled. Ap. light gray to gray-brown or dark red-brown, ± flat -0.8 (1.0) mm, with same color or lighter margin, when moistened first the margin, then the disk darker. Thallus very fine granular (granules 20-40 µm), often cracked, greenish, green-gray, above all in the herbarium also beige, ochre, on limestone. Frequently with 0.2 mm white, rose-whitish to (above all in the herbarium) beige to rose-brownish, hemispherical to bowl shaped pycnidia with 1-celled, 30-50 x 1-1.5 µm pycnospires
   *Bacidina arnoldiana*  
8. Epiphym. olive, blue-green or almost colorless. Ap. gray-brown, dark gray, black-brown, red-black to black, flat, margined, finally even convex without margin, -0.6 mm. Sp. 17-40 x 1.5-2 µm, 4(8) celled. Hyp. red- brown to yellow brown. Thallus thin, fine granular (granules 20-60(90) µm), greenish, light gray, ochre, or brown. Exc. exterior blue-green, violet, or olive-brown. Pycn. like *B. arnoldiana*, but rarely occurring, pycnosp. 20-35 x 1 µm, curved to twisted .  
9. Usually on from time to time flooded silicate rock. Ap. -0.6(0.8) mm, rose, pale brownish-red to brownish, rarely blackish, crowded, flat, permanently margined. Thallus gray- to whitish-green, mostly scurfy to finely warty-uneven, cracked, often with light prothallus. Sp. 20-45 x 1.5-2.5 µm, 4-8 celled. Exc. violet-brown to pale. Hyp. ± colorless, rarely light brown above .  
10. **Bacidina egenula**  


6. **Bacidina chloroticula**  
7. **Bacidina inundata**  

8. **Mycobilimbia sabuletorum**  
9. **Micarea peliocarpa**  
10. **Mycobilimbia sabuletorum**
Bacidia PT 2: Species on mosses and Soil
(only very rarely on moss overgrowing bark ↑ PT 3)

1 Thallus shining citron- to greenish-yellow
   ↑ Arthrorhaphis
2 Thallus not shining yellow
3 Sp. needle- to long bacillar, -3.5(4) µm wide (Sp. a-I).  
4 Sp. fusiform to finger-like, not long pointed, over
   3.5 µm wide (Sp. j-n)
5 Thallus shining citron- to greenish-yellow
6 Thallus gray to bluish-green, intensive green
7 Pycnosp. 10-19 x 0.8-1.2 µm, strongly curved .
   B. fuscoviridis

Bacidina chloroticula

4* Ap. -0.7 mm, whitish, orange, rose-orange.  Sp.
   indefinitely 4-8 celled, (20)25-48 µm.  Pycnosp.
   21-40 x 1 µm.  Thallus pale green to (above all in
   the herbarium) brownish, very finely granular,
   granules ca. 20-40 µm thick .  Bacidina delicata
8 Hym. at least above blue-green, gray-blue, greenish,
   or olive.  Ap. brown-black to black, soon or from the first convex and without margin
   light to brown-black, at least when young with
definitely developed exc., flat and with margin to
   quickly marginless and convex.  Paraph.
   predominantly simple to forked above .  
10 Hyp. brown, red-brown, purple-brown, or black-
   brown
10* Sp. 30-45 x (5)6-7(9) µm, (4)6-10 celled.  Hym.
   over 60 µm high, epit hym. emerald- to blackish-
   green or olive.  Ap. black-brown to black, soon
   convex, with a thin, soon disappearing margin,
   -0.7 mm, exc. in younger ap. clearly developed.
   Paraph. predominantly simple.  Hyp. red- to dark
   brown above.  Thallus mealy, granular, or wary .
   Mycobilimbia accedens
11 Sp. 12-21 x 2.5-3.5 µm, 4(-6) celled.  Hym. up to
   45 µm high, largely blue-green to gray- blue
   (rarely purple).  Ap. black, convex marginless,
   -0.4 mm.  On acid substrates.  Exc. reduced.
   Paraph. branching and bound.  Hyp. purple- to
   black-brown .  ↑ Micarea melaena
11* Sp. at least 4 µm thick (Mycobilimbia) .  
12 Exc., hyp. and epit hym. colorless or slightly
   yellowish.  Exc. clearly developed, cartilaginous
   Mycobilimbia sphaeroides
13* Sp. indefinite 4-8 celled, 20-30(38) µm long.
   Pycnosp. 30-43 x 0.5-1 µm.  Thallus green,
   gray-green, scurfy- granular .
   Zeorine

13* Thallus gray, whitish, pale greenish,
   granular-warty.  Ap. at first flat-cup shaped, with
   rather thick margin, later convex marginless to
   almost spherical, whitish, yellow- to flesh
   reddish, -1.2 mm.  Sp. 12-22 x 4-7 µm, (2-)4(6)
   celled, fusiform.  Close related to M. fusca
**Bacidia PT 3: Bark-dwelling Species**

**Mycobilimbia carneolabida**

14 Thallus gray, yellowish- or greenish-gray, large surfaces erupting yellow-greenish to yellowish sorediate, almost always on bark-dwelling mosses, K-, C-, P-, almost always sterile. Ap. 0.3-0.8(1.3) mm, yellow- to red-brown to brown-black, mostly sparse and scattered, convex, with thin margin, sp. 4 celled, 13-28 x 4-6(7) µm. Epihym. brownish, hyp. light brown

**Mycobilimbia epixanthoides**

14* With other characteristics. Thallus whitish, gray to gray-green, usually ± warty to finely granular, not erupting yellowish to green-yellowish sorediate. Ap. usually numerous.

15 Ap. at first concave to flat, with thick, protruding, often shiny margin, narrowly sessile (cup-form), later convex-marginless, dark brown-red, dark brown, brown-black, 0.5-1.2 mm. Sp. (2-)4 celled, 15-27 x (4.7)5-7.5(8) µm. Hyp. pale to reddish-brown above. Hym. pale brownish, even olive above. Paraph. -2 µm thick. Exc. and hyp. cartilaginous. Thallus finely granular to wrinkled; above all at the base of trees in higher sites.

**Mycobilimbia fusca**

15* Ap. usually rapidly convex-marginless. Hyp. usually red-brown above. Epihym. pale brown to brown-red or olive-brown. Paraph. 2-3 µm thick (M. sabuletorum s.l.)

16 Ap. (yellow-brownish), cinnamon-brown, dark brown to black, often somewhat shiny, very quickly convex marginless, -0.7 mm, relatively close standing. Epihym. pale brown to brown-red, hyp. brown-reddish to almost colorless. Sp. (2-)4(6) celled, 16-30 x 5-6 µm.

**Mycobilimbia microcarpa**

16* Ap. dirty rose-brown, brown to blackish, usually very rapidly convex-marginless, the young however also flat and with weakly raised margin, -1 mm, sometimes slightly pruinose. Epihym. colorless, yellow-brown, brown, olive-brown. Hyp. yellow- to red-brown in the upper part, lighter below. Sp. (4)6-8(12) celled, 18-40 x (4)5-8 µm. Thallus warty-uneven to granular or scurfy

**Mycobilimbia sabuletorum**

2 Commonly on thin branches of conifers and dwarf shrubby stems (e.g. *Vaccinium*). Sp. ellipsoidal. (2-)4 celled, 10-16 x 2.5-4 µm. With whitish, often protruding, -0.2 mm wide pycn. Ap. whitish, pale (rose) yellowish to pale brownish (orange in the herbarium), -0.5 mm, at first flat with thin whitish margin, later convex-marginless. Thallus gray-greenish

**Fellhanera subtilis**

2* Not commonly on thin branches of conifers and dwarf shrubs

3 Thallus, when well developed, pycn. and hym. C+ red, pycn ± sunken, with paler to light greenish, broader, mostly bowl-shaped sunken mouth region. Hyp. ± colorless. Pycnosp. over 20 µm long.

3* Thallus and hym. - C-. Hyp. dark

4 Pycn. white to slightly reddish or above all in the herbarium slightly brownish, ± sunken. 0.1-0.2 mm. Pycnosp. mostly over 20 µm long, threadlike, curved. Thallus green, green-gray, above all in the herbarium also beige to ochre, very finely granular, often relatively thick. Ap. gray-brown to rarely red-brown, -0.8 mm, ± flat, often with somewhat lighter margin, on moistening first the margin, then the disk darker. Hyp. dark-brown. Sp. needle-like, indefinitely separte, 25-35 x 1.2-1.7 µm.

**Bacidina arnoldiana**

4* Pycn. brown, violet-brown, black, projecting. Hyp. dark brown to red brown.

5 Pycn. violet-brown to brown-black, lighter around the open mouth, -0.2 mm, hemispherical or vertically elongated. Pycnosp. 23-36 x 1 µm, scarcely curved, 1-4 celled. Sp. 29-35 x 3-4 µm, pointed on one end, 4-8 celled. Ap. rose-brown to gray-brown, with relatively thick, same colored margin, -0.4 mm. Epihym. and hyp. red-brown. Exc. paraplectenchymous. Paraph. branched and anastomosing. Thallus green to gray-green, with relatively smooth upper surface, not granular

**Fellhanera vezdae**

5* Pycn. black, 0.1-0.3 mm. Pycnosp. 3.5 x 1-1.5 µm. Ap. black, -0.8 mm. Sp. 11-16(20) x 3-5 µm, 2-4 celled. Epihym. green to olive. Exc. and hyp. dark red-brown. Paraph. predominantly simple. Rare on bark.

**B. trachona**

6 Sp. strongly curved. S-form or bean-form (Sp. k, o).

7 Sp. bean-form, with rounded ends, to 8-16, 4(6) celled, 10-18 X 4-5 µm. Ap. black, flat, with thin permanent margin, like a small *Lecidella elaeochroma*, -0.7 mm. Epihym. olive-brown, bluish-green to violet. Hyp. colorless to slightly reddish-brown

**Arthrosporum populorum**

7* Sp. strongly bent, worm-form to spiral, coming to a point on at least one end, up to 8, 4-8 celled, over 18 µm long

8 Epihym. and exc. red-brown to reddish. Paraph. simple. Hyp. colorless to pale red-brown. Ap. black, -0.5 mm, flat to moderately convex, with thin, finally disappearing margin, sp. 20-43 x 2-3.5 µm, 4(6) celled, needle-form to at least partially worm-form. Thallus whitish to indefinite.

**B. hegetschweileri**
8* Epiphyllum. blue-green, olive-brown, rarely brown. Paraph. branching and anastomosing. Ap. brown, red-brown, brown-black, -0.6(0.8) mm, convex-marginless. ↑ Scoliciosporum

9 Sp. needle-form, commonly coming to a long point on one end (Sp. a-g), thread-form or long bacillar, not over 4 µm thick.

10 Sp. fusiform to thick finger-form, ends not long pointed (Sp. h, j-n, p), at the most 40 (-0.6(0.8) mm thick.

11 Epiphyllum. green, blackish-green to olive, rarely pale. K-. Hyp. at least above dark (red)brow, K- or K+ purple. Sp. mostly 6-8 celled, 24-38(40) x 2.5-3.5 µm, bacillar. Ap. black, flat, later convex, with a finally disappearing thin margin, -0.7(0.9). Thallus finely granular to almost isidiate, granules ca. 40-100 µm, when fresh generally gray-green, lightened in the herbarium (whitish).

B. subincompta

11* Epiphyllum. yellow-brown, brown, brown-red.

12 Sp. 15-30 x 2-3 µm, bacillar, (often indefinite) 4-, rarely 6 celled. Epiphylm., often also hym. partially dirty reddish. Hym. and exc. (dark) red-brown, K+ purple. Ap. flat, finally convex, with thin, often permanent margin, dark-purple-brown to black, -0.8 mm. Thallus granular-mealy, gray-white to green.

B. incompta


13 Thallus of close standing, very fine granules, often very thick, greenish to gray-green, often with whitish pycn. Ap. brown-gray to red-brown. Hyp. dark red-brown to dark brown. Sp. 27-45(55) x 1-1.7 µm.

Bacidina arnoldiana (PT 1/4)


14 Ap. disk dark brown, dark-red-brown, brown-black, black, gray-black, or lead-gray

14* Ap. not so colored, generally lighter

15 Epiphyllum. dark greenish to dark olive or blue-green to verdigris green

15* Epiphyllum. colorless, yellowish, brown, red-brown, or violet

16 Sp. needle-like, 30-45(60) x 2-3 µm. Ap. -0.6(0.8) mm, bluish to lead-gray, discolored brown to bluish-black, often varying on a single apothecium, fresh disk lighter than the margin, flat, margined, then convex-marginless. Epiphyllum. olive, bluish-green to blue-black, hyp. colorless. Thallus thin, granular-warty to indefinite B. friesiana

16* Sp. bacillar, up to 30(38) µm.

17 Epiphyllum. blue-green verdigris green, K-, often with small blue crystals. Ap. long flat, thin margined, finally also convex-marginless, black, -0.7(1) mm. Sp. 18-30(38) x 1.5-2.5 µm, thin bacillar, 4-8 celled. Paraph. simple to isolated forked above, above -4 µm thick. Exc. dark purple-brown, K+ definitely purple.

B. circumspecta

17* Hym. olive, greenish, dark green, or black-green above, K+ violet. Ap. soon convex-marginless, gray to black

18 Sp. 17-26(29) x 1.5-2.5 µm, 4(-8) celled, thin bacillar, sometimes slightly curved. Paraph. simple to sparsely branched. Exc. thin, paraplectenchymatous. Ap. blue-black, black, (by pruinosity even) gray, 0.5-1.2(1.5) mm. Thallus thin

B. beckhausii

18* Sp. 10-17(19) x 2.5-3(3.5) µm, 4(5) celled, narrow fusiform, often curved. Paraph. branched and anastomosing. Esc. son strongly reduced. Ap. black, brown-to gray-black, -0.4 (0.5) mm.

Micaena nitschkeana

19 Sp. very narrow, 30-60 x 1.3-2(2.5) µm. Ap. -0.6(0.77) mm, center red-brown, brown-black, flat to mostly moderately convex and (often darker) margined, later often high convex-marginless. Epiphyllum. colorless, yellow-brown, dirty brown to rarely olive, hyp. pale yellowish to pale brownish. All the colored part of the ap. K-+ olive-brown. Thallus thin, scurfy-flat wart

B. arceutina

19* Sp. broader, (2)2.5-3.5(4) µm. Ap. becoming larger

20 Thallus conspicuously fine granular to isidiate to coralloid (granules 50-100 µm, rounded to elongated into isidia, like in B. rubella, but often somewhat browned), as a rule well developed, yellow-greenish, (blue) greenish, greenish-gray, often slightly browned. Ap. mostly very sparse, often conspicuously narrowly sessile, the young often bowl-form, then flat, margined, finally even convex, disk dark (red)brow, black, shiny, margin often definitely lighter. Epiphyllum. brown, lilac-brown, violet-gray, red-brown, purple-black, rarely olive, often (not always!) the colored part K+ purple-violet. Sp. (42)60-75(88) x 2.5-3.5(4) µm. ±Atranorin

B. biatorina

20* Thallus not fine granular to isidiate, but flat warty, smooth or cracked. Very rare species. Sp. 8-16 celled, hym. 65-100 µm.

21 Epiphyllum pale to (brown)yellowish, exc. and hyp. above pale brown, yellow or reddish-yellow, all the strongly colored part of the ap. K+ (purple)violet. Paraph. up to 5 µm thick above. Sp. 45-75 x 2.5-4 µm. Ap. brown, red-brown, rarely blackish-brown (fresh at first the margin dark and the disk relatively light, then even this dark), at first flat, thin margined, later convex-marginless, -1.5 mm. Thallus whitish-greenish-gray, flat warty to almost crustose squamulose.

B. polychroa
21* Epiphyllum mostly strongly colored. Paraph. little thickened (2 μm) above. Uncertain separation

22 Ap. black, purple-black, rarely dark brown, flat, margined, later convex-marginless, crowded sessile. Epiphyllum gray-brown, brown-red, black-brown, blue-black, dark olive-violent, K- or K+ purple. Hyp. colorless, yellowish, towards the exc. often brown to red-brown. Sp. 35-80 x 2.5-4 μm. Thallus cracked to scurfy, gray- to gray-whitish

B. laurocerasi

22* Ap. chestnut-brown, dark brown to blackish, at first cup-form, then for a long time flat with mostly permanent margin, finally somewhat raised and therefore somewhat raised sessile. Epiphyllum blue-violent, lilac-gray, purple-brown, (likewise the exc.) K+ purple. Sp. (42)50-92 x 2-3.5(4) μm. Thallus of scattered, flattened warts, yellowish- to greenish

B. subacerina

23 Sp. up to 2 μm thick, rarely over 50 μm long (except B. arceutina), up to 8 celled. Ap. mostly only -0.6 mm wide. Hym. -65 μm high

23* Sp. 2.5-3.5(4) μm thick, at least partially over 50 μm long. Ap. as a rule over 0.5 mm wide. Hym. over 65 μm high

24 Ap. light brown to dark brown, -0.6(0.9) mm, flat, margined, later often convex, flat to usually moderately convex and (often darker) margined, later often high convex marginless. Sp. very narrow, 30-60 x 1.3-2 (2.5) μm. Epiphyllum colorless, yellow-brown, dirty brown to rarely olive, hyp. pale yellowish to pale brownish. All colored parts of the ap. K+/ olive-brown. Thallus thin, scurfy to flat warty.

B. arceutina

24* Ap. whitish, yellowish, orange, light red-brown, brick-red, -0.6 mm. 8 celled

25 Ap. -0.2 mm, often heaped and coalescing, very numerous, rose, pale gray-brown, red-brown to dark brown, with lighter margin, flat to moderately convex. Epiphyllum pale in dark colored ap. brownish above and then K+ purple. Hyp. weakly developed, colorless. Exc. colorless. Sp. indefinitely 1-4 celled, 20-30(38) x 1.3-1.7 μm. Thallus greenish, gray-green, scurfy-granular, often relatively thick, with sunken whitish pycn. Pycnosp. 34-45 x 1 μm, with indefinite septa, the sp. very similar

Bacida chloroticula

25* Ap. 0.2-0.6 mm wide

26 Thallus of fine granules (20-40(50) μm), greenish to (above all in the herbarium) brownish. Ap. flat, margined, whitish, beige, orange, rose-yellow. Exc., hyp. and epiphyllum colorless. Sp. indefinitely 4-8 celled, (20)25-48 x 1-1.5(2) μm. Pycnosp. 21-40 x 1 μm

Bacida delicata

26* Thallus whitish, gray to gray-green, thin to unevenly warty, not of discrete granules. Sp. 4(8) celled

27 Sp. 20-35(45) x 1-2 μm, often curved Ap. whitish, beige to light yellow-reddish, almost colorless when fresh, numerous, very soon convex marginless, -0.5 mm. Hyp./exc. colorless. Hym. 35-50 μm, colorless or yellow-brown above. Thallus warty to mealy

Bacida phacodes

27* Sp. 34-54 x 1.5-2 μm. Ap. pale yellow-reddish, pale red-brown, rarely to brick red, for a long time flat, margined. Exc. 2 colorless, hyp. pale (orange)brown above. Hym. 45-60 μm. Very close to B. phacodes

B. assulata*

28 Hym. with granular outer layer. Ap. rose to light flesh-color (beige in the herbarium), sometimes slightly pruinose, depressed sessile, for a long time flat, with thick lighter margin, finally convex-marginless, -1.5 mm. Thallus finely granular to mealy, light gray(green). Sp. 60-85(100) x 3-4(5) μm

28* Hym. without granular outer layer. Ap. not rose, -1.5 mm

29 Thallus flat warty to almost crustose-squamulose, whitish to greenish-brown. Ap. brown, red-brown, rarely blackish-brown (when fresh, at first the margin dark and disk relatively light, then even these darken), at first flat, thin margined, later convex marginless. Epiphyllum pale to (brown) yellowish, exc. and hyp. pale brown, yellow or reddish-yellow above, all strongly colored parts of the ap. K+ (purple)violet. Sp. 45-75 x 2.5-4 μm

B. polychroa

B. fraxinea is very similar: Ap. brown to brown-red, K-reaction and structure of the ap. (section) are as in B. rubella, sp. 40-85(109) x 2.5-3.5 μm

29* Thallus granular-isidiate to finely coraloid, gray- to yellow-greenish, bluish-green, fading in the herbarium, granules mostly elongated, 60-120 μm. Ap. yellow-red, brick red to brown-red, narrowly sessile, at first cup-shaped, thick margined, then flat, finally even convex-marginless, sometimes with pruinose margin. Exc., epiphyllum and hyp. colorless to yellowish (pale orange). No region K+ violet. Sp. 45-75(84) x 2.5-3.5 μm

Bacida rubella

30 Hym. dark red-brown to black-brown

30* Hym. definitely lighter

31 S. elongate to fusiform, at best 4 μm thick. Lichens only basally on trees and on decaying wood

32 Bacidaria melaena

31* Bacidaria melaena

32 Bacidaria melaena

32* Sp. 18-40 x 5-8 μm, 4-8(10) celled. Epiphyllum brown to olive. Young ap. margined, brown-red to (almost) black. Hym. red-brown above.

Mycobilimbia sabuletorum (PT 2/16)

33 Epiphyllum green, green-blackish to olive, rarely pale. Sp. 24-38(40) x 2.5-3.5 μm, mostly 6-8
celled. Thallus finely granular to almost isidiate, granules ca. 40-100 μm, generally gray-green when fresh, in the herbarium lightening (whitish)

**B. subincompta** (11)

33* Epithym, often partially also the hym, dirty reddish. Sp. 15-30 x 2.3 μm, (often indefinite) 4-, rarely 6-8 celled. Thallus granular-mealy, gray-white to -green

**B. incompta** (12)

34 Sp. very narrow, -3 μm. Epithym. or upper part of the hym. blue-green, olive, green. Thallus thin, indefinite to warty, gray to pale greenish. Sp. 10-17(19) x 2.5-3(3.5) μm, 4(5) celled, narrow fusiform, often curved. Paraph. branched and anastomosing. Exc. soon strongly reduced. Ap. black, brown- to gray-black, -0.4(0.5) mm

**Micarea nitschkeana**

34* Sp. broader 35

35 Thallus, ap. and hym. C+ red. Ap. 4- to 8 celled. Paraph. strongly branched and anastomosing. Ap. (often on the same thallus) various colored, light gray, lead-gray, violet-gray, yellow-gray, rose-brown to almost black, convex watch-glass form. Thallus with smooth upper surface, coherent and uneven to consisting of rounded convex areoles

† **Micarea peliocarpa/cinerea**

35* Thallus, ap. and hym. C-. 36

36 Thallus gray to greenish, coarse granular- warty, P+ red, on decaying wood, very rarely on acid bark. Ap. pure black throughout, marginless, very rapidly convex. Sp. 16-34(38) x 4-6(7) μm, 4-8 celled

† **Micarea lignaria**

36* Thallus R-. Commonly on bark. Ap. (at least in part) not pure black (with the exception of occasionally *B. auerswaldii*: ap. for a long time definitely margined).

37 Ap. -0.3 mm, red-brown, brown-red, brown-black, rapidly convex-marginless, often shiny. Thallus gray-green to dark green, irregularly granular. Sp. 20-40 x 4-5 μm, commonly 8-celled, usually gradually narrowed toward one end, sometimes curved. Epithym. brown to red-brown, but even olive to green. Paraph. rach'd, anastomosing. Exc. of branched anastomosing hyphae, soon reduced. On acid substrates.

**Scoliciosporum chlorococcum**

37* Ap. commonly 0.3 - 0.8 (1.2), often margined at least when young. Exc. definite. On base-rich bark. Hyp. colorless or brown above.

38 Hyp. brown above. Sp. 4-8 celled, 18-40 x 5-8 μm. Ap. dirty brown, rose-brown, brown, or black-brown. Rarely at the base of stems

† **Mycobilimbia sabuletorum**

38* Hyp. colorless to slightly yellowish in the upper region. Sp. up to 26(28) μm, to 4-, rarely 6-celled

39 Ap. brown to black or lead-gray. Red-brown part of the exc. and epithym. usually K+ (strongly) purple

39* Ap. light colored, whitish, yellowish, rose, rose-brown, or light brown. Exc., hyp. and epithym. colorless or slightly yellowish

40 Ap. dark brown to black, at first concave, thick margined, finally flat to moderately convex and ± marginless, purple-black to black, -0.8(1.2) mm. Thallus finely granular-isidiate-coralloid. Sp. 20-26(36) x 4-5(6) μm, elongate fusiform. Epithym. olive-brown. Lichen very similar to *B. biatorina* (†), but distinguished by the sp. *Rh-Mn-T*

**B. auerswaldii** (Hepp ex Stizenb.) Mig.

40* Ap. very variable in color, lead-gray, blue-gray, gray-brown, brown, or blackish, sometimes varying on the same ap., in shade-forms or in youth even whitish, flat to convex, with lighter margin to marginless, -0.5(0.8) mm. Sp. 13-24(28) x 4-5(6) μm, 4(6) celled, straight or slightly curved. Epithym. brown, red-brown, violet-brown (usually K+ intensive purple), pale greenish, gray-green, blue-green (K+ intensive green) or colorless. Hym. 50-65 μm. Paraph. simple or forked, -5 μm thick above. Thallus thin, ± smooth, pale gray-green.

**B. naegelii** (Danger of confusion with *Lecania fuscella*, there paraph. scarcely thickened above)

41 Ap. whitish, individually often gray, -0.5(0.8) mm. Lichens on branches and stems, scarcely over mosses or in moss communities. Hym. up to 50-60(65) μm. Compare with shade-forms or young thalli of *B. naegelii* (39) with paler epithym.

41* Ap. whitish, yellow- to flesh-reddish, old ones at times also brown, as a rule over 0.5 mm wide. Lichen usually on old or moss covered stems or at the stem base. Hym. 60-80 μm. Very rare species.

42 Thallus gray, green-gray, finely granular to almost mealy-sorediate, granules 25-70 μm. Ap. rapidly hemispherical, then ± spherical, yellow-to flesh-reddish, beige, yellow- brown, or brown (at best brown when old), very rapidly marginless, -0.8 (1.2) mm. Sp. predominantly 2-, sparingly 4-celled, 10-17 x 3.5-5 μm, broadly fusiform to ellipsoidal.

**Mycobilimbia sphaeroides**

42* Thallus gray, whitish, or pale greenish, granular-warty. Ap. whitish, beige, yellow- to flesh-reddish, at first flat-cup form, with rather thick margin, later convex-marginless to almost spherical, -1.2 mm. Sp. 12-22 x 4-7 μm, (2-4)6(celled), fusiform. Closely related to *M. fusca*.

**Mycobilimbia carneoalbida**

**Ecology and Distribution of the Species**

**Bacidia arceutina** (Ach.) Arnold
Up into montane sites on subneutral to moderately acid deciduous tree bark, above all on ash, willow, common maple, and poplar, on humid habitats, especially brook bordered thickets, r.-m.photoph., a-/m.nitroph., weakly toxitol., e.g. in the Acerocordietum gemm., with *B. rubella* – mieur-subat-med – rare (3); Ne, Mn, SFW, O, Rh, Sch, HRh, SJu, Bo, Al, Eif, Ts

**Bacidia assulata** (Körber) Vézda (B. intermedia (Stizenb.) Arnold)

Up into montane sites above all on deciduous trees, favoring relatively base-rich bark, especially on ash, elder, and beech, subneutroph.-m(r.)acidoph., r.hygroph., often with other Bacidias (*B. subacerina, B. arceutina*) – mieur-med – rare (2); süHü, süSch, Ne, Ju, O, Saar, Rh-M-T, ThW

**Bacidia bagliettoana** (Massal. & De Not.) Jatta (B. muscorum (Sw.) Mudd)

Above all up into montane sites on mosses and plant detritus over calcareous soil and in fissures of limestone, in openings of dry turf on flat ground, stony soil, on calcareous dunes, on gravel pits, also on walls, almost never directly on soil, commonly on light-rich habitats, basiph., xeroph.-mesoph., in numerous moss communities, also in the Toninia sed. – bor-med-mo – rather rare (3); above all Ju, SJu, FrJu, moreover rare (e.g. He, Th, Mn, Rh, Ne, Hü, Mos, Eif, Saar)

**Bacidia beckhausii** Körber (B. minuscula (Anzi) Vézda)

From the sub- up into the high montane zone on deciduous trees with usually rather base-rich bark, above all sycamore, ash, old beech, usually on moderately rain exposed sites on stems, e.g. in bark cracks, principally on high precipitation sites in humid forests, subneutroph.-m.acidoph., m.photoph.-r.skioph., a-(m.)nitroph. – bor-med-mo – (r.)rare (3); Sch, Vog, süHü, Ne, Ju, SFW, O, Sp, Rh-Mn-T, Eif, ThW, Erz, Al

**Bacidia biatorina** (Körber) Vainio (Catillaria g. (Flörke) Th.Fr.)

Concentrated in montane, high precipitation sites in moist mountain forests, e.g. on oak, beech, spruce, especially in beech-spruce forests, m.acidoph., v.hygroph., m.photoph., anitroph., e.g. in the Lobarietum pulm. – mieur-subat – rare (2); Sch, Sb, O, SFW

**Bacidia circumspecta** (Nyl. ex Vainio) Malme (B. quercicola (Nyl.) Vainio)

In hilly to montane sites on older deciduous trees in the interior of thinned forests, rare in the open land, m.acidoph.-subneutroph., of similar ecology as *B. subincompta* and *B. rubella* (↑) – s’bor-smed-mo – rare (1); süHü süSch, SJu, Ne, O, Eif, We, Th, ThW

**Bacidia fraxinea** Lönnr. (B fallax (Körber) Lettau)

Very similar to *B. rubella* (↑), but more limited to warm summer continental region – mieur-smed, (subko) – v. rare (1); SFW, Fr, Th

**Bacidia friesiana** (Hepp) Körber

Up into the montane sites on subneutral deciduous tree bark on m.-r.light rich, often eutrophic habitats, especially on elder, elm, maple, ash, above all at the base of free standing trees, subneutroph.-neutroph., m.-r.nitroph., e.g. in the Lecanoretum samb. – (s’bor-)mieur-smed – rare (1); Sch, HRh, Bo, O, Ju, Ne, Ml

**Bacidia fuscoviridis** (Anzi) Lettau

In the climatically mild to warm regions, up into the montane sites on carbonate rock, especially limestone, on nutrient rich, often eutrophic, rather light poor to moderately light rich and rather humid habitats, above all on rain exposed, sometimes also from time to time running water moistened steep surfaces, frequently also synanthrop (old native stone walls), basiph., m.-r.ombroph., e.g. in the Acrocordietum con. – mieur-smed – r.rare; wide-spread, above all Ju, SJu, Ne, Eif, Hü, Th, but rare

**Bacidia globulosa** (Flörke) Haf. & V.Wirth (Catillaria g. (Flörke) Th.Fr.)

Up into the high montane zone on flat to deeply cracked bark of deciduous trees, rarely conifers in cut-over forests, at the forest margin, also on wood, on lower sites above all on the trunk of oak, m.-r.acidoph., r.-v.anombroph., r.hygroph., (r.skioph.-m(r.)photoph., a-/m.nitroph., often with only very little attendance in the bark cracks between other communities, e.g. in contact with Chrysotrichetalia cand. – bor-med(mo) – in SW-Germany moderate frequency, in W and N rarer and at times strongly in regression.

**Bacidia hegetschweileri** (Hepp) Vainio

In the montane sites on moderately acid bark of deciduous trees – bor-mieur-mo – very rare (0); süSch, O, ThW, He, Mfr

**Bacidia herbarum** (Stizenb.) Arnold
Up into the montane zone on dying mosses and remains of higher plants above all over lime-rich soil, on subneutral, mineral-rich bark (e.g. aspen) – bor-mieur – v.rare; Fr(Sugenheim), Th, Saar, Al

**Bacidia incompta** (Borrer ex Hooker) Anzi
Up into the montane zone on deciduous trees, especially on subneutral bark (Norway maple, common maple, popular, and elm) on m.-r.light rich habitats, e.g. in the Acrocordietum gemm. – bor-smed – rare (1); Rh, Bo, Ju, **SFW, Ts**

**Bacidia laurocerasi** (Delise ex Duby) Zahlbr. (B. endoleuca auct., B. atrogrisea (Delise ex Hepp) Körber)
Up into the montane zone on deciduous tree bark, above all on ash, willow, beech, and hornbeam, in humid forests, e.g. oak-hornbeam forest, m.acidoph., m.photoph., anitroph., in the community of Graphidetalia – mieur-subatl-med – v.rare (0); süRh, süHü, HRh, Sch, O, Bo, Ju, Al, Mi

**Bacidia naegelii** (Hepp) Zahlbr.
Up into the montane zone on deciduous trees (rarely conifers), above all on subneutral to weakly acid, mineral-rich bark (e.g. elder, popular, walnut, ash, maple, and oak), on the stems as well as the branches, on (m.-)r.light-rich habitats, subneutroph.-m.(r).acidoph., e.g. in the Lecanoretum sambuci, Acrocordietum gemm. – s’bor-med – r.rare (3), e.g. Hu, Ne, SFW, Ju, SJu, Rh, HRh, Sch, O, Sp, Saar, Ts, Eif, He, Th, disappearing beyond south Germany

**Bacidia polychroa** (Th.Fr. Körber (B. fuscorubella (Ach.) Bausch, B. acerina (Ach.) Arnold)
In hilly and submontane, rarely montane sites, prefers deciduous forests in moist valleys, e.g. in oak-sycamore forests, on subneutral, often soft, water accumulating bark (e.g. ash, maple, elm, and elder), on climatically mild, humid habitats, m.photoph., r.-v.hygroph., e.g. in the Lobarian, in the Acrocordietum gemm., Lecanoretum sambuci – mieur-subatl-med(-med) – rare (1); süSch, HRh, Ju, FrJu, Bo, O

**Bacidia roSELLA** (Pers.) De Not.
In the hilly and submontane (rare in the mild montane) sites on deciduous trees, especially on smooth and flat cracked bark on the stems and stem bases, above all on beech, hornbeam, oak, common maple, in cool oak-hornbeam- and beech-spruce forests, m.acidoph.-subneutroph., anitroph., Char. Pyrenuletum nit. – mieur-subatl-med-mo – rare (2); Mn, Ne, ?Sp, Ts, **MrH, Rh-Mn-T, He, ThW, noHü, O, Ju, FrJu, SFW, Mfr, süSch, Vog**

**Bacidia rubella** (Hoffm.) Massal. (B. luteola “(Ach.) Mudd”)
Up into the montane zone in cut-over forests and on free-standing deciduous trees on mineral-rich, subneutral, often cracked to somewhat spongy or decayed bark, also on overgrowing moss in lower sites especially in oak-hornbeam forests, above all on maple, ash, older oak, in fruit orchards on apple trees and on walnut, in higher (usually mild) sites especially on oak and sycamore, subneutroph.(-m.acidoph.), m.-v.hygroph., m.-r.photoph., a/-m.nitroph., m.toxitol., often with Acrocordia gemm., Opegrapha varia, Aleuroidiscus, above all in the Acrocordietum gemm., **Bacidia rub.-Aleurod.** community. – s’bor-med(mo) – r.rare (-m.frequent) (3), throughout the entire region, up into rather air polluted regions, here however sterile, above all JU, SJu, HÜ, Ne, in the northwestern and northern regions (RhSch, HeBgl) rare to disappearing

**Bacidia subacerina** Vainio
Above all in the montane sites, rarely lower, prefers moist mountain forests in high precipitation regions, e.g. in beech-spruce(-fir) forests, on conifer and deciduous tree bark, m.-r.acidoph., m.photoph.(r.-skioph.), (r.-)v.hygroph., anitroph., e.g. in the Pseudevenietum – s’bor-mieur-subatl – rare (1); süSch rare JU, Ne, Do, Al, ThW

**Bacidia subincompta** (Nyl.) Arnold (B. affinis (Stizenb.) Vainio)
Up into the high montane sites on deciduous tree bark, predominantly on older oak and ash, rather similar to **B. rubella (↑)**, but rarely on free-standing trees, m.photoph.-r.skioph., in the Acrocordietum gemm. – bor-med(mo) – r.rare (3), isolated in the SW, e.g. Sch, Bo, Ju, SFW, Mn, Ne, O, Ts, ± lacking in intensive agricultural regions

**Bacidia trachona** (Ach.) Lettau (B. coprodes (Körber) Lettau)Up into high montane sites on shaded, humid, sheltered places in ravines, forests, on north exposed, on (often moist) rocks on limestone and calcareous or basic silicate rock, generally on steep to overhanging surfaces,
rare also on old walls, commonly passing over to bark – bor-med – rare; Ju, SJu, Al, Mos, Eif


Bacidina Vézda

(Determination ↑ Bacidia)

Introduction

The genus includes crustose lichens, which are very similar to Bacidia, but often have greenish, finely granular thallus with whitish pycnidia and filamentous pycnospores. They are usually dwellers in pioneers or ephemeral habitats, fast growing and resistant to air pollution.

B. phacodes resides on bark of deciduous trees (e.g. beech), but also on moss over bark, lime- and silicate rock. Also B. arnoldiana displays a relatively broad ecological amplitude. They occur on moist shaded sites on the base of trees, on lime- and silicate rocks. B. inundata lives amphibiously on lime-free to weakly lime-containing rocks in brooks. B. egenula on shady habitats on rocks and stones of silicate rock.

Most of the species are widely distributed in the region of the summer green deciduous forests, whereby their area extends more or less into the mediterranean region. B. phacodes occurs up into the boreal zone, B. inundata up into the high north.

Genus Characteristics

Differing from Bacidia by whitish pycnidia with filamentous, often curved pycnospores. Thallus finely granular, of goniocysts, often greenish to green-gray. Spores needle-like, often indefinitely cross septate.

Ecology and Distribution of the Species

Bacidina arnoldiana (Körber) V. Wirth & Vézda (Bacidia a. Körber)

Above all in the hilly and submontane sites, but also up into the montane zone on m.light-rich to r.light-poor, m.-r.humid, also moist substrates on limestone (above all on steep surfaces), on the base to the middle of the trunk of deciduous and conifer trees, especially in meadow forests, oakhornbeam, substrate vagrant, r.acidoph.-basiph., toxitol., e.g. in the Acrocordion con., in species poor Graphidion- community, e.g. with Porina aenea – mieur-med – r.rare-m.frequent, widespread and spreading in hilly and submontane sites

Bacidina chlorotica (Nyl.) Vézda & Poelt (Bacidia ch. (Nyl.) A.L.Sm.)

In hilly and submontane sites on cross-sections of wooden fences, on plant detritus, concrete, stones etc., usually on near the soil on long dew moistened or sites remaining shaded, very substrate vagrant, m.acidoph.-basiph., m.photoph.-r. photoph., (substrate hygroph.) – (s’bor-)mieur – overlooked, Lux

Bacidina delicata (Larbal. ex Leighton) V. Wirth & Vézda (Bacidia d. (Leighton) Coppins)

In the hilly to montane sites, v. substrate vagrant, on subneutral, often ± eutrophic bark of deciduous trees (apple, willow, Sambucus etc.), e.g. in fruit orchards, also on plant detritus, mosses, on calcareous rock, bricks, concrete, rather like B. chlorot. (↑) – mieur-smed – sterile presumable not rare; e.g. Ne

Bacidina egenula (Nyl) Vézda (Bacidia e. (Nyl.) Arnold)

On silicate rock, usually small stones on long time dew moistened or shaded habitats, on shaded brook stone walls – mieur – insufficiently observed, probably O, Sch

Bacidina inundata (Fr.) Vézda (Bacidia i. (Fr.) Körber)

Up to above the tree line, in lower sites rare and even to some extent have disappeared (pollution), above all in clear, cool mountain brooks on frequently flooded or long time moistened boulders or cliffs, commonly on lime-free silicate rock, yet also on calcareous rock and long time moist wood (boards in/on water, wooden fountains), rare also on (not) secondarily moistened, very humid or for a long time dew moistened sites, subneutroph., r.skioph.-m.(r.)photoph., a-(m.)nitroph., substrate vagrant – bor-med-mo – rare (3); süSch. Vog, Eif, nöSch, rare in Sp, O, Bo, Al, Ts, ThW, He

Bacidina phacodes (Körber) Vézda (Bacidia ph. Körber, B. albescens (Stizenb.) Bausch)

Above all in submontane and montane sites on deciduous tree bark, also on conifers, on mosses over bark and silicate rock, very rare directly on rock, preferably on wood (decaying stumps), sociology and ecology widely comprehensive,
### Bactrospora Massal.

(Determination ↑ Lecanactis)

**Introduction**

The 20 species included with the related genus *Lecanactis* are recognized by the decomposition of the multicellular, cross septate thin spores into numerous fragments while in the asci. The thallus is crustose, simply constructed and containing *Trentepohlia* algae, the apothecia are black to brown-black, with or without definite proper margin. Exc. definite, exterior dark red-brown, interior often lighter. Hyp. colorless. Epith. light to dark red-brown. Hym. I- to I+ blue (*B. dryina*). Paraphysoids branched and reticulate, not thickened above, clearly longer than the asci. Asci narrowly clavate to cylindrical, fissionuncinate, with narrow tholus and very short ocular chamber, which sometimes is surrounded by a flat ring-like I+ blue structure. Sp. needle-like, multicellular, commonly already in the ascus disintegrating into short broken pieces. Pycnosp. short cylindric. Ch.: often Stictic acid, Norstictic acid.

**Ecology and Distribution of the Species**

**Bactrospora dryina** (Ach.) Massal. (*Lecanactis dryophila* Lettau)

In the hilly to submontane, mild winter sites on trunks of old oaks on rain-sheltered flanks, similar to *Arthonia pruin.* (†), mostly in even species-poor stands, in the Arthonietum pruinatae – mieur-med, subatl – rare (3); süSch, Ju, SFW, O, Sp. *Rh-Mn-T+, MRh-Ts, Eif*

**Baeomyces** Pers.:Fr.

(Key incl. *Dibaeis*)

**Introduction**

The worldwide distribution of the genus includes three species in Europe. They are characterized by definitely stalked apothecia with a brown colored, flat to convex disk and a light gray to pale greenish or slightly brownish, purely crustose to squamulose, sometimes lobed at the margin, leaf-like thallus. The rose fruited species with spherical apothecial heads have been placed in the genus *Dibaeis.*

*B. rufus* and *B. placophyllus* live on acid mineral soils or on silicate rock near the soil. *B. rufus* is widely distributed in Europe. *B. placophyllus* is largely limited to western Europe and penetrates up into the arctic. In our region the species reaches the eastern border of the contiguous area.

**Genus Characteristics and Determination**


1  Ap. rose, almost spherical from the first, 1-4 mm wide, stalk -5 mm high, whitish, rarely pale rose. Thallus crustose, of convex to almost spherical areoles, whitish to light gray, often extensive and sterile, K+ yellow, P+ yellow, C-, Atranorin, Baeomyic acid, ± Squamatic acid, Barbatic acid.

**Dibaeis baeomyces** (= *B. roseus*)

**LIT.:** *Diederich* 1989, *Purvis* et al. 1992, *Vainio* 1922, *Vézda*
Bellemerea Haf. & Roux

(Determination ↑ Aspicilia)

Introduction

Bellemerea includes alpine rock dwelling crustose lichens, which with their sunken, concave to flat apothecia are reminiscent of Aspicilia. There are perhaps six known species. In the high central mountains of central Europe there exists a strongly disjunct relict occurrence, thus of B. alpina in the Harz and Riesengebirge, of B. cinereorufescens in the Black Forest (only one found), Erz- and Riesengebirge, Bohemian forest and Thüringer forest. All central mountain occurrences are protected. Both species, besides B. sanguinea, occur also in the Baravian Alps, as well as in the Allgäu.

Genus Characteristics

Bellemerea Haf. & Roux

Ecology and Distribution of the Species

Bellemerea alpina (Sommerf.) Clauz. & Roux

(Bellemerea a. (Sommerf.) Arnold, Lecanora a. Sommerf.)

In alpine high precipitation sites on lime-free silicate rock on smaller boulders, on stones and on base surfaces of cliffs on long-time moist, of long-time snow covered, for alpine relatively wind protected, cold sites, especially in maritime boulders, rubble slopes on shaded surfaces, in the moors, near brooks, m.-r.acidoph., (substrate hygroph.) m.-r.photoph., anitroph., Char.

Bellemerea rufus (Hudson) Rebent.

Perhaps up to the tree line on acid, mostly cool, sandy to pure loam soils, mostly on less compacted road embankments, rarely in lacunae of thin turfs, prefers silicate rock, on soil impregnated stones, shady-moist cliff surfaces (pioneer) or near the soil on boulders remaining moist for a long time, frequent in the interior of forests, mostly on rather light poor to moderately light rich habitats, in high precipitation sites also on radiation exposed sites, m.-v.acidoph., r.skiioph.-r.photoph., substrate hygroph., e.g. in the Lecideetum ulig., Porpidietum crust., frequently also dominating and almost without escort – bor-smed(-med-mo) – rather frequent, limestone (v.) rare

Genus Characteristics


Bellemerea alpina (Sommerf.) Clauz. & Roux

Bellemerea Haf. & Roux

Bellemerea cinereorufescens (Arnold, Lecanora a. Sommerf.) Clauz. & Roux

Bellemerea sanguinea (Sommerf.) Clauz. & Roux

Bellemerea Haf. & Roux

Bellemerea Haf. & Roux

Bellemerea Haf. & Roux

Genus Characteristics


Ecology and Distribution of the Species

Bellemerea alpina (Sommerf.) Clauz. & Roux

Bellemerea Haf. & Roux

Bellemerea cinereorufescens (Arnold, Lecanora a. Sommerf.) Clauz. & Roux

Bellemerea sanguinea (Sommerf.) Clauz. & Roux

Ecology and Distribution of the Species

Bellemerea alpina (Sommerf.) Clauz. & Roux

Genus Characteristics


Ecology and Distribution of the Species

Bellemerea alpina (Sommerf.) Clauz. & Roux

Bellemerea Haf. & Roux

Bellemerea cinereorufescens (Arnold, Lecanora a. Sommerf.) Clauz. & Roux

Bellemerea sanguinea (Sommerf.) Clauz. & Roux

Ecology and Distribution of the Species

Bellemerea alpina (Sommerf.) Clauz. & Roux

Genus Characteristics


Ecology and Distribution of the Species

Bellemerea alpina (Sommerf.) Clauz. & Roux

Genus Characteristics


Ecology and Distribution of the Species

Bellemerea alpina (Sommerf.) Clauz. & Roux

Genus Characteristics

**Rhizocarpetum alp. – arct-alp – Alps (e.g. Al), Hz**

*Bellemerea cinereorufescens* (Ach.) Clauz. & Roux (Aspicilia c. (Ach.) Massal., Lecanora c. (Ach.) Hepp)

Like *B. alpina*, often on yet stronger shaded-moist sites, also on heavy metal rich rock, Char. Rhizocarpetum alp. – arct-alp – very rare (R); süSch (Feldberg), ThW, Erz, BayW, Alps


**Belonia Körber ex. Nyl.**

**Introduction**

The *Belonia* species have a uniformly crustose thallus with perithecia-like, usually rose to red-brown fruiting body and *Trentepohlia* algae. The two (of the altogether ca. 12) proven species in Germany occur above all in north Europe and in the high mountains of central Europe, in the Alps and the Carpathians. Isolated discovery points lie in the Riesengebirge, the Black Forest and the Voges (*B. russula*) or in the Black Forest, in the Rothaargebirge and in the Sudenten (*B. incarnata*). *B. russula* lives on from time to time flooded cliff walls of slightly calcareous or basic silicate rock, *B. incarnata* on naked, cool soil in alpine thin turfs.

**Genus Characteristics and Determination**

Thallus thin or ± sessile in the substrate, light, mostly rose tinted when fresh, with *Trentepohlia*. Ap. perithecia-like (in the indigenous species with permanent pore-form opening), sunken in thallus warts, rose, yellow-brown, or brown-red. Exc. light to yellow-brown. Epihym. colorless. Hym I+ blue, often with oil droplets. Paraphyses thin, simple, permanent, septate. Asci narrowly cylindric, thin-walled. Sp. to 8 (non-indigenous species also to 4-6), long needle-form, multicellular, cross-septate. Ch-.

1 On naked soil and soil mosses. Thallus dirty green to gray, thin, ± gelatinous, with *Trebouxia*. Per. half sunken, beige, pale yellowish to pale reddish, -0.5 mm. Sp. 80-170 x 3-4.5 µm . **B. incarnata**

1* On silicate rock. Fresh thallus reddish(brown), in the herbarium pale yellowish to ochre, with *Trentepohlia*. Per. in -0.7 mm wide, hemispherical to almost spherical thallus warts, red-brown, yellow-rose to yellow-brownish. Sp. 50-110 x 3-5(6) µm **B. russula**

**Ecology and Distribution of the Species**

*Belonia incarnata* Th.Fr. & Graewe ex Th.Fr. Commonly above the tree line on cool, humus, fine rich soil, ± nutrient rich, often thoroughly moistened (melt water, high rainfall) soil in openings in turf and dwarf shrub communities, on wind exposed habitats, secondarily on road margins, directly on soil or overgrowing dead soil mosses, r.-v.acidoph., m.-v.photoph., substrate hygroph., in the Lecidomatetum dem. – s’bor-mieur-alp – v.rare (1); süSch (Feldberg), Sauerl, Alps

*Belonia russula* Körber ex Nyl.

In the high montane to alpine, high precipitation sites above all on crystalline, slightly calcareous or basic silicate rock on shaded, sporadically trickle moistened rocks, often on vertical surfaces and slightly overhanging, prefers edges of fissures, subneutroph. (-m.basiph.), r.skioph., r.-v.hygroph., anitroph., e.g. with *Porina lecistissima*, *Opegrapha gyrocarpa* or *Lecanactis dill.* (e.g. in the Porpidietum glaucophaeae, in contact with Enteporographetum zon.) – bor-mieur-h’mo – v.rare (R); süSch. Vog

LIT.: PURVIS ET AL. 1992, VÉZDA 1959

**Biatora Fr.**

**Introduction**

The genus includes crustose lichens with perched, usually light to dark brown (to blackish) biatorine, ± convex, from the first an outwardly marginless or at first weakly margined apothecia with ellipsoid to narrowly ellipsoidial , one- to two-celled, cross-septate spores. The *Biatora* species live on moss, plant detritus and bark of trees in moist mountain forests. *B. helvola*, *B. fallax*, *B. epixanthoidiza* and sometimes *B. vernalis* live on bark, above all the trunk base of deciduous trees and spruce. Since most of the species occur especially in small little disturbed mixed forests, they are threatened, especially *B. fallax*. The *Biatora* species are distributed in the
boreal forest zone and in mountainous central Europe. A few nonindigenous species have an arctic-alpine area and live on plant detritus, mosses and raw humus.

**Genus Characteristics and Determination**

Thallus crustose, usually thin and little differentiated or in the substrate, rarely very finely squamulose. Ap. light to dark brown, red-brown, yellow-brown, with indefinite projecting margin or mostly marginless, soon moderately to strongly convex. Exc. clearly developed, of radiating hyphae, cartilaginous. Hyp. shiny colorless or yellowish above, without granular layer above, I+ blue. Hyp. cartilaginous, colorless to yellowish. Paraphyses simple to scarcely branched, thickened above. Ascii clavate, Biatora type (with thick I+ and K/I+ blue tholus, in which a cone-like, non amyloid central plug is inserted from below, which in due course is surrounded by a thin I+ and K/I+ deep blue zone. Wall K/I-, with a thin I+ and K+/ blue gelatin outer envelop. Sp. 1-2(4) celled, ellipsoidal to elongate. Usually Ch-, sometimes Gyrophoric acid, Argopsin.

1 Thallus of very small, sometimes granular squamules (40x), sometimes split at the margin, P+ red, section also C+ red. Soralia, if occurring, widely scattered, usually P+, C+ red. Argopsin, Gyrophoric acid.

1* Thallus not of such squamules
2 Thallus sorediate, often sterile
2* Thallus not sorediate, at best completely finely granular, R-.
3 Sorediate region yellowish-green to yellowish, C+ red or P+ red, K-.
3* Sorediate region yellowish-green, warty areolate, light gray to gray-green.
4 Soralia P+ red, C-, mostly rounded, bordered, ± flat, -0.5 mm wide, later also coalescing and covering the most of the thallus. Thallus thin, on bark. Ap. like B. helvola, brown to light red-brown, soon convex. Argopsin

**B. epixanthoidiza**

4* Soralia C+ rose-red, P-, mostly irregular, diffuse, thick and mostly convex, soon coalescing. Thallus greenish-gray, thin coherent to granular, often on mosses. Soredia ca. 40-80 μm. Ap. -0.8 (1) mm, soon convex and marginless, pale rose-brown, light brown, red-brown, epiphy. colorless to brownish. Sp. 10-16 x 4-6 μm, 1-2 celled. Gyrophoric acid.

**B. chrysantha**

5 Thallus greenish-gray, very thin, with granular, bordered, soon coalescing soralia, finally widely sorediate, sorediate region pale yellowish to pale greenish. soredia ca. 40-70 μm. Ch-. Ap. very rare, rose, rose-brown, brown, dark brown. Sp. 4-celled 15-18.5 x 4-6 μm

**Mycobilimbia epixanthoides**

5* Thallus greenish-gray, definitely developed, finely granular to largely erupting sorediate, sorediate region greenish, gray-green, soredia 30-70 μm. Ap. (rose-)yellowish to orange, flesh-colored rose-brown to (above all in the herbarium) ochre, old ones even reddish-brown, rapidly strongly convex, -0.9 (1.1) mm, often clustered. Sp. 2 celled, rarely 4 celled, 10-17 x 4-5 μm, with definite epispore. Paraph. 3-4 μm, strongly cemented

**Mycobilimbia sphaeroides**

6 Sp. largely 1 celled, isolated 2 celled.

**Bacidia PT2**

7 Ap. very small, -0.3 mm, whitish-rose, rose-yellow, moderately to finally high convex, at first delicately marginated, then marginless. Sp. 7-13 x (2)2.5-3 μm. Hyp. epiphym. exc. colorless. Hym. 35-50 μm. Paraph. in part thickened above. Thallus whitish, very thin. It is a question whether it is in the region

B. albohyalina (Nyl.) Bagl. & Car. (Lecidea a. (Nyl.) Th.Fr.)

7* Ap. larger, sp. wider. Epihym. colorless, hyp. pale (yellowish).


**B. vernalis** (L.)Fr.

8* On bark. Ap. in section fleeting C+ orange-rose-, 0.6 (0.7) mm, crowded, commonly moderately convex, light brown, yellow-brown, rose-brown, brown, at times coalescing. Sp. (9.5)11-18 x (3)3.5-4.5 μm, sometimes 2 celled. Thallus flat warty areolate, light gray to gray-green. Epihym. ± colorless. Hyphae of the exc. and paraph. encircled by fine, somewhat granular gold-yellow lines (oil immersion). Gyrophoric acid.

**B. helvola**

Ecology and Distribution of the Species

**Biatora chrysantha** (Zahlbr.) Printzen (Lecidea gyrophorica Tonsberg, Biatora epixanthoidiza auct., non (Nyl.) Räsänen)

On similar habitats as B. helvola (?), but predominantly living on bark, rarely on rock dwelling mosses – bor-atl-mieur-mo – r.rare (3); Sch, Vog, Ju
**Biatora epixanthoidiza** (Nyl.) Räsänen (Lecidea e. Nyl., Lecidea efflorescens (Hedl.) Erichsen)

In high precipitation high montane and montane, rare in submontane sites on trunks (above all toward the base) of deciduous and conifer trees, like *B. helvola* (↑), rarely overgrowing moss – bor-mieur-h’mo – rare (3); Sch, SJU, Vog, O, Ne, ThW

**Biatora fallax** Hepp

In montane, high precipitation sites in old, natural spruce-fir and spruce-beech forests, on the base of older trunks of spruce, fir, and beech, on overgrowing moss, on moderately light rich (to rather light poor), v.humid, cool sites, m.-r.acidoph., anitroph., ombroph. – mieur-subatl-smed-mo – v.rare (0); SFW+, Sch, Vog, Erz, Alps

**Biatora helvola** Körber ex Hellbom (Lecidea h. (Körber ex Hellbom) Hedl.

In high precipitation high montane, more rarely montane sites on smooth and flat-cracked, ± acid bark of deciduous and conifer trees in forests (above all beech-spruce forests, Aceri-Fagetum, spruce-fir forests) and on forest borders, in avalanche tracks, predominantly on the trunk base of beech, mountain ash, spruce, fir, on cool humid habitats, often with *B. epixanthoidiza*, tolerating rather long snow cover, (subneutroph.) m.-r.acidoph., r.skioph.-m.photoph., v.hygroph., anitroph., in the Parmeliopsidetum, in the *Biatora helvola* community. – bor-mieur-h’mo, subco – r.rare (2); Sch, Vog. Al, ThW, Erz

LIT.: FRIES 1874, TONSBERG 1992, VAINIO 1934

**Biatorella** De Not.

(Key incl. Biatoridium, Sarcosagium, Sarea, Strangospora)

**Introduction**

The species of the genus *Biatorella* are small and inconspicuous. On the crustose, usually thin thallus develop bright colored, yellowish to orange-reddish, usually convex, marginless biatorine apothecia, which produce the small single-celled spores in large numbers in the asci. They are easy to overlook and are seldom found. *B. hemisphaerica* grows on lime-rich soils or mosses; this widely distributed boreal and temperate zone ephemeral species, is already for a long time not to be found in the region.

**Genus Characteristics and Determination**

Thallus crustose, thin, undifferentiated, with coccoid green algae. Ap. biatorine, yellow to orange-red, marginless, ± convex. Exc. very thin to lacking. Epiphym. pale to orange-yellow. Hym. pale (brown-reddish). Paraphyses simple, slender, scarcely reticulate, richly branched in the ephydemian region, producing a thick tissue, thickened at the ends. Asci ± elongate cylindrical to clavate, with I+ blue cap in the non amyloid wall, the young apex with an interior, I+ blue region, of I+ blue upper cap-like gelatin envelope surrounding. A very large number of very small 1-celled, elongate ellipsoidal sp. in the ascus.. Ch. *Biatoridium* has, in contrast to *Biatorella* spherical spores., a well developed exc., an I+ blue apical cap on the ascus, *Sarcosagium* a definite, outer paraplectenchymous exc. and amyloid, thin walled, cylindric asci without tholus, *Strangospora* ellipsoidal to spherical sp., broad clavate, I+ blue asci with the wall strongly thickened above and a definite, I+ blue tholus.

Notice: All species in the key R-
margined, later moderately convex, black-brown to black. Sp. 2-3 µm. Thallus indefinite, whitish. Epihym. olive, light brown, or red-brown. Pycn. red-brown to black, often like pruinose by pycnospores. Pycnosp. 1.5-2 µm, egg-form to spherical.

**Strangospora deplanata**

6° Exc. as a rule thin, K-. Ap. from the first convex marginless. Sp. 3-3.5 µm. Thallus ± gray-brown, granular to warty-small lumpy or indefinite.

**Strangospora pinicola**

7° Hym. yellow- to red-brown above. Ap. dark red-brown to black-brown. Thallus indefinite to granular or warty-small lumpy. Hym. -65 µm. Pycnosp. 3-4 x 1 µm.

**Strangospora moriformis**

8° Thallus light greenish-yellow to green, granular to granular-scurfy, green when moist. Ap. yellowish to rose-brown, reddish-yellow, translucent when moist, at first thin whitish (not projecting) margin and flat, when young often with exterior thallus granules, soon moderately convex, -0.5 mm. Paraph. ends definitely thickened. Sp. 3.3-3.5 µm

**Biatoridium monasteriense**

8* Thallus indefinite, often in the substrate. Sp. 3-4.5 µm

9° Ap. orange, ochre- to cinnamon colored, orange pruinose, convex, -0.5 mm. Hym. with granular overlay above and there K+ purple. Paraph. with thickened ends.

**Strangospora ochrophora**

9° Ap. very pale yellowish, colorless when moist, marginless, moderately convex, crowded, -0.4 mm. Epihym. colorless, K-. Paraph. ends not thickened.

**Biatoridium delitescens**

Ecology and Distribution of the Species

**Biatorella hemisphaerica** Anzi (B. fossarum p.p.)

Up into the alpine zone on lime-rich soil and calciphilic mosses, on stones, resting flat on the soil and in soil-filled rock fissures on mostly moderately light-rich habitats, subneutroph.-m.basiph., substrate hygroph. – bor-smed – v.rare (0); Ju, Bo, Al


**Biatoridium** Lahm

(Determination ↑ Biatorella)

**Brodoa** Goward

Introduction

The two *Biatoridium* species have a crustose thallus and yellowish to light brown biatorine apothecia with four-spored asci. They occur on base-rich bark of deciduous trees in the summer green deciduous zone; they are rare and endangered region wide.

Genus Characteristics

Thallus crustose, of fine granules, or sitting in the substrate, greenish to gray, with coccoid green algae. Ap. pale yellowish to brownish, flat to convex, with a not projecting light proper margin. Exc. clearly developed. Hyp. colorless to pale brownish, of intertwined hyphae, fleckwise I+ blue. Epihym. yellowish. Paraphyses simple, rarely branched, clavate thickened above. Ascii narrowly clavate, four-spored, thickened above, with internal I+ blue structure, inner layer I+ intensively blue, outer layer less intensively blue. Sp. spherical. Ch-.

Ecology and Distribution of the Species

**Biatoridium delitescens** (Arnold) Haf.

(Biatorella d. Arnold)

On subneutral bark, predominantly on *Populus*, on light-rich, humid habitats in valleys, like *Lecania cyrtella*, r.photoph., a-(m.)nitroph., *Lecanoretum samb.* – mieur – v.rare, ? even overlooked (1); Ne FrJu, Al

**Biatoridium monasteriense** Lahm (Biatorella monasteriense (Lahm) Lahm)

Above all in hilly and submontane, winter mild sites on usually subneutral deciduous tree bark in thinned forests and in open places, predominantly on maple, Norway maple, elm, ash, also going over to mosses, subneutroph., a-/m.nitroph., in the Acrocordietum gemm, Lecanoretum samb, also with *Normandina*, r.toxitol. – mieur-subatl – r.rare, probably also overlooked; HRh, sÜHü, sÜSch, Ju, Ne, O

LIT.: HAFELLNER IN PRESS, MAGNUSSON 1935, POELT & VÉZDA 1977
Introduction

The *Brodoa* species are white, gray to dark gray, sometimes browned foliose lichens with long, narrow, more or less linear lobes. In contrast to the similar *Hypogymnia* species they have compact, small hollow lobes. They live on silicate rock and are arctic (-boreal) and alpine (-high montane) distributed. They grow on open lighted, usually lower silicate rocks in the high montane zone of the central mountains and in the Alps.

Genus Characteristics


Ecology and Distribution of the Species

*Bryophagus intestiniformis* (Vill.) Goward (Hypogymnia i. (Vill.) Räsänen, Parmelia i. (Vill.) Ach., P. encausta (Sm.) Nyl.)

In high montane to alpine sites on usually acid silicate rock, above all small cliffs, or boulders, on m.-r. long-time snow covered habitats, rather like *Parmelia stygia* (\(\uparrow\)), in water relations more completely demanding than most of the *Umbilicaria* species and often on habitats protected for a longer time from direct radiation, m.-r.acidoph., r. photoph., a-/m.nitroph., in the Umbilicarion cylindricae –arct-h’mo/alp – rare (3); süSch, nöSch, Vog, Vgb, Ts, ThW, Erz, Fi, BayW, Hz

LIT.: KROG 1974, GOWARD 1987

*Bryophagus Nitschke ex Arnold* (Determination \(\uparrow\) Gyalecta)

Introduction

*B. gloeocapsa*, living on cool acid soils, especially on dying liverworts, is the single species of the genus in Europe (one additional in America) and is recognized by a thin greenish thallus, gelatinous swollen in the moist condition, apothecia at first only pore-like, later opened wider with yellowish to red-orange colored deeply concave disk with proper margin and cross-septate, needle- to bacillar spores. *B. gloeocapsa* is distributed in the boreal and central European floral region in places with acid soils and contiguous silicate rocks; it is rare in central Europe.

Genus Characteristics

Thallus crustose, yellowish, with *Gloeocystis* like green algae colonies. Ap. at first sunken, closed, then somewhat projecting and ± open, with “cup-like” depth, yellowish to red-orange colored disks and ± similar colored proper margin. Hym. and asci I+ blue, then yellow to brown. Exc. at first closed on all sides, then bowl-form, exterior of thin-walled, ± radial lying hyphae, interior paraplectenchymatous. Paraphyses simple, thin, cemented. Asci cylindrical, thin-walled, very slightly thickened above. Sp. multicellular, needle-like to long cylindrical, cross-septate. Pycnosp. short cylindrical. Ch-.

Ecology and Distribution of the Species

*Bryophagus gloeocapsa* Nitschke ex Arnold (Gloeolecta bryophaga (Körber ex Arnold) Vézda, Gyalecta g. (Arnold) Zahlbr.)

Especially in montane and high montane, high precipitation sites over liverworts on cool sandy loam soils, on peat and sandy soils, on open road fissures on soil boundaries, also directly on soil, often also over liverworts on silicate rock, e.g. on maritime boulders, usually on cool-moist, shaded habitats, m.-v.acidoph., e.g. in ephemeral moss communities, acid soils – bor-mieur-mo – rare; Sch, Vog. Ts, Rhön, O, Fr, Erz, BayW

LIT.: VÉZDA 1966a.
Bryoria Brodo & D. Hawksw.

(Key includes Pseudephebe)

Introduction

The separation of the genus Bryoria from Alectoria is by the brown and gray beard lichen characteristic. These commonly produce richly branched to loose filamentous pendent thallus, rarely growing short, erect bushy or ray-like, the thallus more or less adapted to the substrate. Like the true beard lichens of the genus Usnea, they are in most cases attached to the substrate only at one place with a short base. In contrast to Usnea the filamentous thallus does not have a tough central strand and does not produce Usnic acid. Propagation is, as a rule, by soredia, which are produced in rounded, projecting to split-form soralia, rarely also taken over by isidia. In most species apothecia are only very rarely produced.

The greatest number of the species live epiphytically on conifer and deciduous trees, especially on thinned sites; many of these lichens may however also commonly cross over to silicate rocks. The remaining are inhabitants on silicate rock; among the indigenous species on B. chalybeiformis is numbered in this group. The Bryoria species lay claim to the region mountainous sites with high precipitation; in low precipitation regions their occurrence is limited to humid cool valleys. B. fuscescens exclusively shows a relatively broad ecological amplitude and is also to be found in low precipitation regions even in open habitats. B. bicolor and B. smithii live on very humid, oceanic influenced habitats. The epiphytic species avoid eutrophication. The Bryoria species are declining. B. fuscescens and B. capillaris are to a high degree endangered, several are threatened with extinction.

B. capillaris, b. fuscescens, B. implexa and B. nadvornikiana are distributed in the boreal conifer zone and corresponding sites in central Europe and penetrate into the mountain forests of the mediterranean region. B. fremnotii is also a dweller of the boreal conifer zone, however it is already extremely rare in central Europe. The area of the two oceanic species B. bicolor and B. smithii reaches from central or southern Scandinavia over western Europe into the mild, high precipitation region (especially in the mountains) of central Europe. They are (almost) entirely lacking in the mediterranean region. B. chalybeiformis has an arctic-alpine distribution.

Of ca. 45 species occurring predominantly in the cold and cool regions of the earth, ca. 9 are in Germany and ca. 8 have been proven. B. subcana is one difficult species not proven from the region.

Genus Characteristics and Determination

Thallus bushy, richly branching, usually beard-like pendent, rarely erect to decumbent, of filamentous, ± rounded stems, smooth segments, beige, gray, brown, or black, sometimes with short branches, frequently with split-form or warty soralia, with or without pseudocyphellia. Thallus segments radially symmetrical, with a cortex of periclinal elongate hyphae, medulla almost always loosely structured. Photobiont Trebouxia-like. Ap. lateral, rare, with permanent to soon disappearing thalloid margin. Asci clavate, thick-walled, Lecanora type. Sp. 1-celled, ellipsoidal. Ch: often with Atranorin, Fumarproctotretic acid, rarely Alectorialic acid, Psoromic acid, or Norstictic acid.

1 Thallus (medulla) KC+ red, C+ red/C- (reaction often very rapidly fleeting; do not add too much C after K!), K+ yellow or K-. With (often indefinite and sparse) pseudocyph. With Alectorialic acid and ± Barbatolic acid or Gyrophoric acid .

1* Thallus KC-, C-. Without Alectorialic acid, Barbatolic acid, or Gyrophoric acid .

2 Thallus P- (only soralia usually P+ red), K- or K+ yellowish. Thallus brown to brown-black, similarly variable like b. fuscescens, sometimes with short branches and twisting limbs. Limbs very fragile. Pseudocyph. usually definite, fusiform, whitish to brownish, often twisting around the branches. Branching dichotomously, branching angle rather obtuse. With Gyrophoric acid, ± Fumarproctotretic acid, ± Atranorin (B. vrangiana”).


3 With ± right angle oriented rigid (“thorny”), basal somewhat constricted short branches. Basal thallus segment usually blackish. Thallus otherwise pale brown, pale olive-brown, pale gray-greenish, rarely dark brown, often with rose or violet tones, in the lower parts isodometric-dichotomous branching, toward the tip more
anisotomic-dichotomous ( ). Branching angle obtuse (at least toward the base). Medulla P+ golden yellow, then orange-red. Barbatolic acid, ± Atranorin. * B. nadvornikiana
3* Without such branching. Basal thallus segment not darker. Thallus light gray to light brown, beige, rarely darker brown, in the herbarium with yellowish to rose tones. Branching pointed angles, isotomic to anisotomic-dichotomous. Main filament usually delicate, -0.5 mm, rarely thicker and uneven to pitted (“B. setacea”). Pseudocyph. present, fusiform, often indefinite. Medulla P+ intensive yellow, soralia orange-red. ± Barbatolic acid, ± Atranorin. * B. capillaris
4 Thallus on rock, rock mosses, decumbent-creeeping, bushy spreading to erect . 5
4* Thallus on bark, bark-mosses and wood, pendent, ± creeping or bushy spreading or erect . 10
5 Thallus shrubby erect or bushy spreading on the substrate, brown to black-brown, ± shiny, -5 cm high. without soralia, with numerous short (5 mm long) branches 6
5* Thallus decumbent, closely to more loosely attached . 7
6 Thallus segment filamentous, rounded, smooth, commonly 0.2-0.5 mm thick, in the general basal region (not only at the attachment site) blackish, otherwise brown, not conspicuously rigid. Medulla P- red . B. bicolor (11)
6* Thallus segment not filamentous (main stem up to ca. 1 mm thick), round to flattened, smooth to pitted, rigid and fragile, with looser medulla. Basal part not darker. Thallus mainly brown to black-brown, branches often with short thorny projections. Medulla P-+. Licheneritic acid, Protolichesterinic acid † Cetraria aculeata/mur
7 Thallus thick branched, ± crowded on the rock producing “mats”, often with short branches, usually very rigid, -2.5 (rarely -5) cm in diameter, dark to black-brown. Interval between the branches short (up to 3 mm). Without soralia. Medulla R-. Ch-. Alpine species . 8
7* Thallus loosely branched, loosely attached or the ends ascending, with or without very few short branches, light brown to almost black, mostly over 4 cm long. Thallus segment relatively soft and smooth, elongated, branching interval usually over 3 mm. Commonly ± isotomic-dichotomous branched. Sometimes with soralia. Medulla P- or P+ red. Almost always Fumarprotocetraric acid. (when with Psoromic acid, medulla P+ yellow see B. implexa) . 9
8 Thallus filaments often conspicuously flattened and with nodular thickenings, with numerous short branches. Branching interval very short (0.2-0.5mm). Thallus very closely appressed, often regularly rounded. Apothecia not rare
Pseudephebe minuscula
8* Thallus filaments regularly round and smooth. Branching interval long (1-3 mm). Thallus only ± tight at the margin, otherwise loosely attached. Ap. very rare Pseudephebe pubescens (Caution: when on sporadically trickle moistened surfaces, black, greenish-black, with blue-green algae, see Ephebe lanata, Spilonema) 9
Main filament 0.5-2 mm thick, often compressed. Thallus usually dark brown to almost black, commonly shiny, sparsely branched. Soralia rare, warty (tubercular) projecting, P+ red (Fumarprotocetraric acid). Thallus and medulla mostly P-. Alpine B. chalybeiformis
9* Main filament up to 0.5 (0.7) mm thick, rounded, toward the base and at the branches ± compressed. Thallus usually light to dark brown (rarely black-brown), basal part often lighter. Soralia frequent, warty projecting (tubercular), rarely split-form (in the case of B. chalybeiformis resembling var. positiva thallus dark brown, soralia sparse to lacking). Thallus P+ (slowly) red or P-, soralia P+ red, rarely P-.
Fumarprotocetraric acid . B. fusciformis
10 Thallus short shrubby, bushy spreading to erect, brown, in the entire basal region blackish, thickly branched, with numerous ± right angled short branches, -3.5 cm high. Rare oceanic species . 11
10* Thallus long beard-form to loosely filamentous, pendent (only the juvenile short bushy spreading), rarely decumbent, white-gray to brown-black, at best the attachment site and a single sites at the base of branches blackened 12
11 Thallus with small inconspicuous soralia, the thorny-issidate outgrowths, medulla P-. Short branches often very numerous, ± resembling thorns. Main stems -1 mm thick. Ch-
B. smithii
11* Thallus without that kind of soralia. Medulla at least partially P+ red. Main branches -0.6 mm. Fumarprotocetraric acid B. bicolor
12 Medulla K+ definitely yellow or red 13
12* Medulla K-, C- KC-. Branching isotomic-dichotomous with often obtuse angle 14
13 Thallus/medulla K+ yellow see B. capillaris/ nadvornikiana; carefully test the C/KC- reaction, often rapidly fleeting 13* Medulla K- red. With Norstictic acid. see (a chemical race not yet occurring in the region) B. implexa
14 Thallus and medulla P+ intensive sulfur-yellow. With Psoromic acid. With (sometimes sparse) narrow fusiform to linear, flat to slightly concave, whitish to brownish pseudocyph., which often are “twisting” around the filaments. Thallus very pale brownish to brown, beige, even almost whitish. Often with blackened places, easily broken off ends of the filaments. With small tubercular, rarely split-form soralia (soralia often lacking). Medulla K- B. implexa
14* Thallus P- or P+ red to orange, without Psoromic acid (excepting the apothecia) 15
With (sometimes sparse) narrow fusiform to linear, flat to slightly concave, whitish to brownish pseudocyph., which often "twist" around the filaments. Thallus often very pale brownish, beige, almost whitish, also brown to dark brown or greenish-brown, P+ red. Filaments -0.4(0.5) mm, often with blackened sites, at which the filaments are easily broken. With small tuberculate, rarely split-form soralia (soralia rare). Ap. rather rare, 1.5 mm. Psoromic acid in the ap.; ± Atranorin, Fumar-protocetraric acid, ± Protocetraric acid in the thallus or only in soralia.

**B. implexa**

Commonly without, rarely with inconspicuous pseudocyph. Ap. rare. With or without Fumarprotocetraric acid

Soralia and ap. yellowish, lacking in the region. Thallus middle- to olive brown, usually shiny. Main filament usually over 0.5 mm, often 1-4 mm thick, swollen and angular pitted, P-.

**B. fremontii**

Thallus light gray, gray, green, also very pale brownish, basal part often somewhat darker (brownish), commonly without blackened brittle places. Thallus, medulla, soralia P+ rapidly red. Soralia always tuberculate, often thorny, rather frequent *. Difficult to separate from **B. fuscescens**, questionable whether in the region

**B. subcana** (Nyl. ex Stizenb.) Brodo & Hawksw.

Thallus light brown to dark brown (black), basal part not darker (often lighter) than the remaining parts. Soralia usually occurring, whitish to slightly brownish, tuberculate, a few split-form almost always occurring (long splits soon becoming elliptical and concave). Right angle occurring branches rare or lacking. Ap. very rare, brownish. Occasionally with blackened brittle places. Thallus P+ (slowly) red, rarely also P-, soralia P+ red. Main filament -0.5 mm. *

**B. fuscescens s.l.**

(var. *positiva* is characterized by sparse branching, often relatively thick filaments, lacking or sparse soralia, (even basal) dark brown thallus)

**Ecology and Distribution of the Species**

**Bryoria bicolor** (Ehrh.) Brodo & D.Hawksw. (Alectoria b. (Ehrh.) Nyl.)

In the high montane and montane zones, concentrated in the very high precipitation region, oceanic sites, above all on old mossy trunks of deciduous and conifer trees in near natural beech-spruce (-fir) - sycamore-beech forests and in old beech stands, often also (especially in deep sites) on mossy silicate rocks, on cool oceanic, v.-e.humid, m.-r.light rich habitats, often near brooks, susceptible to forestry intrusion, m.-r.acidoph., anitroph., in the Lobarian pulm., Usneion, Parmelietum omph., Silicate moss community. – s’bor-subatl-mieur-subatl (smed-mo), oc – rare (1); süSch, nöSch, Vog, v.rare: PfW, Saar, Hu, *Rhön*, *Vgh*, Ts, *Eif*, ThW

**Bryoria capillaris** (Ach.) Brodo & D.Hawksw. (Alectoria c. (Ach.) Crombie, A. cana (Ach.) Leighton, A. setacea Ach., A. implexa auct.)

In montane and high montane, high precipitation sites in forests, in corresponding humid sites also on free-standing trees (in robust forms designated as **B. setacea**), usually on conifers, rather like *Usnea fulvoreagens* (†), yet also on r.light poor places, above all in the Usnetum filip., Evernietum div., also Psudevernietum, M.-r.acidoph., m.-r.photoph., v.ombroph., v.ombroph., anitroph. – bor-med-mo - r.rare (3); Sch, Vog, Al, otherwise (v.)rare (SFW, Ju, Ne, Do, Av), 0+, Ts, ThW

**Bryoria chalybeiformis** auct. (Alectoria ch. auct., Bryocaulon ch. auct.)

In subalpine and alpine sites on very wind exposed, open to light, fully rain exposed silicate rocks, also crossing over on plant detritus on soil, often on somewhat dunged habitats (with *Candelariella cor.*, *Ramalina cap.*), also like *Pseudephebe p.*†, acidoph., m.-r.nitroph. – arct-alp – v.rare (1); süSch (1x), Vog (Hohnbeck)

**Bryoria fremontii** (Tuck.) Brodo & D.Hawksw. (Alectoria f. Tuck.)

In montane, high precipitation sites. Usneion-species – bor(-mieur) – v.rare (1), till now only found one time in Germany; nöSch (Freudenstadt), on sycamore by a road

**Bryoria fuscescens** (Gyelnik) Brodo & D.Hawksw. (Alectoria f. Gyelnik)

Predominately in montane and high montane, high precipitation regions, but isolated into the hilly zone, on trees, wood (e.g. fences), more rarely silicate rock, hygrophytic, at other times r.euryöke species, embracing the ecological
amplitude of *Pseudevernia f.* (↑) and *Usnea filip* (↑), above all in the Usneion, Pseudevernietum, Parmelietum omph.; var. *positiva* (Gyelnik) Brodo & D.Hawksw. (Alectoria p. (Gyelnik) Mot.) above all on r.light rich, relatively open to the wind sites (free-standing trees, avenues), often on silicate rocks, on wood fences, more on moderately nutrient rich sites; bor-med-mo – r.rare (3); above all Sch, Vog, Al, additionally r.rare to rare, almost lacking in dry warm regions, in recent time once more somewhat increasing

*Bryoria implexa* (Hoffm.) Brodo & D.Hawksw. (Alectoria i. (Hoffm.) Nyl., B. osteola (Gyelnik) Brodo & D.Hawksw., incl. B. vrangiana (Gyelnik) Brodo & D.Hawksw. (with Gyrophoric acid), incl. B. pseudofuscescens (Gyelnik) Brodo & Hawksw. (with Norstictic acid)
Like *Evernia dev.* (↑), rather like *B. capillaris* (↑), in cool to cold conifer forests, e.g. in the Evernietum div. – (s’)bor-mieur-mo(-smed-mo), low hilly – v.rare (1); nöSch, süSch (Schramberg, Dunningen), Ju, Do

*Bryoria nadvornikiana* (Gyelnik) Brodo & D.Hawksw. (Alectoria n. Gyelnik) In montane and high montane, high precipitation sites in the interior above all of beech-spruce and spruce-fir forests on v.humid, foggy habitats, on conifer, rarely deciduous trees, mostly on twigs, m-r.(s.)acidoph., anitroph., in the Usneion – bor-mieur-mo – rare (2); Sch (over 600m), probably also Vog. Al

*Bryoria smithii* (Du Rietz) Brodo & D.Hawksw. (Alectoria s. Du Rietz) Like *B. bicolor* (↑), but almost only on bark and fastidious in water relations, on very oceanic sites, above all on spruce, fir, beech, Norway maple, especially on the branches – mieur-atl/subatl-pralp, oc – v.rare (0); süSch (Gersbach), BayW, bayer. Av/Alps


**Buellia** De Not

(Key includes Catocheia, Epilichen et al.)

**Introduction**
in the north in southern Scandinavia; B. griseovirens reaches to central Fennoscandia. B. aethalea, B. badia, B. disciformis and B. epipolia are very widely distributed from north to south Europe. B. schaereri is at home in the boreal and central European region and found isolated in the mountains of the Mediterranean region.

### Genus Characteristics and Determination

Thallus crustose, commonly clearly developed, rarely living in the substrate, sometimes appearing squamulose or appearing effigurate, mostly white, gray, brown, rarely yellowish, with coccoid green algae. Ap. black, at times pruinose, proper margin definite to lacking, without distinct thalloid margin, but sometimes sunken into the thallus (cryptolecanorine). Exc. very thin, light or usually strongly developed and dark. Hyp. usually dark brown, epihym. brown to olive. Paraphyses simple to mostly sparsely branched above, thickened above, often with brown pigmented cap. Asci clavate, branched above, thickened above, often with (weakly) muriform, gray-green to brown, wall or less sp. Sp. 2- up to cross-septate 4-celled or type, with commonly 8, exceptionally also more or less sp.

#### Key hint: Spore ornamentation only recognizable with oil immersion

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<th>Living on other lichens</th>
<th>Not living on other lichens</th>
<th>Own thallus well developed</th>
<th>Without own thallus</th>
<th>On the rock dwelling crustose lichens</th>
<th>Sp. predominantly bent sickle-like</th>
<th>Thallus greenish-yellow to yellow, on</th>
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**Epilichen scabrosus**

Thallus brown to gray, not on Baemoyces, on silicate rock.

**Rhizocarpon epiphyllum**

Not island-like on yellowish crustose lichens. Sp. smaller.

**Buellia badia**

Thallus appearing squamulose (squamules usually coalescing), brown, at first living on brown and green-yellow Parmelia species or on crustose lichens. Ap. sessile, often crowded, flat to moderately convex, permanent margin, -0.8 mm. Sp. 10-16 x 6-8(9) µm. Ch.-

**B. uberior**

Sp. upper surface without ornamentation. Sp. wall ca. 1.5 µm thick. Sp. 9.4-10.0-11.2 x 5.3-5.7-6.0 µm. Ap. sunken to siting up and clearly lecideine. Hyp. middle to dark brown, epihym. olive-brown, rarely olive to black-green. Thallus white-gray, areoles flat to convex, dull. Mironiroid acid. B. miriquidica

**Korschia santessonii** Haf.

On the rock dwelling crustose lichens Porpidia glaucophaeaea or Diploschistes scrouposus. Sp. 2-4 celled. Ascii not I+ blue (Korschia).

**Korschia talcophila** (Ach. ex Flotow) Körber

(Ach. ex Flotow) Zopf

*On Porphidia, Ochrolechia or Baemoyces*. Sp. 2 celled, 9-15 µm long. Ascii covered above with gelatin caps, which are colored intensive blue with 1 (Dactylospora).

**On Porphidia glaucophaeaea (†)**. Ap. -0.5 mm. Sp. 15-20 x 7-9.5 µm, rather long time colorless. Epihym. and hyp. light brown to brown.

**Korschia santessonii**

On Diploschistes scrouposus (†). Ap. -0.6 mm. Sp. 11-17(19) x 6-8(9) µm. Epihym. and hyp. brown

**Korschia talcophila** (Ach. ex Flotow) Körber

Sp. 2 celled, 4.5-7 µm wide. Hyp. and epihym. red-brown, K-. Ap. -1mm. On bark dwelling Pertusaria and Ochrolechia species

**Dactylospora parasitica** (Flörke) Zopf

Sp. 2 celled, 4.5-7 µm wide. Hyp. light to yellow brown. Ap. -0.8 mm
11. On rock dwelling yellow-whitish to yellowish crustose (Pertusaria, above all amarescens, flavicans, mostly C+ orange, UV+ yellowish to orange). Epiphyll. brown, K-.

Dactylospora saxatilis (Schaerer) Haf.


Dactylospora athallina (Mull.Arg.) Haf.

12 Lichens on soil, mosses, or plant detritus.

12* Lichens on bark, wood, or rock.

13 Thallus ± citron yellow, ochre yellow. Sp. 2 celled

13* Thallus whitish to gray. Sp. 2- or 4 celled

14 Thallus ochre, (ochre)yellow, K+ yellowish, C+ orange, warty to squamulose, squamules rounded to elongate, mostly strongly convex, with black rhizine strands, UV+ yellow to orange. Ap. -1(1.8) mm, flat to moderately convex, with receding margin. Sp. 17-22 x 7.8-5.6 µm. Arrothelin Granulosin, (Dichlorornelle-

14* Thallus citron yellow, C-, with Pulvinic acid derivatives, UV+ orange

15 Ap. -2 mm, flat, narrow margin, later convex marginless, between the squamules. Thallus clearly squamulose, squamules often elongated at the margin, thick, folded to undulating, undersides black, with rhizine strands, -3 mm wide. Sp. 12-18 x 7-10 µm. Epiphyll. dark olive green to black. Rhizocarpic acid et al

Catolechia wahlenbergii

15* Ap. -0.6 (0.8) mm, mostly soon high convex marginless, on the areoles. Thallus granular, warty areolate to appearing squamulose, thin, without elongated marginal squamules, parasitic on Bacomyces. Epiphyll. brown to olive brown

Epilichen scabrosus (4)


16* Sp. 2 celled

17 Thallus brown, occasionally on rock mosses B. badia (6)

17* Thallus white to gray

18 Sp. to 4 per ascus, 10-17 x 5-8 µm, with almost smooth (very weakly finely warty) upper surface, gray to gray-brown. Ap. -0.8 mm, flat to very convex, young ones also pruinose. Thallus lobed at the margin, chalk white, up to ca. 4 cm wide, K+ yellow/K-, P+ orange/P-. Atranorin, ± Norstictic acid On calcareous soils, gypsum .

B. asterella

18* Sp. to 8, predominantly over 17 µm long. Thallus not or only appearing lobed

19 Thallus K-, on gypsum and calcareous barren soils, warty-lumpy, up to ca. 1.5 cm wide. Ap. -1.2 mm, flat, long time pruinose. Sp. 14-26 x 6.12 µm, already the young clearly warty, old ones coarsely warty. Ch-.

B. epigaea

19* Thallus K+ yellow, on mosses and plant detritus in the high mountains. Ap. up to 1.5 mm, soon convex marginless, non pruinose.


B. papillata (Somm.) Tuck.


B. insignis

21 Thallus sorediate

21* Thallus not sorediate.

22 Thallus rosetted, with definite ray-like elongated, compressed coalescing lobes at the margin, the interior with (coalescing) fleck soralia, bluish gray-white, K+ yellow. On rock and bark. Atranorin, Diploicin, Xanthone

Diploicia canescens

22* Thallus not placoid. As a rule on bark or wood.

23 Thallus KC+ red, C+ rose, K-, P+ yellow, mealy-granular, gray-green to dark brown-gray. Ap. -0.4(0.5) mm, flat to slightly convex. Sp. 12-14(17) x 6-7(8) µm. Allocetaria acid

B. pulverea

23* Thallus KC- to + yellow(ish), C-, with fleck soralia, thin, often in the substrate and then only the soralia conspicuous

24 Soralia gray-greenish, greenish, blue-gray, yellowish ± round to irregular, -0.3 (0.4) mm, K+ yellow to (brown)red, P+ yellow/yellow-orange, ap. rare, -1.2 mm, long-time flat to moderately convex, with margin, sitting up. Sp. 15-28 x 1-13 µm, weakly muriform. Thallus ± smooth or of thin areoles, sometimes indefinite, light gray. Atranorin, Norstictic acid B. griseovirens

24* Soralia whitish, bluish, greenish, sometimes brownish, often surrounded by a apparent thallloid collar, flat to concave, round to (on wood) elliptical or elongate, -0.4 mm, K-/P+ yellowish, P-. Ap. very rare. Thallus whitish, of thin areoles or usually indefinite. Atranorin, Placodiolic acid

B. arborea

25 Sp. 2-celled

25* Sp. 4-celled to muriform

26 Thallus on bark or wood. Epiphyll. brown

26* Thallus on rock

27 Sp. rarely over 16 µm long and 8 µm wide. Ap. -0.4(0.5) mm. Thallus R-, Ch-. Hym. always without oil droplets

27* Sp. predominantly longer and wider. Ap. usually larger. Thallus K-, K+ yellow or red. Hym. without or with oil droplets

28 Sp. 7-10(11) x 2.5-4(5.4) µm. Hym. 45-60 µm. Ap. flat to ± convex, soon ± marginless, mostly -0.3 mm. Thallus indefinite.

B. schaereri
28* Sp. 11-16 x 5-8 µm, rarely somewhat larger, often slightly curved. Hym. 60-70 µm. Ap. at first flat, margined, then moderately convex, -0.5(0.6) mm. Thallus indefinite to definite, smooth, cracked or granular-warty, gray to dull gray-green. **Amandinea punctata**

29 Thallus light gray, R-; definitely developed, smooth or rugose, coherent to cracked. Ap. -0.8 mm, longtime flat and ± margined. Hym. 80-90 µm, without oil droplets. Exx. symmetrical ± 60 µm thick. Sp. 16-22 x 7-10 µm. Placodiolic acid et al **B. poeltii**

29* Thallus whitish to gray, K+ yellow or yellow to red (reaction often indefinite in the case of thin thallus), often with black prothallus. Ap. -1.5 mm, but often clearly smaller. Hym. 60-90 µm. Sp. (14)17-25(30) x 6-10 µm, often apparently 4-celled

30 Hym. without oil droplets. Thallus thin, smooth to sturdy, warty areolate to cracked areolate, K+ yellow, then red, P+ yellow-orange, C-. Ap. flat to convex, margined, (0.4-)0.6-1.5 mm. Atranorin, Norstictic acid **B. erubescens**

30* Hym. with numerous oil droplets. Thallus usually thin, even almost lacking, smooth to cracked areolate, whitish to yellowish-gray, K+ yellow, P+ yellowish, C-. Ap. usually flat and margined, (0.3-)0.5-1.3 mm. Atranorin, unknown substance **B. disciformis**

31 Thallus on limestone, K-. Ap. black to brown-black, often brown tinted when moist. Sp. with or without inner wall thickened. Further described in Rinodina

31* On silicate rock

32 Thallus greenish-yellow, gray-yellow, or pale yellow

32* Thallus without yellow tint

33 Thallus areolate, with elongated marginal areoles, yellowish to yellowish-white, in the region C-, P+ yellowish to red (Fumarprotocetraric acid), also P-, C+ red. Ap. sunken, margined by the thallus. Sp. 9-13(15) x 5-8 µm. **Dimelaena oreina**

33* Thallus without elongated marginal areoles

34 Asci with thicker, I+ blue gelatin caps. Ap. -0.5(0.7) mm, on yellowish lichen **Dactylospora saxatilis (11)**

34* Asci without thick gelatin caps. With single thallus. With Xanthones (Arthothelin), UV+ orange, C+ orange

35 Ap. soon sitting up, with permanent proper margin. Sp. usually sickle form curved, rarely straight, also 3-4 celled, 13.5-18 x 7-8.5 µm. Thallus granular to thick warty, when young on other lichens. Alpine **B. concinna (3)**

35* Ap sunken into the thallus, bordered by the thallus (cryptolecanorine), exx. usually weakly developed. Sp. straight, 2-celled, 13.5-18 x 7-8.5 µm, with very finely wrinkled upper surface. Epihym. olive, brown, subhym. usually green, hyp. dark brown. Thallus cracked-areolate. Pycnosp. 4.5-5.5 µm (if pycnosp. 6-9 µm long, thallus of isolated areoles, on high mountain ridges: **B. jugorum** (Arnold) Arnold **B. ocellata**

36 Ap. sunken into the thallus

36* Ap. sessile

37 Medulla C+ red, K+ yellow-red or K-. Thallus with Gyrophoric acid, ± Stictic acid. Ap. sunken into the thallus (Cryptolecanorine to Zeorine). Sp. 8-12 x 4.5-6.5 µm **B. uberior (7)**

37* Medulla K- or K+ yellow

38 Thallus K+ yellow, then (yellow)red (crystals in the medulla)

38* Thallus K- or K+ yellow

39 Ap. -0.40(0.7) mm, cryptolecanorine (by collar-like surrounding thallus areoles) or with narrow proper margin. Sp. 12-18 x 6-10.5 µm, weakly constricted at the septum, very finely warty (oil immersion). Thallus cracked-areolate to areolate, brown, brown-gray to gray or whitish, usually only -1.2 cm wide, areoles flat to moderately convex. Medulla I+ blue/I-. Norstictic acid, rarely also with Stictic acid **B. aethalea**

39* Ap. -1(1.5) mm, often with irregular outline, with or without thin margin, disk sunken to sessile, not with surrounding collar-like areoles, with thin proper margin. Sp. 9-15 x 5.5-7 µm, with smooth or finely wrinkled upper surface. Thallus (cracked-) areolate, light gray to whitish, areoles conspicuously flat, thin to thick. Medulla I+ blue. Atranorin, Norstictic acid, ± Stictic acid. Very rare, above all west European sea coast **B. spuria**

40 Thallus K-, cracked areolate to areolate, areoles flat to moderately convex, brown, brown-gray to gray or whitish, without Atranorin

40* Thallus K= light yellow, cracked to flat areolate, white, gray-white, with Atranorin, 2’-O-Methyl-pentalotic acid and Confluentinic acid, ap. clearly narrow margined, completely sunken, -0.35 mm. Sp. 9.5-13 x 5-7 µm, with flat wrinkled upper surface. Medulla I-: mier-med **B. stellulata** (Taylor) Mudd

41 Thallus R-, medulla I-, Ch-, bark-dwelling, but occasionally going over onto silicate rock, above all sandstone, gray-green to gray. Sp. 11-16 x 5-8 µm **Amandinea punctata (28)**

41* Thallus whitish to indefinite, with lichen substances, at the least the medulla K+ yellow, orange, red, if thallus indefinite, exc. K+ orange solution. Medulla I+ blue

42 Sp. 12-16 x 7-8.5 µm. Thallus lacking to clearly developed, cracked, gray, K+ yellow. Ap with bulging, long time remaining proper margin, flat to moderately convex, -1.2(1.5) mm. Atranorin
Buellia aethalea

Ecology and Distribution of the Species

Buellia aethalea (Ach.) Th.Fr. (B. aethaleoides (Nyl.) Oliv., B. sororioides Erichsen, incl. B. sororia Th.Fr.)

Above all in sub- to high montane sites on lime-free, mostly hard crystalline rock on r.-v.light rich habitats, pioneer lichen, on rubble and boulder slopes or frequently on grave stones (above all on granite) and roof tiles, often on m.eutrophic sites, m.-r.acidoph., xeroph., r.-v.photoph., a-/m.nitroph., above all with Rhizocarpon geographicum in Buellio-Rhizocarpetum, Aspicilietum cin., also in the Umbilicariion cyl., Acrasporicetalia sin. – (s’)bor-mieur-med – v.rare; süSch and Vog scattered, RhSch, Eif, Pf, He, ThW, but usually syanthropic

Buellia alboatra (Hoffm.) Th.Fr. (Diplotomma alboatrum (Hoffm.) Flotow, ?B. pharcidia (Ach.) Malme)

In hilly and submontane (to montane), mostly rather low precipitation sites on deeply cracked dust impregnated bark on the middle trunk and at the base of old, free-standing deciduous trees, above all linden, oak, predominantly on little traveled main roads and paths in calcareous regions, especially on rather rain sheltered sites, this species ? in addition on limestone (vertical surfaces), on walls, basiph.-m.acidoph., r.photoph., xeroph., r.nitroph., in the Physcietum adsc. and related communities. – mieur-med – rare, strongly regressed on bark (2); Ne, Ju, SJu, FrJu, Bo, süHu-HRh, nöHu, Rh-Mn-T, RhSch, Th

Buellia asterella Poelt & Sulzer

In hilly to montane, mostly rather low precipitation sites on dry, stony to sandy, calcareous soils, often in voids in dry turfs over sandy dolomite, limestone, even gypsum, also over river gravel, gravel pits, on thin soil outcrops between boulders, commonly on sunny, ± dry warm habitats, subneutroph. (-m.basiph.), v.xeroph., v.photoph., thermoph., anitroph., in the Toninion sed. – mieur – v.rare (0); Ne (Ludwigsburg+), Ju (Pfronstetter), FrJu, Eif (Iversheim), He

Buellia badia (Fr.) Massal.

Above all in montane and submontane sites on lime-free silicate rock on sunny, usually rather warm, wind sheltered habitats, usually over mosses (especially Grimmia spp., Rhacomitrium heterostichum) and directly on rock, commonly over lichens, usually on somewhat nutrient enriched, e.g. sporadically irrigated or slightly dust impregnated sites, m.-r.acidoph., r.-v.photoph., m.nitroph., in the Parmelion consp., Umbilication hirs., Polychidio-Massalongietum –
(s’)bor-med-mo – rare (3); süSch v.rare. nöSch, Vog, Pf, O, Sp, RhSch, He

**Buellia disciformis** (Fr.) Mudd
Up into the high montane sites on mostly smooth, moderately acid, non eutrophic bark of deciduous trees (above all hornbeam, beech, rarer e.g. oak), rarely on spruce, commonly in the interior of cool oak-hornbeam and spruce-fir forests, like Graphis scripta, Pertusaria leiopl., (†), m.(r.)acidoph., r.hygroph., r.skioph.-m.(r.)photoph., -r.skioph., in the Graphidion – bor-med-mo – r.rare (3); in regression because of eutrification of the bark in the lower sites

**Buellia epigaea** (Pers.) Tuck.
Like **B. asterella** (†), but the mainly on gypsum or gypsum soils and often over growing mosses, usually on Fulgensia bract in the Gips-Varianten of the Toninio-Psoretum – mieur-med – He, Hz-foothills, Westf

**Buellia epipolia** (Ach.) Mong. (Diplotomma epipolium (Ach.) Arnold)
Above all up into (high) montane zone of the carbonate rock, prefers stones and smaller boulders in dry turfs, also on walls and on lime impregnated silicate rock (e.g. sandstone), on m.-v.light rich, dry-warm habitats, basiph., xeroph., m.(-r.)nitroph., e.g. in the Aspicilion calc. – bor-med – r.rare; Ju, Mn and Ne moderately frequent to rather rare, also e.g. süHü, O, Eif, Pf

**Buellia erubescens** (Arnold (B. zahlbruckneri J. Steiner)
In high montane, rarely lower sites on hard, tough wood, on bark-free stumps, on fences etc., commonly also on acid bark above all on conifers, like Xylographa parall. (†), Char. Xylographetum vit. – bor-med-h’mo – rare; süSch, s129Hü-HRh, SJu, Av, Al

**Buellia griseovirens** (Turner & Borrer ex Sm.) Almb. (B. betulina (Hepp) Th.Fr.)
Up into the high montane zone, on smooth to flat-cracked bark of deciduous trees and spruce, in the loser sites especially on hornbeam in cool oak-hornbeam forests and ash, in higher sites above all on beech and sycamore in beech-spruce and sycamore-beech forests, likes cool valleys, also a synathrop on wood (especially on round wood fences), also decreasing in air-polluted regions, m.acidoph., m.photoph., r.skioph., r.-v.hygroph., anitroph., above all in the community of the Graphidion – s’bor-mieur-subatl-med – moderately frequent, spreading

**Buellia insignis** (Naeg. ex Hepp) Th.Fr.
From the high montane up into the alpine zone on mosses and plant detritus (dying base of Carex-nests, saxifrage cushions) usually over calcareous rocky soil, over thin soil layer on rock, rarely going over to bark, m.acidoph.-m.basiph., in the Megasporion verr. – arct-alp – Al, possibly also süSch

**Buellia leptocline** (Flotow) Massal.
In the high montane, rarely montane zone on high precipitation, cool, r.light rich, m.-r. exposed habitats on rainy vertical surfaces of silicate rock, r.acidoph., anitroph., e.g. in the Pertusario-Ophioparmetum — bor-mieur-mo/alp – v.rare (2); süSch, Vog, ?Bo, ?Eif

**Buellia miriquidica** Scheideg.
In the montane and high montane sites usually on hard silicate rock parasitic on Schaereria fuscoacin. (†) on light rich habitats, m.-r.acidoph., r.-v.photoph., anitroph. – bor-mieur – v.rare (1); süSch

**Buellia ocellata** (Flotow) Körber (B. verruculosa auct.)
In the montane and submontane sites on acid and basic silicate rock, e.g. on boulders of rubble heaps and on cool, little weathered rock surfaces, pioneer lichen on sloping and rainy vertical surfaces on r.-v. light rich, often rather warm habitats, m.-r.acidoph., a./m.nitroph., e.g. with B. aethalea in the Buellio-Rhizocarpetum, also in the Pertusarietum asperg. -flav. – mieur-med – rare; Sch, Vog, Mos, SFW, Ne, Al, ThW

**Buellia poeltii** Schauer
In the montane and high montane, high precipitation, oceanic sites in moist mountain forests on the bark of deciduous, rarer on conifers, in the region above all on sycamore, m.-r.acidoph., v.hygroph., m.photoph.-r.skioph., anitroph. – mieur-(paralp?) – v.rare (2); süSch (Feldberg), also north Alps

**Buellia porphyrica** (Arnold) Mong. (?B. chlorophaea (Hepp ex Leighton) Lettau, Diplotomma chlorophaeum (Hepp ex Leighton) Szat.)
Up into the montane sites on basic (e.g. basalt) and neutral or calcareous or lime impregnated silicate rock as well as on tiles, often on vertical
surfaces, subneutroph.-neutroph., m.-r.photoph., e.g. in the Xanthorion fall., Caloplacetum obl. – rare; Sch, Bo, RhSch, He, Th etc.

**Buellia schaereri** De. Not.
Especially in the submontane to sub alpine sites on the bark and tough decayed wood of conifers, rarely on acid bark of deciduous trees (above all oak), mostly in open forests and on free-standing trees, on wooden fences and posts, often on rather rain sheltered tree flanks or on after a rain quickly drying substrates, r.-v.acidoph., m.-r.photoph., m.ombroph.-r.anombroph., a-/m.nitroph., above all in the Calicietum vir. and related communities -- bor-mieur-(smed-mo) – rare (-r.rare); e.g. Sch, Vog, süHü-HRh, SJu, Al, Th

**Buellia spuria** (Schaerer) Anzi (B. lactea (Massal.) Körber, B. italica Massal.)
In the hilly sites on silicate rock on well lighted habitats, in the region on anthropogenic substrates (Wall crowns on sandstone), like Lecidella carp. (↑), in the Lecidelletum carp. – mieur-subatl-med – v.rare (1), probably however also overlooked; Ne

**Buellia thiopoliza** (Nyl.) Boistel
In the high montane, very high precipitation sites on mosses (above all Grimmia spp, Rhacomitrium heterost.) over mineral rich silicate rock on ± sunny, occasionally seep irrigated, very nutrient rich, soil encrusted surfaces, e.g. with Toninia squalida, m.acidoph. (-subneutroph.), local. Char. Polychidio-Massalongietum – mieur-paralp-smied-paralp/alp – v.rare (1); süSch (Belchen), Vog (Rosskopf/Thann)

**Buellia uberior** Anzi
In the montane and high montane sites on ± hard silicate rock, usually parasitic on Schaereria fuscocin., like B. miriquidica (↑) -- bor-med-mo – v.rare (2); süSch

**Buellia venusta** (Körber) Lettau (B. suevica Bertsch, Diplotomma venustum Körber)
Above all in the hilly to montane, mostly low precipitation sites on carbonate rock, usually on m.-r.eutrophic summits and sloping surfaces of lower rocks on sunny habitats, e.g. in the region of dry and semi-dry trufs, basiph., xeroph., v.photoph., in the Placocarpetum monstrosi -- mieur-med(mo) – r.rare; above all u, SJu, FrJu, Mn, Th, rare Ne, süHü, Eif

**Byssoloma Trevisan**

**Introduction**
The essentially tropically distributed genus numbering ca. 20 species contains crustose lichens with simple thallus with coccoid green algae and sessile, gray-brown to black lecideine apothecia, which in a few species appear margined because of the white hyphae growing out of the excipulum. *B. subdiscordans* is the species penetrating furthest out of the tropical region and reaches (thus in the region ) the boundary of its area in southern central Europe. Here it grows in cool, foggy sites on thin branches of conifers. The lichen has been missing in central Europe for a long time.

**Genus Characteristics**
Thallus crustose, undifferentiated (in the case of the indigenous species white to light gray), with coccoid green algae. Ap. orange-brown to (in the case of the indigenous species) black, often lighter margin, in a few (so well as European) species surrounded by a cob-webby tomentum white margin caused by hyphae extending out from the excipulum. Exc. of loosely intertwined hyphae. Hyp. dark red-brown. Paraphyses simple to sparsely branched. Asc. clavate, with K/I+ blue tholus with ring structure, exterior with thick amyloid gelatin envelop. Sp. 2- to 4-celled, in the case of exotic species also 4-celled. Pycnosp. pear-shaped to flask-form. Ch.-

**Ecology and Distribution of the Species**
**Byssoloma subdiscordans** (Nyl.) P.James (B. rotuliforme (Müll.Arg.)R.Sant., B. tricholomum auct.)
In montane, mostly rather high precipitation sites on thin branches of fir, rarely spruce, in ± pure conifer forests, also in spruce forests, often even
Calicium Pers.

Introduction

The genus Calicium numbers only the group of coniocarpic or dust fruited lichens (goblet lichens). As for the characterization of this group, disintegration of the asci when ripe into fragments and producing together with the spores a dust-like mass covering the upper side of the apothecium (Mazaedium). The fruiting bodies are, as a rule, clearly stalked and end with a clavate to egg-form “capitulum” and have thereby a certain similarity to a short needle. The thallus of the Calicium species is found in the interior of the substrate or is developed as a definite crust and is colored gray to green or pale yellowish, the mazaedium is black, the capitulum is often brown on the exterior and white or yellowish pruinose. The spores are two-celled, dark brown.

Of the 25 species distributed mainly in the cool-temperate zones of the earth, 10 occur in Germany. They occur on rain-sheltered, humid habitats, above all on bark (in bark cracks) of older deciduous and conifers and on wood, only one species (C. corynellum) lives on overhanging silicate rocks. C. adspersum is found almost exclusively on old oaks in oak-hornbeam forests in slightly continental influenced sites, C. viride occurs mainly on conifers in the mountains. C. abietinum, C. adspersum, C. quercinum and C. corynellum are species of the central European summer-green deciduous forested region; reaching in the north approximately to the distribution boundary of Quercus robur or extending only a trifle farther. C. lichenoides, C. viride, C. trabinellum and C. glauceum are distributed in the boreal conifer forest region and in central Europe (here occurring in the mountains). The most of the indigenous Calicium species also occur in the mediterranean region, often – above all the boreal species – more in the mountains. Often avoiding the atlantic regions.

Genus Characteristics and Determination

Thallus crustose, in the substrate or clearly developed, granular, warty to appearing squamulose, gray, gray-green, yellowish, or green, with Trebouxia. Ap. definitely stalked, rarely short stalked to sessile, with ± spherical to lens-form capitula, margined, black, but on the capitulum underside and the margin sometimes whitish, brown or yellowish pruinose, with black, sometimes pruinose mazaedium. Exc. clearly developed. Paraphyses branched. Asci cylindric to clavate, early disintegrating and with the spores producing a mazaedium. Sp. 2-celled, dark brown, thick walled, often with characteristic ornamentation. Pycnosp. short cylindric to broadly ellipsoidal. Ch: above all Pulvinic acid derivatives, Norstictic acid etc.

Keying caution: The ap. height is measured excluding the stalk. Sp. measurement is on ripe spores. Unripe spores are often smaller. Ornamentation is only clearly recognized at higher magnification (oil immersion); treatment with K facilitates the study of structure.

1 On silicate rock. Thallus light yellow to greenish, finely mealy, parasitising whitish to beige crusts (Haematomma ochr.). Ap. short stalked to almost sessile, capitulum -0.7 (1.5) mm wide. Sp. dark brown, 12-16 x 4-6 µm. R-,

C. corynellum (if ap. stalked, sp. 6.5-8 x 2.3-3 µm, spiral ribbed:

Microcalicium arenarium)

1* On bark and wood 2
2 Ap. sessile . 3
2* Ap. clearly stalked . 4
3 Ap. yellow to greenish-yellow pruinose. Sp. 5.5-6.5 µm thick .

C. adspersum (5)
3* Ap. not yellow pruinose. Sp. 3-4 µm thick  .

Microcalicium subpedicellatum

4* Ap. capitulum not yellow (-greenish) pruinose  .

Microcalicium subpedicellatum

5 Thallus usually clearly developed, warty to almost squamulose-scurfy, gray to yellowish-gray, K+ red, Pr+ yellow, then red. Ap. often only short stalked, even almost sessile. Capitulum broad, -0.8 (1.1) mm, yellowish pruinose at the margin and on the mazaedium (“disk”). Sp. 13-16 x 5.5-6.5 µm, clearly
ornamented (spirally ordered ribs). Norstictic acid ..

*C. adspersum*

5* Thallus indefinite (mostly in the substrate). Ap. clearly stalked, capitulum underside and the margin pruinose, -0.4 mm wide. Mazaeedium commonly nonpruinose (black). Sp. 10-11.5 x 5-6 µm, irregularly ornamented, in the half-ripe condition spirally ribbed.  

*C. trabinellum*

6 Capitulum underside and margin brown, upper side (mazaedium) and stalk (at least the underside) black

7* Thallus usually clearly developed, warty to granular, yellow-green to green. Ap. -3(4) mm high. Sp. 11-13.5 x 6-7.5 µm, irregularly ornamented (cracks). Asci narrowly clavate. Rhizocarpic acid, Epanorin

*C. viride*

7* Thallus thin, light gray (mostly in the substrate), K- or K+ yellow, then ± red. Ap. -2 mm high. Sp. 8-11 x 4-5 µm, with regular ornamentation in the form of spirally ordered ridges. Asci cylindrical. ± Norstictic acid .

*C. salicinum*

8 Stalk and exc. (section) I+ dark blue. Capitulum underside and margin pruinose or nonpruinose, like C. glaucellum. -0.6 mm wide. Stalk black to red-brown. Ap. -1.3 mm high. Sp. 9-13 x 4.5-7.5 µm. Thallus finely granular, blush-green, even yellow-green to whitish, Ch-

*C. lenticulare*

8* Stalk and exc. I- .

9 Ap. capitulum underside or/and margin whitish pruinose

9* Ap. capitulum not pruinose .

10 Ripe asci clavate. Ap. weakly white pruinose. Sp. 8-11 x 3.5-5 µm, shrunken at the septum, not single series in the ascus. Thallus gray to greenish-gray, often with pycnidia, K+ dark yellowish, P+ pale yellow, C-. Diffractic acid. .

*C. parvum*

10* Ripe asci cylindric. Ap. usually clearly pruinose, -1 mm high. Half ripe sp. with regular spiral pattern or fine streaks, single series in the ascus. Relative height of the ap. to diameter of the stalk (middle) = 4-8:1

11 Thallus definite, warty, gray, K+ yellow-red, P+ yellow. Ripe sp. clearly constricted at the septum, 9-11 x 4-5 µm, perhaps 2.2 times as long as wide, with regular spiral pattern. Ap. capitulum -0.6 mm wide .

*C. quercinum*

11* Thallus indefinite, in the substratum. Ripe sp. weakly constricted at the septum, irregularly ornamented, 9-13 x 5.56 µm, ca. 2.0 times as long as wide. Capitulum -0.35 mm wide. Unknown substances

*C. glaucellum*

12 Ripe asci clavate, sp. not order in one series. Thallus usually definite


13 Thallus gray to greenish-gray, warty to indefinite, often with black punctiform pycnidia. Sp. 8-11 x 3.5-5 µm. Ap. -0.8 mm high. Relative ap. height to stalk thickness (center) = 6-8:1. Pycnosp. 2-3 x 1-1.5 µm. Diffractic acid – s’bor-mieur .

*C. parvum*

13* Thallus green, warty to granular, pycn. rather rare. Sp. (11)12-13.5 x (5)6-7 µm. Ap. 1.1-1.9 mm high, relative ap height to stalk thickness = 9-16 : 1

*C. viride*

14 Ap. black to brown-black, -0.9 mm high, relative ap. height to stalk thickness (center) = 6-11 : 1. Sp. 11.5-15 x 5-7 µm, 2.0-2.4 times as long as wide, finely warty, as punctations. Ch-

*C. abietinum*

14* Ap. black, -1.3 mm high. Relative ap. height to stalk thickness = 10-14 : 1. Sp. 11-13.5 x 6-7.5 µm, ca. 1.-1.9 times as long as wide, coarsely and irregularly areolate – bor-mieur-h’mo

*C. denigratum* (Vainio) Tibell

### Ecology and Distribution of the Species

**Calicium abietinum** Pers. (C. curtum Turner & Borrer ex Sm.)

Up into the montane zone on tough decayed wood of conifer, rarely deciduous trees, on bark free trunks and stumps (flanks) as well as old fence posts and similar material, on moderately to rather light rich habitats, avoiding cold sites, r.-v.acidoph., r.-v.hygroph., anitroph., e.g. in the Calicietum glauc. – (s’bor-)mieur-med-mo – rare-v.rare, threatened; Saar, Mos, Ts-Lahn, He

**Calicium adspersum** Pers. (C. lenticulare auct.)

In hilly and submontane, mostly rather warm in the summer, low precipitation to moderately high precipitation sites on moderately old trunks and old deciduous trees with deeply cracked hard bark, strongly preferring oak (above all Q. robur), common in cut-over oak-hornbeam forests and at forest margins on scarcely rained on trunk surfaces or in bark cracks on wind protected, moderately lighted habitats, r.acidoph., r.-v.hygroph., anitroph., in regression because of eutrophication (green algae occurrence) as well as removal of forests, char. Chrysotrichetum cand. – mieur(-med-mo) – r.rare-rare (3); above all Fr, Mn, Sp, rare O, Ne (northern region), Hül, Pf, Saar, nöRh+?, RhSch, He, ThW

**Calicium corynellum** (Ach.) Ach. (C. paroicum Ach., C. chlorinum auct.)
In submontane and montane, usually rather high precipitation, oceanic sites on rain protected over-hanging surfaces on (often hard) silicate rock on (r.-)v.humid, m.(-r) lighted habitats, usually in m.cool, foggy valleys, parasitic on crustose lichens, above all *Haematoma ochr.*, m.-r.acidoph., anombroph., m.thermoph., anitroph., char. Lecanoretum orosth. – s’bor-med-mo, oc – v.rare (R); süSch, O (Heidelb.), PfW, Ts, ? Vgb, Sp

**Calicium glaucellum** Ach.
Up into the high montane zone on rain protected trunk surfaces of older deciduous and conifer trees, on r.-v.acid bark (usually in bark cracks of oak and conifer tree bark), also on ± hard, tough decayed to rather decayed wood of debarked tree trunks on, in lower sites usually on old oak in humid valleys and forests (oak-hornbeam and oak-beech forests), on higher sites also on windy habitats, r.-v.acidoph., r.skioph. -r.photoph., anombroph. -r.anombroph., anitroph., char. Calicion vir., in lower sites usually with *C. salicinum*, on higher sites often with *C. trabinellum*, above all in the Calicietum glauc., Xylographetum vit., in the montane forms of the Chaenothecetum ferr. – bor-mieur-h’mo – rare (3); süSch, nöSch, Al, SFW, Ju, O, PfW, ThW

**Calicium lenticulare** Ach. (C. subquercinum Asah., C. amylocaule Lettau, C. schaereri auct.)
In the montane and high montane, high precipitation sites on rather decayed, rotting wood of debarked stumps and trunks (usually basal) above all of conifers, rare on conifer bark, on usually rather shady, very humid, rain sheltered small habitats, r.-v.acidoph., m.substarthygroph., anitroph., e.g. with *C. trabinellum* – bor-mieur(mo) – v.rare (1); süSch, ThW, O+, Ju, SJu

**Calicium quercinum** Pers. (C. sphaerocephalum (Ach.) Ach.)
In the montane, rarely montane, high precipitation sites (only occasionally lower), on trunks of conifer, rarely deciduous trees with acid bark (thick barked oaks), preferably on spruce and fir, also on wood, on rain protected flanks, on cool to cold, v.humid, foggy habitats usually in the interior of fir, fir-spruce and spruce-beech forests and on the forest margins, r-v.acidoph., anombroph., r.photoindiff., anitroph., char. Calicion vir. – bor-mieur-mo-med-mo, subco  – rare; Sch, Vog, BayW, Al, additionally (v.)rare (Ju, Ne, Bo, Rh-Mn-T, Bit, RhSch, ThW, Erz)

**Calicium trabinellum** (Ach.) Ach.
In the high montane, rarely montane, high precipitation sites on tough decayed (rarely rather rotted) wood, on debarked conifer trunks and stumps as well as on fence posts, boards or sheds, rarely on the bark of conifers, in fir and fir-spruce forest as well as on free-standing, rather windy trunks, on moderately rainy to rain protected, cool to cold habitats, r.-v.acidoph., r.photindiff., r.hygroph., anitroph., above all in the Calicietum glauc., Xylographetum vit., in the montane forms of the Chaenothecetum ferr. – bor-mieur-h’mo – rare (3); süSch, nöSch, Al, SFW, Ju, O, PfW, ThW

**Calicium viride** Pers. (C. hyperellum (Ach.) Ach.)
In the high montane, rarely montane, high precipitation sites (only occasionally lower), on trunks of conifer, rarely deciduous trees with acid bark (thick barked oaks), preferably on spruce and fir, also on wood, on rain protected flanks, on cool to cold, v.humid, foggy habitats usually in the interior of fir, fir-spruce and spruce-beech forests and on the forest margins, r-v.acidoph., anombroph., r.photoindiff., anitroph., char. Calicion vir. – bor-mieur-mo-med-mo, subco  – rare; Sch, Vog, BayW, Al, additionally (v.)rare (Ju, Ne, Bo, Rh-Mn-T, Bit, RhSch, ThW, Erz)

**Caloplaca** Th.Fr.

**Introduction**

The species rich genus worldwide numbering about 500 species includes crustose lichens with simple structure (sometimes endolithic) to highly differentiated, marginally lobed, whitish, gray, yellow to orange-red or almost black thallus and usually yellow to red, rarely blackish apothecia with thalloid or proper margins. Very characteristic is the structure of the two- to very rarely four-celled, ellipsoidal to elongate spores. They commonly exhibit a thick dividing wall bored through by a fine canal. The anthra-
quinone containing yellow to red colored part of the *Caloplaca* species react blue-red with KOH.

The genus in certain groups still taxonomically unclear is represented in central Europe by perhaps 50, in Germany with ca. 75 species, of which however not a few are insufficiently known. The individual species reside on truly variable substrate, which mostly are however dependent on basic, subneutral or weakly acid conditions. Many are found on distinctly nutrient rich habitats, such as the calciphyllic rock lichens *C. cirrochroa*, *C. ochracea*, *C. polycarpa*, *C. saxicola*, *C. variabilis granulosa*, *C. holocarpa*, *C. lactea*, *C. flavescens*, *C. granulosa*, *C. percerocata* reside on calcareous rock, commonly in well lighted habitats. *C. proteus* is found predominantly on dolomite. The species *C. teicholyta* and *C. flavovirescens* are typically limited to calcareous rock. Such substrates are scarce in the region, however tomb stones, wall crowns and similar substrates have been used. On them, new habitats have been found by these and ecologically related species. *C. teicholyta* and *C. crenulatella* occur almost only on this kind of anthropogenic habitats.

A greater part of the epilithic *Caloplaca* species tolerate dryness and live on relatively rain protected, often warm vertical surfaces and overhangs. Many species bargain for an “alternative habitat” a nutrient rich, eutrophic, rainy habitat (bird roosts, wall crowns etc.), as in the case of *C. decipiens*, *C. saxicola* and (less pronounced) *C. flavescens*, in the case of others almost never abandoning the typical niche, such as *C. cirrochroa*, *C. obliterans*, *C. proteus*, *C. chrysodeta* and *C. teicholyta*.

Silicate rock “favoring” *C. arenaria*, *C. atroflava*, *C. crenularia*, the *C. grimmmiae* living as a parasite on *Candelariella vitellina* as well as *C. irrubescens*, *C. obliterans*, *C. scotopola*, and *C. subpallida*; frequently occurring on relatively SiO2-poor, so called intermediary (“neutral”) or slightly calcareous or at best “mineral-rich” silicate rock. *C. atroflava* lives also amphibiously on silicate boulders in cool brooks.

*C. cerina* resides on base-rich barks, where closely related *C. haematites*, *C. cerinella*, *C. cerinelloides*, *C. holocarpa*, *C. obscurella*, and the threatened with extinction *C. ferruginea*, *C. lobulata*, *C. hungarica* and *C. herbidella* were earlier found in Heidelberg. *C. lucifuga* almost always occurs in rain sheltered bark crevices of old oaks. *C. tirolensis* (Black Forest), *C. sinapisperma* (E.g. Schwäbisch-Fränkischer Jura) and *C. ammiospila* (Sudeten) occur residing on moss and plant detritus in boulder fields sheltered cliff fissures distributed in the arctic-alpine, very isolated in the central European Mediterranean region. Growing over mosses and plant detritus in the dry turfs and on calcareous rocks, *C. cerina var. chloroleuca*, is significantly more widely distributed, often in the montane zone and penetrating more deeply. The arctic-alpine moss dwelling *C. jungermanniae*, *C. epiphyta* and *C. tetraspera*, as well as *C. aurea* occurring on soil in rock fissures in the alpine regions of central and south Europe, are known in Germany only from the alpine (e.g. Allgäu).

Many *Caloplaca* species are indigenous in southern Europe and reach the north boundary of the area in central Europe, thus in southern central Europe *C. aurantica*, *C. conversa*, *C. granulosa*, *C. irrubescens*, *C. ochracea*, *C. polycarpa*, *C. xantholyta* and *C. haematites* in southern Scandinavia (in part only with isolated outposts) *C. biatorina*, *C. chalybaea*, *C. cirrochroa*, *C. coronata*, *C. decipiens*, *C. dolomitica*, *C. erythrocarpa*, *C. flavescens*, *C. lactea*, *C. teicholyta*, *C. variabilis*, *C. lobulata*, *C. lucifuga*, *C. obscurella* and *C. chrysophthalma*. Perhaps thrusting further toward the north *C. subpallida* and *C. cerinella*. *C. obliterans* occurs in north and central Europe. *C. proteus* and *C. Arnoldii* have their high point in the calcareous mountains of southern central Europe and the Mediterranean region. *C. ferruginea* and *C. herbidella* are predominantly westward distributed and limited in continental Europe to oceanic influenced mountain sites. *C. hungarica* is known from south Sweden, in the Alps and their environs. *C. grimmmiae* is widely distributed in the drier regions. The area of *C. cerina*, *C. citrina*, *C. flavovirescens*, *C. chrysodeta*, *C. crenularia*, *C. holocarpa* and *C. saxicola* includes the greater part of Europe.

**Genus Characteristics and Determination**

Thallus very variable, crustose, mostly clearly developed, but also in the substrate, also rosette lobed (placoid), rarely squamulose (in the case of exotic species even almost shrubby), yellow to red-orange, rarely whitish to dark gray or black,
Overview of the Key

Key Pt 1: On soil and rock mosses, plant detritus, soil
Key Pt 2: On bark and wood
Key Pt 3: On rock

Pt 1: On soil and rock mosses, plant detritus, soil

1 Thallus crustose (to finely squamulose), citron- to gold-yellow, soon erupting into similar colored soralia, later uniformly granular-sorediate to sorediate-isioidiate. Ap. very rare, gold-yellow to orange, narrowly sessile. Above all in rock fissures of calcareous rock. Alpine – Al

C. epiphya

Lynge (C. bryocephryos) Poelt

1* Thallus not sorediate

2 Sp. with very thin (-1 mm) septum, narrowly ellipsoidal to fusiform. Thallus ± yellow, K+ red

2* Sp. with thicker septum. Thallus K+ red

3 Thallus lobed to areolate, like the ap. orange-yellow. Sp. 12-20 x 4-6 µm, not shrunken at the septum. In calcareous rock fissures, alpine – Al

C. aurea (Schaerer) Zahlbr.

3* Lichens with other characteristics see Fulgensia

4 Ap. margin white-gray to blackish, definitely other color than the disk, K-. Thallus whitish, gray, rarely gray- to blue-black (when thallus pale brown, ap. disks cinnabar red to brown-red, see C. congrediens)

5* Ap. margin not whit-gray to blackish, disk color relatively little different, K+ red

5 Ap. rust red, the young with thick, often partially thallus colored margin see C. amniopsis

5* Ap. light yellow, orange, orange-red, brown-red, even dirty orange, remaining flat with raised margin, -1.5 mm. Sp. 10-16 x 6-8.5 µm (C. cerina)

6 Disk ± pruinose (often weak), under the pruinosity light yellow, greenish yellow, dirty olive to olive-blackish, rarely orange-yellow. Thallus whitish to gray, rarely gray- or blue-black

C. cerina var. chloroleuca

6* Disk not pruinose or orange pruinose, orange to red(brown). Thallus gray, gray- to blue-black

C. cerina var. muscorum

7 Ap. rust red, rust-brown, brown-orange, older ones also blackish-red to dirty olive black

7* Ap. light yellow, yellow- to red-orange, with age also olive-black, flat, with thin margin

8 Ap. from the first convex and marginless, -0.8 mm. sp. 12-22 x 6-12 µm. Thallus granular to unevenly membranous, gray-white to dark gray

C. sinapisperma

8* Ap. for a long time flat to slightly convex, margined, finally with age often marginless, usually crowded, -1.5 mm. Margin often lighter than the disk, often partially thallus colored, finally disappearing. Sp. 13-17 x 6.5-8 µm. Thallus white-gray, thin, uneven to granular

C. amniopsis

9 Ap. yellow-orange, -0.7 mm. Sp. 10.5-13 x 3.5-8 µm. Thallus whitish, on dying saxifrage cushions in the alpine zone – alp – Al

C. saxifragarum Poelt

9* Ap. light yellow, yellow-orange to olive black, - 0.7(1) mm. Sp. 11-16 x 6-9 µm. Thallus gray, thin

C. tiroliensis

Pt 2: On Bark and Wood

1 Thallus with soralia or entirely erupting sorediate or thickly covered with isidia

1 Thallus without soredia or isidia

2 Thallus ± granular or areolate and then ± thickly covered with short warty to cylindric, simple to branched (coralloid) isidia (isidia usually 40-120(150) µm thick), gray-white to greenish-gray,
K-, also partially yellowish-gray to ochre and K+ red. Thallus customarily reminiscent of bleached *Bacidia rubella*. Ap. disk rust red, flat, with definite, ± same colored, often undulating distorted margin, -0.8(1.4) mm, often sparse. Sp. 10-15 x 6-8.5 µm. *Caloplaca herbidella* (C. furfuracea) H.Magn. is similar, on wood, thallus dark gray, dark gray-green, scurfy-granular to finely isidiate, Alps)

2* Thallus sorediate .

3 Thallus and soralia gray-white, gray, greenish-gray, greenish to blackish-gray, K- .

4* Thallus or soralia yellow, ochre-yellow, orange, at least the soralia K+ red .

4 Thallus areolate, areole margins erupting sorediate, without rounded soralia, greenish-gray, gray, blue-gray, see *C. chlorina* (13). Unclearly separated from *C. virescens* (Sm.) Coppens: Thallus areoles unevenly granular, usually the surface soon sorediate. Ap. very scattered and usually only a few occurring, -0.8(1) mm, light orange, with granular, later ± disappearing thalloid margin. Sp. 11-13 x 4-5 µm, septum 1-3 µm, -1/4 of the spores reaching the length. On the ± euphotic base of deciduous trees, above all ash and hornbeam, e.g. Sch, Ju

5* Thallus with ± rounded, sharply bordered, concave ("crater form") gray-green or whitish soralia, gray-white to gray. Ap. rather rare, when occurring, then usually sparsely developed .

5 Thallus whitish, thin, varnish-like. Soralia scattered, pale yellow-green to greenish-white (not blue-gray), breaking up into smaller thallus pustules, -0.3 mm. Ap. -0.5 mm, soon flat to convex, orange or orange-red, like *C. holocarpa*, K+ red, proper margin soon the same height as the disk, later disappearing, (Thalloid margin only visible in the young first appearing ap.). Sp. 8-12 x 4-6 µm. Hym. 55-60 µm. On deciduous tree bark, ecologically similar to *C. cerina* .

6* Thallus light to dark gray, gray when moist. Soralia pale to bluish-gray, rounded, often crater form or with protruding, irregular, lighter margin, consisting of tiny torn pustules, -0.3 mm, in the older thalli often eroded marginless coalescing. Ap. reddish-brown, brown, blackish-brown, at first with thalloid margin, soon marginless, -0.8 mm, K-. Sp. 10-13 x 5-7 µm .

6 Thallus becoming sorediate, soredia ca. 30-50 µm thick. Ap. yellow-orange, with thin thalloid margin .

7* Thallus with bordered soralia .

7 Thallus indefinitely under the bark, K-, soralia ochre, orange-brown to gold-yellow, K+ violet-red, generally not coalescing, erupting from the tree bark flat to convex. Soredia 17-25 µm. Usually on old oaks. Sterile. Parietin, Fallacinal .

7 Thallus ± clearly developed, light yellow, yellow-gray, yellow-green, orange. Ap. often lacking .

8 Thallus thin, pale yellow to gray, ± under the bark, K- (to weakly reddish), flat warty to flecked coherent, with flatter upper surface, with well separated (later even coalescing), rounded to elongate at the margin of the areoles, erupting, gold- to green-yellow, K+ violet-red soralia (soredia ca. 25-50 µm). Ap. very rare, gold-yellow to dark orange. Sp. 10-10 x 7-10 µm. Parietin, Emodin, Fragilin.

8* Thallus yellow to orange, of small areoles or squamules, which erupt into marginal or ± irregularly sorediate, or entirely granular, K+ violet-red. Sp. 10-16 x 5-7 µm. Parietin, Emodin .

9* Ap. with clearly developed, long remaining whitish, gray to almost black thalloid margin .

9* Ap. margin yellow, orange, orange-red, K+ red

10* Ap. -0.5 mm, yellowish, then brown to blackish, closely crowded and heaped, with later disappearing whitish thalloid margin. Thallus yellowish to gray, K+ yellow. Sp. 9-12(14) x 4.5-6(7) µm. Very rare .

10* Ap. commonly larger, with long lasting or permanent elevated, light gray to blackish thalloid margin. Thallus light to dark gray, even almost blackish or blue tinted, K-. Disk usually flat, somewhat concave when young. Sp. 10-15 x 5-8 µm, with thick dividing wall (1/4 to ½ of the spore length) .

11 Disk ± pruinose, light yellow, often olive tinged, rarely orange-yellow. On mosses, very rarely crossing over to decaying bark and wood. Thallus usually white-gray to gray *C. cerina* var. Chloroleuca

11* Disk not pruinose, not olive tinged .


C. haematites

12* Disk yellow, orange, red-orange, red-brown. Thallus light to dark gray, gray-black, green-gray

13 Thallus thin, smooth to warty, light to dark gray or gray-black, even blue tinged, rarely indefinite. Disk yellow, orange, orange-red. Ap. -1.5(2) mm .

13 C. cerina var. cerina

13* Thallus relatively thick, cracked areolate to lumpy, often raised somewhat at the areole margin and there warty to erupting sorediate, lead gray, greenish-gray, bluish-gray, black-gray, usually greenish when moist. Disk (yellow) orange, brown-orange, ochre. Ap. usually -1mm, often rather sparse *C. chlorina* (Similar to *C. isidiigera* Vězda: Thallus areoles with uneven granular upper surface because of
numerous close standing very small isidia, thereby appearing rough, bluish gray)
14 Thallus yellow, green-yellow, (yellow) whitish, K+ violet red, coherent, smooth to warty, often extensive, often with gray prothallus. Ap. usually 1-2 mm, orange, with orange margin and occasionally (young) in addition a recognizable thin, pale yellowish thallloid margin. Hym. below and the hyp. conspicuous turbid because of numerous oil droplets. Sp. 15-18 x 6-10 ᵀ Scriptures, sepa 1/3 to ½ the length of the spores. Very rare

C. flavorubescens
(When thallus small, -1.5 cm, of 0.5-2 mm lobes, very thickly covered with ap. ap. -0.5 mm, lichens uniformly colored yellow to yellow-orange:
14* Thallus not yellow to green-yellow, K- (Beware of false judgment: ap. slowly reacting K+ red). If ap. over 1mm, then hym. under/hyp. not conspicuously turbid because of oil droplets
15 Ap. margin yellow
15* Ap. margin orange, brown-orange, orange-brown, rust red .
16 Sp. septum very thin, -1(1.5) μm, sp. 8-12(14) x 3-6.5 μm. Ap. 0.6(0.8)mm, sunken to depressed sessile, flat to slightly convex, light orange, young ± sunken and sometimes whitish at the outside of the margin, later ± sessile, numerous, crowded. Thallus whitish to gray, thin to indefinite, in the herbarium because of very fine crystals growing pruinose. On subneutral bark on older trunks. Very rare .

C. luteoalba
16* Sp. septum clearly thicker, ¼ to ½ of the sp. length. Ap. -0.3(0.5) mm, yellow to orange-yellow, flat, usually very numerous, and often closely crowded, with usually somewhat lighter, only at first little raised, later the same height as the margin. Thallus small, indefinite, whitish to light gray .
17 Sp. to (8)12-16 in the ascus, 9-13 x 5-7 μm. Septum 3-5 μm. Exc. cortex rarely clearly set off, thin -12 μm

C. cerinella
17*Sp. to 8 per ascus, 9-13 x 5-7 μm. Septum 3-4 μm, always completely closed. Exc. cortex clearly set off, 15-25 μ thick. Like C. cerinella

C. cerinelloides
18 Ap. 0.8-1.5 mm, rust red to red-brown, often wavy in outline, clearly and often irregularly marginated. Sp. 12-17(20) x 6-9(11) μm, septum usually 5-6 μm. Paraph. ends little thickened, -3.5 μm. Thallus light gray, smooth to warty, thin to indefinite

C. ferruginea
18* Ap. smaller, rounded .
19 Ap. rust red, red-brown, -0.6 mm, usually scattered. Sp. 11-14 x 6-7 μm, septum -4.5 μm. Paraph. ends clavate swollen, -3.5 μm. Exc. weakly I+ blue. Thallus small, usually indefinite, often on twigs. Rare

C. hungarica
19* Ap. orange, orange-brown. -0.5(0.7) mm, with orange colored, often somewhat shiny margin (exterior sometimes with apparent gray thallloid margin), flat to convex and finally marginless, numerous, close standing. Sp. elongate. Paraph. ends thickened, 4-5 μm. Hym. 60-75 μm. Thallus very thin or indefinite, ± gray, rarely blackish. Frequent

C. holocarpa

Pt 3: On Rock
1 Ap. black, sometimes pruinose, then whitish to light bluish. Thallus white, gray, blackish. Thallus and ap. K- or slightly violet tinged.

Epiphym. K+ violet or K-

2* Ap. yellow, orange, rust red, brown (or lacking), K+ intensively (violet) red.
2 Thallus ± in the rock (endolithic), indefinite. Ap. flat to moderately convex, without thallloid margin, with or without thin proper margin, sunken in the rock or more rarely ± sitting up, pruinose or nonpruinose. Epiphym. K+ violet. Sp. 11-21 x 6-11 μm, septum thin, -3 μm .

C. alcicila
2* Thallus not endolithic, usually clearly developed. Ap. not sunken into the rock
3 Hym. with a thin layer of gold-yellow to orange-brown granules (crystals) above, K+ red. Ap. blackish-brown to black, sometimes ochre colored “pruinose”, mostly brown when moist, ± flat, usually with black proper margin, sitting up to sunken, ±0.4 mm. Sp. 8.5-15.5 x 5-8 μm. Thallus coherent to areolate, gray, brownish, black-brown

C. conversa
3* Hym. without granular layer, epiphym. commonly K+ reddish, then violet. Ap. whitish to blue-gray pruinose on nonpruinose .
4 Ap. sunken into the thallus to half sunken, with often rather indefinite thallloid margin, -0.6(0.9) mm. Thallus white-gray to gray, sometimes blue tinted, rather thick, even, cracked areolate (cracks between the areoles narrow, upper surface smooth), clearly bordered, mostly rounded, often with dark prothallus border, reminiscent of Aspicilia. Sp. 9-15 x 5-8 μm .

C. chalybaea
4* Ap. usually ± sessile, black (-black-brown), flat to convex, with definite light thallloid margin, -1(1.2) mm. Thallus light gray to blackish or ± brownish, egg-shaped crustose to areolate, upper surface not smooth. Sp. (12)14-18(20) x 6-10 μm

C. variabilis
5 Living on other lichens
5* Not living on other lichens
6 On silicate lichens. Without its own definite thallus .
7 On calcareous lichens. (C. dolomiticola group)
9 On yellow crustose lichens (Candelariella vitellina/coralliza) on sunny habitats. Ap. disk
Thallus ochre-yellow, on rosetted, elongated areoles or indefinite lobules, 7-15 x 6-8 µm. C. grimmiae

(From the same host C. vitellinaria Szat: ap. orange, margin of same color or somewhat lighter; not recorded from the region)

7* On other crustose lichens. Ap. -0.5 mm, rust-red to rust brown, margin ± same color, possibly somewhat lighter or darker than the disk. In alpine sites

8 On gray crusts with blackish soralia (Miriquidica nigroleprosa) in alpine sites. Ap. convex and marginless from the first, -0.4 mm. Sp. 9.5-12 x 7-8 µm. Arct-alp – Alps, BayW, Riesengeb C. magni-filii Poelt

8* On crustose and foliose lichens, above all Dimelaena oreina, Lecanora muralis, Rhizoplaca, Umbilicaria etc. Ap. -0.5 mm, with permanent margin. Sp. 9-13 x 6.5-7.5 µm. Alps C. epiphthallina Lynghe

9 On endolithic Verrucaria species. Thallus thin or lacking. Ap. -0.6 mm, orange, with border

9* On various epilithic crustose lichens, e.g. Acarospora. Thallus orange-yellow, clearly developed, thickish, coarse warty (-granular) to small lumpy or minutely crenate-lobed. Areoles scattered or grouped, closely attached to the host thallus. Ap. -1.5(2) mm. Sp. 11-14 x 6-7 µm. Aspect of Candelariella vitellina C. inconnexa Zaw.

10 Thallus indefinitely (endolithic), "on" Bagliettoa parmiagera and relatives. Ap. usually covering a rounded surface of up to 0.6 cm in diameter. Sp. 7-15 x 6-8 µm C. oasis

10* Thallus ochre-yellow, ± circular, usually -1.5 cm, of thin, at the margin indefinitely ordered radiate-rossetted, elongated areoles or indefinite lobules, on Verrucaria calcissa. Ap. orange to orange-red. Sp. 9-15 x 5-8 µm . C. polycarpa

11 Thallus yellow, orange, red, brown-yellow, K+ violet-red .

11* Thallus not so colored, clearly developed or lacking, K- or K+ slightly violet colored, rarely fleck-like K+ weakly violet-red (!: the K-Reaktion yellow to red often depends upon the color of bordering thallus part!) .

12 On calcareous rock and calcareous anthropogenic substrates (concrete, mortar etc.) .

12* On silicate rock

13 Thallus very clearly developed .

13* Thallus indefinite or very thin

14 Thallus rosetted-roundish, sometimes appearing lobed, with exception of the region of the margin scuffy-granular to sorediate surface, whitish to light gray. Ap. rare, rust-red to red, often with undulating proper margin, frequently with thalloid margin in addition, -1 mm. If fruiting, then thallus (almost) not lobed. Only on the upper surface of lime removed limestone, dolomite or anthropogenic substrates

14* Thallus thick, cracked (-areolate), clearly bordered, but not appearing lobed, not scuffy-granular to sorediate, white. Ap. red, numerous and crowded, clearly bordered, exterior often with only a whitish thalloid margin remnant, -0.5 mm. Sp. 16-18 x 4-6 µm C. teicholyta

15 Sp. with thin, up to 2(2.5) µm thick septum (1/8 of the sp. long), (13)15-20(22) x 6-9 µm. Ap. yellow to rust-red, scattered, with like-colored or somewhat lighter, usually very thick, finally disappearing margin, -0.6 mm. Thallus indefinite, usually as whitish flecks. Above all on limestone C. lactea

15* Sp. with thicker, up to (2.5)3.5-5 µm thick septum (at least 1/4 of the sp. long), (9)10-16 x 5-9 µm. Ap. orange-yellow, orange, orange-brown, close standing with disappearing margin, 0.3-0.5 mm. Hym. 60-75 µm. Thallus indefinite or thin, gray. Especially frequent on anthropogenic substrates C. holocarpa

16 Thallus whitish to light gray, with exception of the ± decorticate marginal part of the sorediate to granular-scuffy ± rosetted surface, usually appearing lobed at the margin. Soredia 60-160 µm. Ap. rare, rust-red to red, at first concave, then flat, margined, with or without thalloid margin, -1 mm. Almost only on anthropogenic substrates . C. teicholyta

16* Lichens with other characteristics, in the center as a rule not whitish sorediate to scuffy-granular .

17 Margin of the ap. clearly colored other than the disk, not yellow, orange, or red .

17* Margin of the ap. usually rather similar colored to the disk, yellow, orange, rust red, or olive .

18 Thallus pale brown to bleached out, small, areolate to almost squamulose. Ap. dark cinnabar red to brownish red, with brown to blackish brown thalloid margin, long time sunken. Sp. 11.5-14.5 x 4.5-6.5 µm C. congrediens

18* Thallus/ap. margin not brown. Yet insufficiently studies species group .

19 Thallus throughout with granular upper surface, gray, dark gray, scuffy to cracked areolate. Disk rust red, with definite, often lighter proper margin, often with exterior deposited light gray to gray thallloid margin. Ap. -1.5 mm. Ecology like C. teicholyta ! C. albolutea


20 Disk brown-orange, dark red, dark rust brown to blackish red. Ap. -0.8 (1) mm, with permanent, raised, ± thallus colored margin, flat, often sparse. Thallus dark gray to gray-blackish or dark greenish-gray, cracked-areolate, rather thin, often rounded, sometimes appearing zoned at the margin, with blackish prothallus. Areoles irregularly angular, often elongate toward the
margin and ± radially aligned. Paraph. scarcely thickened above. Sp. 11-15 x 6-8 µm

C. aractina
(Possibly to this species: Disk dark rust-red to blackish. Ap. -0.4 mm, scattered, sitting up, flat, with blackish margin. Thallus dark gray to blue-gray, areolate to cracked. Exc. dirty green. Sp. 10-14 x 5-7 µm, septum ca. 4-6 µm. Paraph. scarcely thickened above.

C. holocarpa*

C. festivella (Nyl.) Kieffer)

20* Disk (yellow)orange, brown-orange, ochre. Without blackish prothallus. Ap. usually -1 mm, often rather sparse. Thallus greenish-gray, gray, bluish-gray, black-gray, usually greenish when moist, relatively thick, areolate, areoles unevenly warty, often somewhat raised at the margin and finally sorediate to granular-warty or blastidiate there. Paraph. up to 5 µm thick above. Sp. 10-18 x 5.5-9 µm. Septum ca. 4-5 µm thick.

C. chlorina
(When thallus not granular or sorediate or blastidiate, gray, gray-brown, black-brown, see C. conversa (3))

21 Thallus not recognizable or very thin and indefinite.

21* Thallus definitely developed. Paraph. ends only slightly thickened (2-3(3.5) µm).

22 Ap. yellow-orange, orange, orange-brown, -0.5 (0.7) mm, with orange colored, often somewhat shiny margin (rarely (young) outer with apparent gray thallloid margin), flat to soon moderately convex and finally marginless, numerous, close-standing. Sp. 10-16 x 5-8 µm, septum 2.5-5 µm, ¾ -1/2 of the spore length. Paraph. ends thickened up to 4-5 µm above. Hym. 60-75 µm. Thallus very thin, ± gray, or indefinite. Commonly on symbiotic and calcareous substrates, frequently on concrete.

C. holocarpa*

22* Ap. orange, dark orange, orange-red, dirty orange, orange-brown, even with olive colored tint, flat, with permanent, orange to orange-red colored margin, -0.5(0.7) mm, sessile with a narrowed base, usually rather scattered or in small groups. Sp. 11-15(15) x 3.5-5.5 µm, septum 1.5-3.5 µm thick. Paraph. ends gradually up to 2-3 µm thickened. Hyp. without oil droplets. Thallus light gray, thin to indefinite (when sp. 12-15 x 4.5-6.5 µm, septum 2.5-6 µm, ap. margin disappearing, exc. cortex slightly blue: ! C. caesiiorufella (Nyl.) Zahlbr. (C. leptocheila H.Magn.))

C. arenaria

23 Sp. 13-17 x 5.5-7, septum 2-3.5 µm thick, ca. 1/5 of the spore length. Ap. light to dark orange, orange-brown, permanently margined, -0.5 (0.7) mm. Thallus light gray to gray, cracked-areolate to areolate, often extensive (probably host thallus).

C. subpallida*

23* Sp. septum thicker, 1/3 - ½ of the spore length

24 Ap. rust red, red-brown, with definite, permanent brown-red margin, -1.0 mm. Thallus dark gray to gray, coherent-uneven to cracked-areolate. Sp. 12-17(21) x 6-8(10) µm, septum ca. 5-6 µm.

C. muricata

24* Ap. orange, brown-orange, with lighter, shiny orange colored thick, flat, convex, projecting, permanent margin, -0.5(0.7) mm, basally constricted, often thick-standing. Paraph. ends little thickened. Thallus lead-gray to black, cracked to cracked areolate, with black, sometimes fibrous prothallus, fleck-like K+ violet. Sp. 12-17 x 8-10 µm, septum 5-7 µm.

C. arenaria

25 Thallus lobed (placoid) at the margin.

25* Thallus not lobed at the margin

26 Thallus upper surface entirely mealy-granular to granular, decorticate, granules mostly ca. 0.15-0.2mm thick. Thallus well developed ± rounded and clearly bordered at the margin, indefinitely effigurate, shiny yellow, thin to thickish. Medulla whitish. Ap. lacking C. xantholyta

26* Thallus with other characteristics, with definite cortex, usually rounded-rosetted and with definite, narrow, marginal lobes (placoid).

27 With soralia or ± spherical isidia. Ap. rare

27* Without soralia or isidia, usually with ap.; ap. above all in the center part of the thallus

28 Thallus without soralia, in the center with numerous close standing, narrowed at the base, - 0.1 mm thick, spherical isidia, usually -1.5 cm wide, yellow to yellow-orange. Marginal lobes very narrow, coalescing C. granulosa
(Attention: In the case of C. decipiens sometimes soralia development is arrested, instead of which lumpy warts are produced, thallus usually over 1.5 cm in size)

28* Thallus with soralia

29 Thallus disintegrating soridiate in the center and citron- to light yellow, at the margin with narrow (up to 0.5 mm wide) radiating lobules

† (C. cirrhochroa 31)

29* Thallus with small bordered soralia, usually -2 cm wide

30 Thallus with lip- to capitulate soralia at the ends of small, very short lobules (in the interior and central region, scarcely in the outer region), not dying in the interior, light yellow to orange-yellow, ± pruinose, -2(3) cm. Soralia colored like the thallus. Marginal lobes commonly closely coalescing, branching toward the end divisions, sometimes slightly pruinose.

C. decipiens

30* Thallus with small (flat to concave) fleck soralia at the interior end of narrow, radiate arranged lobules, ca. -1.6 (2.5, rarely more) cm, interior often dying and therefore ring form. Marginal lobes often forked, closely coalescing to separate.
Thallus yellow to yellow-orange. Fleck soralia (citron)yellow, clearly lighter than the thallus, commonly definitely bordered and rounded to radially elongated. Marginal lobes up to 3 mm long and 0.5 mm wide, at the front often somewhat widened, ± pruinose. C. cirrochroa

Thallus red-orange to red lead red, fleck soralia orange to red. Marginal lobes small, not broadened at the front, usually not pruinose. C. proteus

Sp. with outward bulging dividing walls, ± lemon shaped to almost four-angled (Sp.). Thallus often large, -5(10) cm, yellow to orange. Lobes coalescing (C. aurantis s.l.)

Sp. not bulging outward in the region of the dividing wall, ellipsoidal. Thallus scarcely over 2.5 cm.

Thallus very thick and flat pressed closely to the substrate, -5(10) cm. Lobes very flat, as though flattened, mostly 1.5-3 mm wide. Interior of the thallus often (zoned) lighter colored. Cortex usually without crystal layer. Sp. 10-16 x 7-12 µm

C. aurantis sstr.

Thallus lobes narrower, -1 (1.5) mm, convex, clearly separated from one another, but closely coalescing, at the ends ± branching. Thallus usually -4(6) cm. Cortex usually covered with a thin layer of crystals (section). Sp. 8-15 x 5-10 µm

C. flavescens

Thallus up to the central part in long, narrow strongly convex to almost round stalks, underside corticate, with the lobes not completely attached to the substrate (thallus with loosened with a thin knife), usually orange to orange-red, -4 cm

↑ Xanthoria elegans

Thallus surface attached to the substrate, only the upper side corticate

Thallus lobes very thin and narrow, very delicate, 0.1-0.3 mm wide. Ap. commonly -0.3 mm. Thallus parasitic on endolithic Verrucaria (calciseda).

C. polycarpa (10)

Thallus more robust, wider. Not parasitic.

Ripe spores broadly ellipsoidal, 9-16 x 5-9 µm (Sp.) Sp. septa at most 1/4 of the sp. long. Ap. very narrowly sessile. Thallus usually brownish-red, red-orange, red lead red, very rarely pruinose, -1.5 cm. Medulla very loose (on silicate rock: var. baumgartneri (Zahlbr.) Poelt. Difficulty addressed, rare species.

C. biatorina

Sp. elongate to (narrowly) ellipsoidal.

Very rare alpine species on overhanging calcareous boulders, intensively red lead red, nonpruinose or slightly pruinose at the lobe ends. Thallus -1 cm, with very narrow, lobules branching toward the tips, interior ± areolate and covered with ap. Sp. 9-14 x 3.5-7 µm, septa 1/4 to 1/3 the length of the sp. Difficult to separate from C. saxicola-forms.

C. arnoldii

Frequent. Thallus yellow, orange, rarely red lead red, pruinose, rarely nonpruinose, -2.5 cm, interior warty areolate and covered with ap. Sp. ellipsoidal, 9-12(14) x 4.5-6(7) µm (Sp.), septa reaching at least 1/3 of the length of the sp. Form rich species.

C. saxicola

(IF on the sea coast, in the water-spray region, rosetted, thallus often over 1 cm in size, sp. 11-16 x 5-7 µm: C. scopularis (Nyl.) Lettau)

Thallus with bordered soralia or uniformly leprose, i.e. consisting of fine granules.

Thallus not sorediate, not granular or “mealy”

Thallus with bordered fleck soralia

Thallus continuously with mealy, granular or finely isidiate upper surface

On silicate rock on overhangs, of ± irregularly ordered, compressed, -1(1.5) mm long 0.3 mm wide, thinner at the margin, smooth, areoles, often times appearing branched, ochre yellow, yellow, yellow-orange, brown-orange, with yellow to yellow-orange fleck soralia. Ap. Rare

C. obliterans

Thallus usually on lime-rich rock and artificial stone, small squamulose to areolate, usually citron-yellow to (orange)yellow, with citron-yellow soralia at the margin of the 0.8 mm large areoles, sometimes finally entirely sorediate. Ap. moderately frequent, disk orange, margin yellowish, entire or sorediate.

C. citrina

Upper surface of the thallus uniformly leprose, consisting of fine granules or at least with powdery upper surface, ± white, decorticate, not cracked or areolate. Ap. lacking. On rain sheltered overhangs and in niches.

Thallus not uniformly leprose, but producing a cracked areolate crust, granular to finely granular-sorediate or finely isidiate, not uniformly powdery. Ap. rather rare to frequent

Thallus upper surface disintegrating sorediate, under the sorediate upper surface corticate thallus part (granules). Soredia corticate, commonly yellow, citron-yellow. Thallus generally irregularly bordered, not rosetted-rounded, often cracked

↑ C. citrina

Without corticate thallus part.

Thallus yellow, well developed rounded and clearly delimited, even appearing lobed-folded at the margin, with continuous powdery upper surface or of -0.2 mm thick granules. Medulla whitish.

C. xantholyta

Thallus ochre, gray-yellow, light ochre-yellow, consisting of -0.1 mm thick granules, powdery, not delimited, usually not rounded, not appearing lobed

C. chrysodeta

Thallus powdery- to granular-sorediate (to finely isidiate) (soredia mostly ca. 40 µm), cracked-areolate or small squamulose to granular, citron-yellow to yellow, in the shade even greenish. Ap. orange, with sorediate to granular thallloid margin, -1 mm. Sp. 10-15 x 5-6 µm

C. citrina
45* Thallus white-yellow to yellow, usually pruinose, with very uneven upper surface of convex to almost spherical or even flattened, ± attached areoles/granules, thick to very thick. Ap. brown-orange, at first concave, then flat, with yellow, often pruinose proper margin and swollen, permanent, ca 0.2 mm thick pruinose thalloid margin, -1.5 mm. Sp. 10-15 x 6-8 μm. On walls.

45* Thallus (orange)yellow to ochre-yellow, not pruinose, areolate, areoles -1 mm, thick, of granules to elongate narrow cushions of (40)50-100 μm diameter, moderate to very thick. Ap. orange to orange-red, soon moderately convex, with depressed, usually soon regressing, commonly same-colored, nonpruinose proper margin, often covered on the outer side with thallus granules, -0.6(0.9) mm. C. rubelliana

46 On silicate rock

46* On lime-rich rock, mortar, concrete

47 Thallus gray-rose to (yellowish)cinnabar red, small, -1.5 cm, cracked areolate, areoles conspicuously flat, smooth, usually somewhat enlarged at the thallus margin, -1.5 mm. Ap. carmine-red, at first punctiform, then flat, usually angular, indefinitely margined, -0.4 mm. Sp. 7-11 x 4-6 μm. C. coronata

47* Thallus not gray-rose to cinnabar red.

48 Septum thin, -2(3) μm. Sp. 12-23 x 5-7.5 μm. Thallus thin, areolate to indefinite, citron-yellow, yellow, yellow-gray. Areoles flat to somewhat raised and there lighter at the margin. Ap. -0.6(1) mm, often crowded into groups. Disk orange-yellow to ochre, flat, with permanent, entirely yellow margin and often with outer layer depressed, sometimes granular thallus “collar.” Relation to C. ferrarii (Bagl.) Jatta yet unclear.

48* Septum thicker.

49 Ap. yellow to olive-yellow, flat to convex, often with lighter margin, -0.5 mm. Thallus light yellow, yellow, citron-yellow, thin, smoothed, coherent to fleckwise developed. Sp. 9-15 x 4.5-7.5 μm. C. vitellinula*

49* Ap. disk orange, orange- to rust brown.

50 Thallus orange yellow to yellow-brown, areolate to almost lumpy, areoles ± angular, usually 0.2-0.4 mm. Ap. orange to red-orange, with depressed, finally indefinite, same-colored proper margin, -0.3(0.5) mm. Sp. 9-15 x 4.5-8 μm. Septum ¼-1/2 of the sp. length.

50* Thallus citron-, green- to gray-yellow, ochre, pale yellow-(whitish), weakly cracked to usually cracked-areolate, areoles flat to concave, often grazed by snails. Ap. brown- orange to rust-brown (color clearly contrasting from the thallus, thereby the thallus ± two colored), with usually somewhat lighter, orange colored proper margin, sometimes with outer layered thallus margin, which thins out very soon and only remains recognizable only in section, -1(1.3) mm. Sp. 12-19 x 7-10(11) μm. Septum 1/3 - 1/2 of the sp. length.

51 Ripe sp. 4-celled, 11-19 x 5-8 μm (Sp.). Thallus light yellow, light ochre, white-gray with yellowish flecks, smooth to finely cracked, thin. Ap. yellow- to brown-orange, with yellow/orange proper margin, at first concave, then flat, -0.7 mm.

51* Sp. 2-celled

52 Septum very thin. Lichens usually on mortar.

53 Thallus green-yellow, citron yellow, gray-yellow to pale yellowish, often grazed upon and whitish in places, weakly cracked to cracked-areolate (areolate-squamulose), with the ap. becoming “two colored.” Ap. -1.5 mm, orange-brown, with usually lighter, orange colored proper margin and sometimes outer layer of the thalloid margin, sitting up. Sp. 12-19 x 7-10(11) μm. (Hyp. in the region commonly not/scarcely inspersed). Only on the upper surface of leached limestone.

53* Thallus usually deep yellow to orange, even ochre-yellow, very variable, coherent to cracked areolate or almost squamulose, sometimes even reduced, not becoming two-colored. Ap. -1 mm, usually orange, margin often somewhat lighter than the disk, but commonly not clearly other colored, soon convex and marginless. Sp. 10-16 x 6-9(10) μm. (Hyp. not or ± inspersed). (C. dolomitica s.l.)

54 Living on endolithic Verrucaria species, small, -1.5 cm.

54* Not on endolithic Verrucaria species.

55 Parasitic on epilithic crustose lichens, e.g. Acarospora species. Thallus areolate, almost small squamulose, with ca. 0.5 mm large, scattered or in several groups or areoles. Ap. - 1.5(2) mm.

55* Commonly not parasitising other lichens. Thallus cracked areolate to mostly areolate, thick to thin and disappearing, even granular. Areoles 0.2-2 mm with uneven upper surface, often grazed upon. Ap. -1(1.5) mm, sessile to sunken. Very variable species. Ap. size and thallus condition very distinctive. ! C. dolomitica

Ecology and Distribution of the Species

Caloplaca albolutescens (Nyl.) Oliv. Like C. teicholyta (1), but predominantly on sandstone, scarcely on mortar – mieur-med – rare (3); Ne, Rh, süSch, Hü
Caloplaca alociza (Massal.) Migula
(≡C. agardhiana (Massal.) Clauz. & Roux)
To above the tree line on rather to very like rich, hard rock on undunged, rather sunny, rained-on surfaces rapidly drying after the rain, rather like Verrucaria marm. (†), Rinodina imm., above all in the Verrucarietum marm. – (bor-)mieur-med – rare; SJu, Ju, FrJu, Th, Al

Caloplaca ammiospila (Wahlenb.) Oliv. (C. cinnamomea (Th.Fr.) Oliv.)
On plant remains, soil mosses, old wood in the alpine zone, Char. Caloplacetum tir. – arct-alp – Al

Caloplaca aractina (Fr.) Häyrè (C. viridirufa auct., C. fuscoatra auct.)
On hard basic (and neutral) silicate rock, or slightly calcareous silicate rock on dry-warm sites, like Lecanora dem. (†), yet more strongly preferring warmth – s’bor-med – Questionable in the region?

Caloplaca arenaria (Pers.) Müll.Arg. (C. lamprocheila (DC.) Flagey)
Up to above the tree line, predominantly on hard, mineral-rich (to basic) silicate rock, on sunny, rained-on to moderately rain protected surfaces, subneutroph. -m.acidoph., r.-v.photoph., a-/m.nitroph. – bor-med – rare; at this time not sufficiently clarified species, in the region above all syanthropic on tomb stones of schistose or basic silicate rock, e.g. Sch, Do, additionally 0, Al

Caloplaca arnoldii (Wedd.) Zahlbr.
In alpine and high montane sites on overhangs of calcareous rock, like C. cirrochroa (†) – mieur-alp – v.rare (R); süSch (Feldberg), Alps

Caloplaca assigena (Lahm ex Arnold) DT. & Sarnt. (Blastenia a. (Lahm) Arnold)
Up to the tree line on usually acid bark and wood, above all on branches, fences – mieur – v.rare (0); süSch, Ju, Av

Caloplaca atroflava (Turner) Mong. var. atroflava
Probably like C. subpallida. At this time taxonomically yet insufficiently clarified var. submersa (Nyl.) H.Magn.
Above all in submontane and montane sites on hard silicate rock on occasionally submerged or from time to time irrigated habitats, like

Verrucaria praeterm. (†) – (s’bor-)mieur-subatl-med – rare (R); süSch, Vog, O, Ts

Caloplaca aurantia (Pers.) J.Steiner (C. aurantia var. aurantia)
In hilly to submontane, low precipitation, warm sites, above all in the wine growing region, on lime-rich to more rarely moderately lime-rich rocks, above all on smaller rocks in dry turfs and on limestone walls (e.g. vineyards), on m.-r.nutrient rich (dust deposits), ± rainy, full sun to semi-shaded warm habitats, scarcely on mortar, concrete, basiph., v.(-r)xeroph., r.thermoph., r.-r.photoph., m.(-r.)nitroph., -- s’mieur-med – (r.)rare; above all Ne, Mn, additionally SJu, Ju, süHü, HRh, Rh, nöHü, Eif, He, Th, but v.rare

Caloplaca biatorina (Massal.) J.Steiner
Up into the alpine sites, yet always on relatively dry warm habitats, on rather rain sheltered overhangs and vertical surfaces on calcareous silicate rock and lime-rich rock (above all limestone), above all on nutrient rich habitats, m.basiph., photoph., m.-r.nitroph., in the Community of the Caloplacion dec. – mieur-med, paralp/alp – v.rare (R); Mos, Bo (Hohentwiel), SJu, Al

Caloplaca cerina (Ehrh. ex Hedwig) Th.Fr. var. cerina
Up to the tree line on basic- and nutrient-rich bark of free or open standing deciduous trees, especially on avenue and field trees, usually on dust impregnated trunks, but also on non eutrophic, subneutral bark (e.g. aspen, hornbeam), rare on wood, like Physconia dist. (†), Xanthoria fallax (†), Lecania cyrtella (†); subneutroph. (-m.acidoph.), r.photoph., (a-)m.(-r.)nitroph., in the Xanthorion par. – bor-med – r.rare (3); above all Ju, SJu, Ne, but r.rare-rare, e.g. RhSch, He
var. chloroleuca (Sm.) Th.Fr. (C. stillicidiorum (Vahl) Lynge)
Predominantly above the tree line, yet isolated to the hilly zone (there relict), on mosses and plant detritus above all surface established calcareous thin turfs and on calcareous rocks, above all on radiation exposed, relatively dry habitats, like Megaspora verr. (†), rarer also on mossy old deciduous trees, neutroph.-r.basiph., r.-v.photoph., in the Megasporion verr. – arct-mieur(alp)-med-alp – rare(3); SJu, Ju, FrJu, Ries, Mn, Al, v.rare süSch, süHü, Ne, Bit, Eif, He
var. *muscorum* (Massal.) Jatta over mosses on tree trunks and rocks above all in the montane sites e.g. in the Antitrichion

**Caloplaca cerinella** (Nyl.) Flagey
Up into montane sites on deciduous trees with base-rich, usually not or only a little eutrophic bark, above all on hornbeam, maple, ash, also on wood, like *Lecania cyrtella* (↑), above all in the Lecanoretum samb., with *Lecania* species and *C. cerina* – (s’bor-)mieur-med – (r.)rare (3); Ju, SJu, süSch, süRh, O, Do

**Caloplaca cerinelloides** (Erichsen) Poelt
Like *C. cerinella* (↑) – s’bor-med – (r.)rare (3); e.g. süSch, Ju

**Caloplaca chalybaea** (Fr.) Müll.Arg.
Up into the alpine zone on hard, lime-rich rock (above all limestone) on rainy, rather open and often rather wind exposed habitats, commonly on larger rocks, on sloping and steep surfaces, avoiding stronger sun and very dry sites, basiph., r.xeroph., r.(-v)photoph., (a-)m.nitroph., increasing in numerous regions – mieur-med – rare; SJu-Ju-FrJu scattered, Ries, Al, but very rare (süHü ?+, Saar, Eif)

**Caloplaca chlorina** (Flotow) Oliv. (C. cerina v. ch. (Flotow) Müll.Arg.)
Predominantly on neutral to basic, often hard silicate rock, on walled in acid silicate rock, even on dust impregnated bark at the base of trees, like *Xanthoria fallax* (↑) – bor-med – rare; e.g. süSch, Ne, O, Rh, Pf

**Caloplaca chrysodeta** (Vainio ex Rässänen) Dombr. (Leproplaca ch. (Vainio ex Räs.) Laundon)
Up into high montane sites on lime-rich rocks on rain sheltered (but occasionally slightly foggy) overhangs and high relief vertical surfaces of rocks on shaded habitats, also crossing over on to mosses, even in niches on older walls, basiph., m.photoph.-r.skioph., m.nitroph., on contiguous rocks e.g. with *Lepraria flavescens* – bor-med – r.rare, but widespread, upper half of the calcareous region (e.g. Ju, SJu) syanthropic

**Caloplaca chrysophthalma** Degel.
Up into montane sites on trunks of older deciduous trees, above all on ash, oak, elm, on free standing trees, e.g. with *Bacidia rubella* – mieur(subatl)-smed(-med-mo) rare (1); süSch, Ju, Sju

**Caloplaca cirrochroa** (Ach.) Th.Fr.
Up into the alpine zone, in the region above all in submontane and montane sites, on carbonate rock, rare on calcareous silicate rock, on rain sheltered (but often also very sporadically weakly irrigated), often relatively warm overhanging and vertical surfaces on moderately to rather well lighted, in reduced forms also on rather light poor habitats, strongly avoiding dunging, scarcely on anthropogenic substrates (walls etc.) or in settlements, basiph., mesoph.-r.xeroph., (a-)m.nitroph., in communities of the Caloplacion dec., above all in the Caloplacetum cirr. – (s’bor-)mieur-med(mo) – rare; SJu, Ju, FrJu and Al. scattered, but rare: süHü, s129Sch, Bo, Ne, nöHü-O, MRh, Eif, Th

**Caloplaca citrina** (Hoffm.) Th.Fr.
Lichen of a wide ecological amplitude. Up to above the tree line, above all on limestone and calcareous artificial rock (above all concrete), rarer on lime influenced silicate rock, on bark of deciduous trees and over bark mosses, on wood, predominantly on ± nutrient rich sites, relatively weakly competitive species, above all on new habitats, as on walls, grave curbs, boundary markers etc., or on strongly dunged sites (at the base of walls (dog urination sites!), near manure heaps), here often surviving as a single species (or with *Caloplaca decipiens* (highly NH₄⁺-tolerant), at the base of steep surfaces and overhangs of rocks (in case of eutrophication even on lime-free silicate), largely lacking on bird-roost sites (summits): on wood and bark on correspondingly eutrophic sites (above all at the base of trees or in bark cracks); basiph.-subneutroph., in the Caloplacion dec., Char. Caloplacetum citr. – bor-med – (v.)frequent

**Caloplaca congrediens** (Nyl.) Zahlbr.
In montane and high montane sites on mineral rich (neutral to basic or slightly calcareous) or dunged silicate rocks on mostly sunny, relatively warm sites, mostly on smaller boulders, also crossing over on moss, subneutroph., r.-v.photoph., anitroph.-m.nitroph. – mieur-subatl-med – v.rare; Vog

**Caloplaca conversa** (Krempelh.) Jatta
Above all up into montane sites on carbonate rocks and calcareous silicate rock on sunny, often sporadically irrigated, rapidly drying habitats, subneutroph.-basiph., xeroph., ombroph., (substrate hygrophytic) – mieur-mo/alp/pralp-
Caloplaca coronata (Krempehl. ex Körber) J. Steiner
On m.-r.(s.) dunged limestone, above all on sunny surfaces, on rock caps, e.g. with Buellia venusta, (↑) basiph., r.-v.photoph., above all in the Placocarpetum monstrosi, also in the Caloplacetum sax. – mieur-med – r.rare; SJu Ju, FrJu moderately frequent (-r.rare), Mn, Th, additionally v.rare Ne, Bo, Eif, He

Caloplaca crenularia (With.) Laundon (C. festiva (Ach.) Zwackh)
Yet a little known lichen in the region at this time, predominantly on anthropogenic substrates, above all on wall crowns (mortar, concrete) – mieur-med – e.g. Ne, Mn, Rh

Caloplaca decipiens (Arnold) Blomb. & Forss.
Up into the alpine zone on limestone on rather to very eutrophic habitats, predominantly a synanthrop, above all on walls (preferring vertical surfaces) in settlements, on mortar, plaster, concrete, asbestos, very strongly tolerant of nitrogenous dunging (manure heaps), on near natural habitats (on bird roosting places, on caps and sloping surfaces of smaller rocks, often also on anthropogenic habitats, on walls (also on mortar), grave stones etc., clearly requiring less warmth than C. aurantiaca, basiph., m.-r(s.)nitroph., in the Caloplacion dec., often dominating – mieur-med – r.rare- m.frequent; SJu, Ju, and FrJu rather .frequent, Ne, Mn, also r.-v.rare (e.g. süRhön, Bo, Do, Hü, Rh, O, Pf, Saar, RhSch, Rh-Mn-T, He, Th

Caloplaca dolomitica (Hue) Zahlbr. (C. velana auct.)
On carbonate rocks on well lighted habitats, rather like C. variabilis (↑), Lecidella stigm. (↑), above all Aspicilicion calc., rarer Caloplacion dec. – s’bor-mieur-med(mo), (subko) – frequent, relatively rare in silicate regions

Caloplaca flavescens (Hudson) Laundon
Up into the montane zone on carbonate rock on nutrient rich (e.g. slightly dust encrusted), m.-v. well lighted, often relatively warm habitats, of poorer nutrients above all on rather rain sheltered to moderately rainy vertical surfaces and overhangs (little erosion), additionally on bird roosting places, on caps and sloping surfaces of smaller rocks, Bo additionally v.rare Ne, Bo, additionally Rh, Rhön, O, süRh, süPf, süHü, O, Ne, Ju, Fr

Caloplaca flavoreubescens (Hudson) Th. Fr.
In the montane, high precipitation or humid sites on subneutral, usually soft sap-rich or water storing bark, above all on aspen, in the Xanthorion, subneutroph., m.-r.photoph., a-(m.) nitroph. – bor-mieur-subatl-med – v.rare; Lux, Th+

Caloplaca flavovirescens (Wulfen) DT. & Sarnth.
Up into the high montane sits on mostly moderately lime-rich to lime-poor rocks or upper surfaces of leached carbonate rocks as well as slightly lime impregnated silicate rocks, above all on sandstone (arundinaceous sandstone) and dolomite in the region going over to walls (e.g. in vineyards), even on mortar, on sunny to semi-shaded, rainy surfaces, subneutroph.-m.basiph., m.-r.(v.)photoph., (a-)m.-r.(r.)nitroph., e.g. in the Caloplacetum teich., Aspicilion calc. – bor-med – r.rare (3); above all Ne, SFW, Bo. additionally Av, Al, süSch, Vog, HRh, O, süRhön, Saar, RhSch, Bit, Rh-Mn-T, He, Th

Caloplaca ferruginea (Hudson) Zahlbr. (C. heppiana (Müll.Arg.) Zahlbr., C. aurantia var. heppiana (Müll.Arg.) Poelt
Up into the montane zone on carbonate rock on nutrient rich (e.g. slightly dust encrusted), m.-v. well lighted, often relatively warm habitats, of poorer nutrients above all on rather rain sheltered to moderately rainy vertical surfaces and overhangs (little erosion), additionally on bird roosting places, on caps and sloping surfaces of smaller rocks, often also on anthropogenic habitats, on walls (also on mortar), Bo additionally v.rare Ne, Bo, additionally Rh, Rhön, O, süRh, süPf, süHü, O, Ne, Ju, Fr

Caloplaca granulosa (Müll.Arg) Jatta
Up into montane sites on lime-rich rock, occasionally even on calcareous, mostly basic silicate rock, on moderately rainy to rain
sheltered, then however sporadically short time irrigated, sunny to semi-shaded surfaces, above all under overhangs, always on r.-v. nutrient rich sites, basiph., m.-v.photoph., Char. Caloplacetum gran. –(mieur-)smed-med(mo) – rare; SJu, Ju, FrJu, Vog. süHü, Ne, Bo

**Caloplaca grimmiae** (Nyl.) Oliv. (C. consociata J. Steiner)
In montane to alpine sites parasitic on *Candelariella vit.* (†) and *C. coraliza* (†) on mineral rich (neutral to basic or slightly calcareous) or dunged silicate rock on mostly sunny, relatively warm sites, mostly on smaller boulders, subneutroph., r.-v.photoph., m.-r.nitroph., in the Parmelion consp., Lecidelletum carp. – bor-med – v.rare (0); süSch, Pf, He, Al

**Caloplaca haematites** (Chaub. ex St.Amans) Zwackh
In hilly, warm, low precipitation sites on subneutral bark, in the region on walnut, like *C. cerina* (†), yet limited to warm habitats – (s’mieur-)smed-med – v.rare (0); O, (Heidelb), Th

**Caloplaca herbidella** (Hue) H.Magn.
In (sub)montane to high montane, high precipitation, oceanic sites, above all on deciduous trees, on conifers commonly on branches (like *Pertusaria ophth.* †), on climatically mile to cool, relatively foggy habitats in open, near natural forests (on very moist sites even on free standing trees), in the lower sites above all in oak-beech forests on oak like *Parmotrema chin.* †, on higher sites above all on beech, ash, sycamore (like *Normandina* †), even on bark mosses, (subneutroph.-)m.(r.) acidoph., hygroph., a-(m.) nitroph., e.g. in the Parmeliétum rev., Lobarion – bor-subatl-med0mo, oz -- rare (2); süSch and Vog, but v.rare (nöSch, Ju (Albtrauf), Sp. Pf, Mos, Bit, Eif, Av, also SJu, Al

**Caloplaca holocarpa** (Hoffm. ex Ach.) Wade (C. pyracea (Ach.) Th.Fr.) Lichens of wide ecological amplitude (however taxonomically probably non uniform), on subneutral to basic substrate, thus on usually dust impregnated bark, dust impregnated wood, calcareous rock (in the region almost exclusively on anthropogenic substrates: walls, grave markers etc. often on artificial rock, like terrazzo, laundry concrete, here like *Candelariella aur.* †), on open and nutrient-rich habitats, the bark dwelling form above all on avenue and field trees, yet also on non eutrophic bark (aspen, hornbeam), basiph.-subneutroph., m.-v.photoph., a-rt.nitroph., in the Xanthorion par., Caloplacion dec., in *Xanthoria elegans* stands – arct-med – frequent (epiphytically rare)

**Caloplaca hungarica** H.Magn. (C.subbathallina H.Magn., C. depauperata H.Magn.) In montane and high montane, high precipitation, (r.)oceanic sites above all on smooth bark twigs of deciduous trees, shrubs, rarely conifers, e.g. on hawthorn, willow, ash, on well lighted habitats, in the region e.g. in the region of extensive willows, subneutroph.-m.acidoph., r.ombroph., r.hygroph., anitroph., in the Lecanori on subf. – mieur-pralp – rare (1); süSch, Ju, Al

**Caloplaca inconnexa** (Nyl.) Zahlbr.
On carbonate rock, parasitising on other lichens, like *Acarospora cerv.* † -- s’mieur-med – rare, e.g. Ju

**Caloplaca irrubescens** (Arnold) Zahlbr.
Up into montane sites on carbonaceous or neutral to basic silicate rocks on sunny to semi-shaded, warm habitats, e.g. like *Lecanora demissa* (†) – s’mieur-med – v.rare; süSch, süHü, Bo

**Caloplaca lactea** (Massal.) Zahlbr.
Up into the montane sites on limestone, first colonists on small stones in dry turfs and scree fields or on new surfaces of limestone (like *Rinodina bisch.* †, on usually sunny habitats, rarely also on walls, lime calcareous dust impregnated silicate rock, rather weak competitively and disappearing in lichen covered stands, basiph., (a)-m.nitroph. – mieur-med – r.rare; above all SJu, Ju, FrJu, also e.g. süHü, süRh, Ne, Bo, Mn, O, He, Th, Al

**Caloplaca lobulata** (Flörke) Hellbom (Xanthoria l. (Flörke) B.de Lesd.) Up into the montane sites on subneutral, often dust impregnated bark, above all on Norway maple, *Sambucus*, poplar, often on branches, like *Xanthoria polyc.* (†), subneutroph., r.-v.photoph., (a)-m.nitroph. – mieur-med – rare (1); Ne, Ju, O-nöRh

**Caloplaca lucifuga** Thor
Up into the montane, penetrating however into the submontane sites in open forests and on forest margins on trunks of old oaks in deep bark cracks, r.acidoph., (r.skioph.-)m.photoph.,
anombroph., a-/m.nitroph., e.g. in Chrysotrichetalia cand. -com., e.g. often with Calicium sal. (†) – s’bor-med – rare (3); Sch, Ju, Ne, O, Mn, Bo, do, SFW, Ts

**Caloplaca luteoalba** (Turner) Th.Fr.
On subneutral, usually dust impregnated deciduous tree bark, but strongly preferring elm, rarely also going over to limestone (above all stones), e.g. with *C. cerina* (†) in the Xanthorion par., subneutroph., r.photoph. – mieur-med – rare (0), names from O

**Caloplaca oasis** (Massal.) Szat.
In montane sites on endolithic Bagliettoa species, e.g. *B. parmigera* (†) – mieur-med – Ju

**Caloplaca obliterans** (Nyl) Blomb. & Forss.
In montane and high montane, high precipitation sites on mostly hard, crystalline, slightly calcareous silicate rock on rather rain sheltered, sometimes sporadically weakly irrigated (crevice water) overhanging surfaces on cool, r.(-v) humid, semi shaded to shaded sites, (sub)neutroph., r.skioph.-m.photoph., Char. Caloplacetum oblit. – bor-mieur-mo(-med-mo) – rare (3); süSch, Vog, nöPf, O, Al, BayW, ThW

**Caloplaca obscurella** (Lahm ex Körber) Th.Fr.
In hilly and montane sites on subneutral or correspondingly eutrophic, usually cracked bark, above all at the base of the trunk, up to the middle of the trunk, above all on poplar, elder, elm, ash, and older fruit trees, like *C. cerina* (†), *Rinodina colobina*, Char. Xanthorion – (s’bor- )mieur-med – r.rare, often overlooked; above all widespread in lime regions, Ju, SJu, süSch, Ne, süRh, HRh, Bo, O, ThW

**Caloplaca ochracea** (Schaeer) Flagey (Xanthocarpa o. (Schaeer) Massal. & De Not.)
Up into the montane sites on mostly hard, lime-rich rocks (above all limestone) on rainy, not to m.eutrophic sloping and vertical surfaces on completely sunny to half shaded habitats, basiph., a-/m.nitroph. – (s’)mieur-subat-med-mo – (r.)rare; SJu, Ju, FrJu; süHü and Eif v.rare

**Caloplaca polycarpa** (Massal.) Zahlbr.
C. tenuatula (Nyl.) Zahlbr.
On limestone parasitising above all on Verrucaria calciseda (†), like Aspicilia calc. (†), Char. Aspicilietum calc. – s’mieur-med – rare; Ju, Mn, Ne, FrJu

**Caloplaca proteus** Poelt
In montane to alpine sites on limestone, especially dolomite, like *C. cirrochroa* (†) – (bor-paralp-)mieur-pralp/alp – v.rare (R); Ju, FrJu, Alps

**Caloplaca rubelliana** (Ach.) Lojka
In hilly, warm, low precipitation sites on hard, basic, neutral or slightly calcareous silicate rock on very warm, moderately rainy steep surfaces, e.g. with *Dimelaena oreina*, e.g. in the Lecanoretum dem., subneutroph., thermoph., xeroph., r.-v.photoph. – s’mieur-med – v.rare, ; MRn, Rh-Mn-T

**Caloplaca ruderum** (Malbr.) Laundon
In hilly and submontane sites on vertical surfaces old walls, especially at the base under the influence of ammonium compounds (urine soaked surfaces), above all on mortal, basiph., m.-r.photoph., nitroph. – mieur – r.rare?; e.g. Ne, Sch, Ju, SFW

**Caloplaca saxicola** (Hoffm.) Nordin (C. murorum (Ach.) Th.Fr.)
Penetrating into alpine sites, but scattered (relict dealpine) also in the montane zone, on dying mosses and other plant detritus over limestone and lime rich, ground surface or sandy soils, on open to the light habitats, e.g. in Megasporion verr. – arct- mieur(mo)alp(-smed-alp) – rare (3); al, Ju, SJu, FrJu, Do-Av, Eif (v.rare)

**Caloplaca sinapisperma** (Lam. & DC.) Maheu & Gillet (C. leucoraea (Ach.) Branth, Blastenia l. (Ach.) Th.Fr.)
Penetrating into alpine sites, but scattered (relict dealpine) also in the montane zone, on dying mosses and other plant detritus over limestone and lime rich, ground surface or sandy soils, on open to the light habitats, e.g. in steppe heath, subneutroph.(-m.basiph.), r.-v.photoph., a-/m.nitroph., e.g. in Megasporion verr. – arct- mieur(mo)alp(-smed-alp) – rare (3); al, Ju, SJu, FrJu, Do-Av, Eif (v.rare)
Caloplaca subpallida H.Magn,
Above all up into montane sites, but also up over the tree line, predominantly on mineral rich silicate rocks or on slightly dust impregnated surfaces, on sunny, warm, rainy surfaces, often parasitic on crustose lichens, e.g. Aspicilia species (gibbosa group), like Rhizocarpon virid. (†), Parmelia pulla (†), above all in the Aspicilietum cin., Parmelietum consp., Lasallietum (above all initial stages), subneutroph.-acidoph., r.-v.photoph., a-/m.nitroph. – s’bor-med – r.rare; Sch, Bog, O, nöPf, Mos, Eif, MRh-Ts, Al, Fr

Caloplaca teicholyta (Ach.) J.Steiner (C. arenaria auct. p.p., non (Pers.) Müll.Arg.)
Above all in hilly-submontane, warm, low precipitation to moderately high precipitation sites on ± neutral/subneutral, calcareous or lime dust impregnated or ± strongly eutrophic rock substrate on almost exclusively artificial habitats (walls, tombstones etc.), on walled in natural stone (often sandstone), on mortar, concrete, tiles, terrazzo, v.rare on near natural habitats on contiguous rocks (e.g. lime leached carbonate rock), on light rich, nutrient rich habitats, (sub)neutroph., xeroph., r.-v.photoph., m.-r.nitroph., above all Caloplacetum teich., Lecidellietum carp. – mieur-med – m.-r.frequent, mostly introduced

Caloplaca tiroliensis Zahlbr.
In alpine sites on fresh dying plant detritus (moss, cushions plants) over calcareous soils in openings in the vegetation (e.g. from Caricetum curvulae) or over calcareous rocks (Androsacion alpinae), on well lighted sites, tolerating long time snow cover, subneutroph.-neutroph., Char. Caloplacetum tir. – arct-alp – v.rare (†); süSch (Belchen), Al

Caloplaca variabilis (Pers.) Müll.Arg.
Up into the alpine zone above all on lime rich, rarely lime poor rock, sometimes on lime dust impregnated or walled in silicate rich sandstone, usually on stones and smaller rocks or on rock caps (rainy surfaces), on r.-v well lighted, usually m.-r.eutrophic sites, also on anthropogenic habitats (walls, grave markers etc.), often on artificial stone (e.g. terrazzo), basiph., xeroph., above all Caloplacion dec., Aspicilion calc. – mieur-med – m.frequent; lime region, introduced in silicate region

Caloplaca vitellinula auct. medieur. (non (Nyl.) H.Olivier)
Like C. obliterans . (†), fruiting, nor sorediate parallel species? -- bor-mieur – rare; süSch, Vog, Bo, Saar, ThW

Caloplaca xantholyta (Nyl.) Jatta (Leproplaca x. (Nyl.) Harm.)
On very fragmented or porous, in the case of very high humidity on compact and smooth limestone, on humid, not sunny, dry substrate to at time moist substrate sites, in canyons, on north faces, in forests, like Lepraria flavesc. . (†), habitat amplitude overlapping even Gyalecta jen., basiph., m.-r.(v.)hygroph., (substrate hygroph.), (r.)m.photoph.-v.skioph., m.nitroph, above all in Verrucario-Caloplacetum xanthol., Gyalectetum jen. – s’mieur-med(mo) – r.rare; SJu, FrJu, Al, MRh, süHü


Candelaria Massal.

Introduction

The thallus of Candelaria species is small, delicate, very narrow lobed, deeply incised and – like the lecanorine apothecia – yellow colored. In contrast to the similar in habit, small lobed Xanthoria species, the red coloring with potassium hydroxide fails to appear. The single species occurring in Europe of the six species included in the foliose lichen genus grows especially on subneutral bark on free standing deciduous trees. They are widely distributed in Europe, they are however rare in the boreal zone and lacking in the arctic and alpine regions.

Genus Characteristics

Thallus very fine lobed divided to very small fruticose, green-yellow to yellow, sometimes (thus in the indigenous species) granular to sorediate at the margin, both sides with paraplectenchymatous cortex, with coccoid green algae. Ap. yellow, with thalloid margin. Exc. very reduced. Hyp. colorless. Hym. I+ blue. Paraphyses simple to sparsely branching,
thickened above. Asci clavate, *Candelaria* type, tholus only amyloid in the lower part, filled with non amyloid drops. Sp. to 16 up to about 50, single celled to appearing 2-celled. Pycnosp. ellipsoidal. Ch: Pulvinic acid -derivatives.

**Ecology and Distribution of the Species**

*Candelaria concolor* (Dickson) B.Stein

On subneutral (to moderately acid) mineral rich, often dust impregnated bark on free standing deciduous trees, like *Physconia dist.* and *Parmelia acet.*

Lit.: HILLMANN 1936

**Candelariella** Müll.Arg.

**Introduction**

Typical of *Candelariella* is a yellow, crustose, sometimes round lobed thallus with yellow apothecia with thalloid, rarely proper margin and with one or two-celled spores. In many species the thallus is gray or indefinite. In habit like the species of *Caloplaca*, showing however, because of the lack of anthraquinones, not deep red potassium hydroxide reaction.

Of a total of perhaps 40 and about 20 European species, the partially yet insufficiently known are, 10 proven n Germany, 9 from the region. *C. reflexa*, *C. xanthostigma* and the very rare *C. subdeflexa* and *c. viae-lacteae*, which are distributed in the south and in southern central Europe, occurring on bark. *C. kuusamoensis* lives on wood on nutrient rich sites (alpine huts, cattle fences, bird roost sites); *C. aurella* and *C. vitellina* occasionally found even on wood and bark, however as a rule reside on rock, preferably on calcareous, lastly on lime-free rocks. *C. coralliza* is characteristic of bird roosting sites on silicate rock, *C. medians* from corresponding sites on limestone, is however very frequent on anthropogenic habitats (walls). *C. aurella*, *C. vitellina*, *C. coralliza* and *C. xanthostigma* are distributed over all of Europe up into the arctic; finally into the high north of course rare. *C. kuusamoensis* has up to now been found in the outer part north Europe only relatively rarely (in central Europe). The so far known area of *C. reflexa* stretches from the mediterranean region up to southern Scandinavia. *C. medians*, a lichen of the mediterranean region, reaches the north boundary of its distribution in central Europe, where the natural occurrences are rare.

**Genus Characteristics and Determination**

Thallus crustose, usually definitely developed, granular, warty, areolate, sometimes rosetted and placoid, rarely indefinite and sessile in the substrate, yellow-green, yellow, yolk-yellow, sometimes with soralia or isidia, paraplectenchymatous cortex, with coccoid green algae. Ap. yellow, with thalloid margin, rarely (additionally) with proper margin or marginless. Exc. usually indefinite. Hyp. colorless. Hym. I+ blue. Epihym. yellow-brown, granular. Paraphyses simple to isolated branching. Asci clavate, of the *Candelaria* type. Sp. to 8-32, ellipsoidal to elongate, rarely drop-like, 1- to apparent 2-celled. Pycnosp. short cylindric to ellipsoidal. Ch: Yellow part with Pulvinic acid -derivatives in different parts (Calycin, Pulvinic acid, Pulvinic acid dilactone), P-, C-/C± orange, K-, but even occasionally slightly reddish colored. Several species occur as Calycin-free mutants and are then – in the case of unaltered morphology and anatomy – citron-yellow-green (*C. vitellina*, *C. aurella*, *C. medians*).

1 Thallus rosetted, with elongated lobules at the margin, therefore radially lobed (placoid), interior granular-warty, light yellow, -3 cm. Ap. rare. On rock .

1* Thallus not rosetted, not lobed at the margin 2

2 Thallus thick to very thick, deep cracked areolate, with almost cushion-like areoles, with granular uneven upper surface, yellow. Ap. rare. Sp. to 12-32. Above all on bird roost sites 3

2* Thallus not thick and deeply cracked areolate with granular upper surface . .


3* On wood, other sites even on mosses, plant detritus, rarely on rock. Thallus consisting of closely crowded, -0.3 mm granules, not of elongated segments. Sp. 9-15 x 4.5-55 µm

4 Thallus erupting sorediate or throughout fine granular to mealy
4* Ap. occurring . . 7
5 Thallus at least in places with flattened, -0.5 (1) mm, rounded to lobed, yellow-green to citron-yellow squamules, which first of all erupt sorediate on the underside and margins. Thallus squamules ultimately becoming sorediate, soredia covering the squamules. Often is to be found a thallus with hemi-spherical heaps of soredia without every spur of the squamules (C. efflorescens). Soredia ca. 20-40 (60) μm in diameter, usually more intensively yellow than the squamules (Attention, see also Candelaria with deeply divided lobules) . C. reflexa
5* Thallus purely granular to finely mealy, without squamules or areoles 6
6 Thallus of fine mealy, usually consisting of thick, irregularly divided heaps (soralia) of grouped soredia, yellow. Soredia ca. 20-40 (60) μm . ↑ C. reflexa (5)
6* Thallus consisting of equally divided, scattered to rarely thickly coalescing ± spherical to somewhat flattened granules, yellow to orange-yellow, without soralia. Granules ca. 30-110 (150) μm . C. xanhostigma
7 Thallus gray, granular to coralloid or appearing squamulose. Ap. yellow, bordered, the margin sometimes with a outer gray thalloid layer. Sp. to 8 per ascus. On bark C. viace-lactae
7* Thallus ± yellow or indefinite . 8
8 Thallus with soralia, in places with flattened, green-yellow to yellow squamules. Ap. light to orange-yellow, rare. Sp. to 8 per ascus, 10-17 x 4.5-5.5 μm . C. reflexa (5)
8* Thallus without soralia . 9
9 Sp. to 8 per ascus . 10
9* Sp. to 12-32 11
10 Ap. convex and usually marginless, -0.4 mm, usually very scattered. Thallus scarcely recognizable or thin, whitish to light gray, on bark and wood. Sp. 11-18 x 3.5-5.5 μm . C. subdeflexa
10* Ap. flat to slightly convex, clearly margined. Thallus variable, granular or areolate, ± yellow, or almost lacking. Ap. 0.3-1.2 mm, usually numerous, often crowded. Disk yolk yellow, yellow, olive-yellow, olive. Sp. 10-18 x 4.5-7 μm. On calcareous rock, wood, dust impregnated bark on tree trunks . C. aurella
11 Thallus on bark and wood, uniformly fine granular. Granules ca. 0.1 mm in diameter. Ap. 0.2-0.9 mm, usually deep yellow, sparse. Sp. 9-12 x 4.5 μm. Paraph. ends often capitate thickened . C. aurella
11* Thallus on silicate rock, rarely wood and bark, scattered or thickly granular to areolate, rarely rather thick and with almost cushion-like areoles, light yellow, yellow, more rarely reddish- or brownish-yellow, often K+ slightly reddish (yet never deep red). Ap. 0.5-1.5 mm, usually thallus colored. Sp. 9-15 x 4.5-6.5 μm. Paraph. ends mostly not thickened C. vitellina

Ecology and Distribution of the Species

Candelariella aurella (Hoffm.) Zahlbr. (C. heidelbergensis (Nyl.) Poelt)
Up into alpine sites on lime-rich to weakly calcareous rock, frequent on mortar and calcareous artificial stone, also on lime dust impregnated wood, rare on the dusty trunk base of free-standing deciduous trees and on other mineral rich substrates, on well lighted, often nitrogen rich habitats, frequent on walls, laundry concrete plates etc., regionally introduced, basiph., xeroph., (m.)r.-v.photoph., (a)-m.-r.nitroph., above all in the Caloploclion dec. – arct-med – frequent, above all synanthrop

Candelariella coralliza (Nyl.) H.Magn.
Up into the subalpine zone, rarely higher, on silicate rock on strongly dunged bird roosting places on radiation- and often r. wind exposed habitats, commonly on the crown of rocks, often on Aspicilia caesiocincta (1), m.-r.acidoph., ombroph., r.-v.photoph., r.-v.nitroph.. Char. Candelarielletum cor. – arct-med(mo) – v.rare; Sch, Vog. Pf, RhSch, Lahn, Sp. O. HeBgl, Ries

Candelariella kuusamoensis Räsänen
In montane to alpine sites on bird roosting places, above all on the dunged cross-section of posts and wood planks of sheds (above all roof ridges), often with Thelomma, m.acidoph., v.photoph., ammonoph. – bor-mieur-h’mo – rare (2); SFW, Do, Obay, Alps

Candelariella medians (Nyl.) A.L.Sm. (C. granulata (Schaerer) Zahlbr.)
Up into the montane zone in mostly low precipitation, relatively warm-summer sites on limestone and calcareous artificial stone (mortar, concrete) on sunny sites, high point on anthropogenic, strongly eutrophic habitats, above all on wall crowns and on strongly eutrophic base or walls, on grave stones, highly resistant to dust-and gas form emissions of dunging, penetrating into the interior of large stands, regionally introduced, rare on near natural habitats, thus on bird roosting places on the crown of limestone, e.g. in open to light dry turfs (above all Ju), basiph., xeroph., ombroph., r.-v.photoph., r.-v.(e.) nitroph., in the Physcio-Candelarielletum,
Caloplacetum sax. – s’mieur-med(mo) – v.rare-m.frequent; above all lime region, in forest rich and silicate regions (e.g. RhSch) rare

Candelariella reflexa (Nyl.) Lettau (C. efflorescens auct. p.p.)
Above all in submontane and montane, m.-v. high precipitation sites, on trunks of deciduous trees on mineral rich, subneutral bark, well developed above all on r. strongly rainy flanks and on sloping trunks, often on apple trees, ash, maple, also going over to moss, in lower sites often strongly sorediate and squamulose scarcely developed, here also on relatively dry habitats, often on poplar, subneutroph.-m.acidoph., ombroph., r.photoph., a-/m.(r.)nitroph., e.g. often with Normandina – s’mieur-med – m.frequent; above all Sch, Ju, SFW, Bo, RhSch

Candelariella subdeflexa (Nyl.) Lettau
Up into the montane zone, isolated even higher, above all on high precipitation sites on subneutral bark ± at the base of free standing deciduous trees, e.g. Walnut, ash, maple, also on dust impregnated sites, subneutroph., r.photoph., a-/m.nitroph., probably Xanthorion species – s’mieur-med – v.rare (0); süSch (+?), Ju

Candelariella viae-lacteae Thor & V.Wirth
Up into montane sites on free standing deciduous trees with subneutral to m.acid, often dust impregnated bark, above all on ash, subneutroph., r.photoph., m.ombroph., a-/m.nitroph., Xanthorion – s’mieur-med – v.rare (1); Ju (lx)

Candelariella vitellina (Hoffm.) Müll.Arg. (C. flavovirella (Nyl.) Lettau)
Up into the alpine sites, acidoph. Lichens with wider ecological amplitude, on lime-free silicate rock, rarely on silicate mosses, wood, (basal) on trunks of deciduous trees especially on m.dunged sites, mostly on smaller boulders, rock caps, in fissures of rocks, on natural stone walls, tomb- and grave stones (thus introduced in lime regions), often with Lecanora muralis (†), also on bird boulders and on occasionally flooded boulders in brooks, commonly on r.-v. well lighted rainy habitats, m.-v.acidoph., ombroph.-m.anombroph., m.-v.photoph., m.-r.(v.) nitroph., Char. Rhizocarpetea geogr., above all in the Candelariella vit. -Lecanora muralis community – arct-med – one of the most frequent silicate lichens, in rock free region on anthropogenic substrates

Candelariella xanthostigma (Ach.) Lettau
Up into high montane sites on deciduous trees, rarely on wood and on conifer trees, r.euryök, especially on m.acid, m.eutrophic bark on the middle of the trunk of free standing trees and on forest margins, also on wound flux, often on fruit trees, linden maple, ash, oak, rather tolerant to toxins, in lichen poor regions above all with Amandinea punctata (†), also like Physcia adsc. (†), subneutroph. -r.acidoph., (m.)r.photoph., a-/m.(r.)nitroph., above all in Physcietales adsc. – (arct-)bor-med -- frequent

Carbonea (Hertel) Hertel
(Determined ↑ Lecidea group)

Introduction
To the genus Carbonea number autotrophic and parasitic lichens with clearly developed crustose to endolithic thalli as well those living on lichens as parasymbionts with completely reduced thallus. The apothecia are black, lecideine. Of to this time ca. 20 species, 8 occur in Germany, predominantly silicate dwellers, in the Alps also a lime dweller (C. atronivea). C. vorticosa and those parasitising various crusts C. intrusa and C. assimilis are lichens of mineral rich (intermediary) silicate rock. In central Europe are the – with exception of C. vorticosa in the Alps – all becoming very rarely found (recorded e.g. in the Black Forest and in the Vosges). While C. assimilis occurs in temperate and warm temperate regions – in atlantic region as well as in north Norway -- the two other species are distributed in the boreal zone and montane to alpine sites above all central Europe. C. vitellinaria is parasymbiotic on Candelariella species and C. supersparsa is parasymbiotic on Lecanora species; both are distributed over a greater part of Europe. C. latypizodes is possibly very rare. C. distans – a central European-alpine species – lives parasitically on the alpine crustose lichen Orphniospora mosigii and is to be found in Germany in the Allgäu.

Genus Characteristics and Determination

**Ecology and Distribution of the species**

**Carbonea assimilis** (Körber) Haf. & Hertel (Lecidea a. (Körber) Th.Fr.)
In montane-high montane, (r.) oceanic, high precipitation sites on ± neutral to basic, ± lime free silicate rocks (mineral rich gneiss, slate, basalt) on sunny, relatively warm sloping and rainy vertical surfaces, parasitic on crustose lichens, subneutroph.-m.acidoph., r.-v.photoph., a-/m.nitroph., e.g. in the community of *Aspiciletalia gibb.* – bor-atl-mieur-subatl – v.rare (1); süSch, Vog, BayW, Erz, Hz

**Carbonea distans** (Krempelh.) Haf. & Obermayer (Lecidea distand Krempelh., Lecanora mosigiicola (Eitner) Hertel & Rambold)
In alpine sites parasitic on the thallus of *Orphniospora mosigii* (Körber) Hertel & Rambold, on hard, acid silicate rocks – mieur-alp – arct-med

**Carbonea intrusa** (Th.Fr.) Rambold & Triebel (Catillaria i. (Th.Fr.) Th. Fr., Micarea i. (Th.Fr.) Coppins & Kilias)
In montane to high montane, high precipitation sites on open and ± wind open metamorphic and magmatic silicate rocks, probably parasitic on crustose lichens, like e.g. *Schaeeria cinereorufa* (†), m.-r.acidoph., v.ombreph., above all in the *Umbilicarion cyl.*, Pertusario-Ophioparmetum – bor-mieur-mo/subatl – v.rare (R); Vog. süSch

**Carbonea latypizodes** (Nyl.) Knoph & Rambold ined. (Lecidea l. Nyl., Lecidella lacteola (Nyl.) Hertel & Leuckert)

Like *Lecidella carpath.* (†), probably above all on near the soil, slightly eutrophic surfaces – v.rare (0); O

**Carbonea supersparsa** (Nyl.) Hertel (Lecidea s. Nyl., Nesolechia s. (Nyl.) Rehm)
In montane to alpine sites on silicate rock dwelling on *Lecanora* species, e.g. *l. polytropa* – bor-med – süSch, Rhön

**Carbonea vitellinaria** (Nyl.) Hertel (Lecidea s. (Nyl.) Rehm)
Above all in the montane to alpine zone on the thallus of *Candelariella vit.* (†) and *C. coralliza* (†), predominantly on m. acid to subneutral, sunny, often relatively warm habitats – arct-med (–alp – rare; Sch, Vog, O, Mn, Ne, Ju, Ries, He, Erz, Al

**Catapyrenium** Flotow

**Introduction**

The thalli of the *Catapyrenium* species consist of scattered to crowded, light gray to dark brown squamules with cortex. The small, ring blackened around the mouth fruiting bodies (perithecia) are sunken into the thallus or stand between the squamules. Similar in habit to the *Endocarpon* species, they are distinguished from them by single celled spores. There are today about 40 species known.

Ten species are recorded in Germany. They grow on base-rich soils, e.g. in openings in dry turf, in soil filled rock fissures, on calcareous rock, on loess. *C. michelii, c. pilosellum* and *C. squamulosum* are found predominantly on naked soil in pioneer communities, *C. cinereum, C. daedalum, C. psoromoides* and *C. tremniacense* partly on soil, partly on mosses, e.g. on thin turfs.
*C. rufescens* sits on high relief limestone and calcareous silicate rocks. *C. lachneum* and *C. waltheri* which are not recorded from the region, occurring in the neighboring Allgäu arctic-alpine, establish themselves often in soil filled rock fissures. The soil dwellers are as a result of amelioration and enclosure of land (e.g. vineyard allocation) in regression.

*C. cinereum*, *C. daedalum*, *C. lachneum* and *C. waltheri* are arctic/boreal-alpine species, which penetrate up into the mountains of south Europe; *C. cinereum* and *C. daedalum* existing, thus in the region, as relict occurrences in relatively nearer sea level. The area of *C. psoromoides, C. pilosellum* and *tremniacense* reaches over central- and south Europe; here we have also *C. rufescens*, *C. squamulosum* and the more rare *C. michelii* whose high point, occurs however even in north Europe.

### Genus Characteristics and Determination

Thallus squamulose, commonly light to dark brown, red-brown, sometimes thickly white pruinose, stratified construction, upper side with paraplectenchymatous cortex, of ± anticlinal hyphae with rounded-angular to somewhat stretched cells, under side without or with weakly to clearly setoff paraplectenchymatous cortex, attached to the substrate with colorless to brown “rhizo-hyphae.” Photobionts: coccoid green algae. Per. sunken or, when between the squamules, projecting, with black apex. Exc. dark in the region of the apex, otherwise light to dark, with or without involucrem. Hym. I+ yellow-orange to reddish, rarely bluish-green, K+/+ blue. Paraphyses lacking in ripe per. Periphyses predominantly simple. Asci thin walled, clavate to elongate cylindrical, without tholus, wall I-, exterior with thin amyloid gelatin layer. Pycnosp. short cylindrical to cylindric or elongate ellipsoidal. Sp. 1-celled, ellipsoidal. Ch-.

1 Per. sitting between the thallus squamules, not sunken, with carbonate involucrum. Squamules ± crustose coalescing, very small, ±1(1.5) mm, thin (mostly 100-200 µm thick)  
2 1* Per. sunken into the thallus squamules, without involucrum  
3 2 Thallus squamules with blackish paraplectenchymatous lower cortex. Exc. brown to black-brown, surrounded by a ring-like carbonate involucrum. Sp. elongate egg form to almost clavate, 17-21 x 8-10 µm. Rhizoid hyphae dark. In alpine sites *C. waltheri*  
2* Thallus squamules without lower cortex and medulla. Exc. brown to black-brown, surrounded by a carbonate involucrum only in the upper part. Sp. ellipsoidal, 13-17(18) x 6-7 µm. Rhizoid hyphae colorless. In lower sites *C. tremniacense*  
3 Squamules entirely white pruinose, but margins often dark bordered, finely crenate to deeply crenate lobed, usually coalescing, ± compressed, 1-2(3) mm. Thallus with definite dark prothallus. Lower cortex blackish, paraplectenchymatous. Sp. 17-23 x 6.5-8.5 µm  
4 Rhizoid hyphae dark, producing a thick dark prothallus. Asci clavate, sp. ± two rows. Upper cortex thin (30 µm)  
5 4* Rhizoid hyphae light. Asci cylindrical, sp. single series  
6 Squamules finely crenate to deeply crenate lobed, usually whitish pruinose, often dark bordered, usually coalescing, ± compressed. Lower cortex blackish, paraplectenchymatous. Sp. 17-23 x 6.5-8.5 µm  
5* Squamules not deeply crenate, not dark bordered, to foliose lobed, approaching ± effigurate thallus (with somewhat elongated marginal lobes), without lower cortex. Very rare species  
6 Asci 55-65 x 13-15 µm. Sp. ellipsoidal to almost fusiform, on the average under 17 µm long (13-17 x 5.5-7 µm, sometimes with apparent two part content. Squamules usually light brown to gray or grey greenish. Lobe ends often flecked gray to violet gray pruinose  
6* Asci 75-85 x 17-20 µm. Sp. elongate egg form to clavate, on the average over 17 µm (17-22 x 6-8 µm), content not two-part. Marginal lobes broadly rounded, thick, nonpruinose, often somewhat indented. Thallus sometimes finely diffusely pruinose on the interior thallus parts (not flecked)  
7 Per. wall dark, 20 µm thick below. Sp. 11-15 x 5-6 µm. Squamules 1-4 mm large, thin, ±200 µm, closely attached, light to dark brown, dull, undersides blackish  
8 Squamules covered with very fine colorless hairs at the margin  
9 Squamules not hairy at the margin  
10 Thallus on soil or on soil encrusted rock  

* Genus *C. rufescens*  
* Genus *C. cinereum*  
* Genus *C. daedalum*  
* Genus *C. michelii*  
* Genus *C. psoromoides*  
* Genus *C. pilosellum* (12)  
* Genus *C. tremniacense*  
* Genus *C. waltheri*
Squamules very robust, (300) 350-600 µm thick. Medulla hyphae almost exclusively with long cylindric lumina. Sp. 12-17 x 5.5-7.5 µm

Squamules thin, 200-400 µm thick, 2-6 mm broad. Medulla hyphae with numerous spherical lumina. Sp. 14-17 x 6-8 µm. Squamules 2-7 mm, middle to mostly dark (red) brown, dull, often with bulging margin. C. lachneum

Medulla hyphae almost exclusively with long cylindric lumina. Sp. 15-20 x 7.5-9 µm. Squamules mostly 6-10 mm, middle to dark brown to red-brown. * C. rufescens (9)

Squamules mostly somewhat raised at the margin, delicately hairy when young, mostly brown to orange-brown, dull. Pycn. sparse, indefinite, sessile at the margin of the squamules. C. pilosellum

Squamules compressed, flat, commonly attached at the margins, not hairy, light to dark brown, dull or slightly shiny. Pycn. sunken in the squamule surface. Sp. frequently unripe. C. squamulosum

Ecology and Distribution of the Species

Catapyrenium cinereum (Pers.) Körber (Dermatocarpon c. (Pers) Th.Fr.)
Above all in the montane to alpine sites on ± calcareous, soil surfaced rock bases on fine rich soils, often humus sites, on thin soil layer on calcareous rocks, often on weathered dolomite soils, going over to raw humus and moss, e.g. in openings on (semi)dry turfs, in pioneer communities on rock crowns (Alysso-Sedion), old rock rubble and on rubble surfaces, neutroph.-basiph., phym., xeroph., e.g. in Toninio sed., − arct-mieur-alp − v.rare (3); above all FrJu; Ries, Ju, Do, Rh-Mn-t, He, Hz, Th; frequent in the Alps

Catapyrenium daedalum (Krempelh.) B. Stein (Dermatocarpon d. (Krempelh.) Th.Fr.)
In montane to alpine sties on calcareous subsoil, like C. cinereum (†) and Physconia musc. (†) − arct-mieur(alp)-(med-alp) − v.rare (1); FrJu, Ries, Al, Alps

Catapyrenium lachneum (Ach.) R.Sant. (Dermatocarpon l. (Ach.) A.L.Sm.)
In alpine sites, rarely lower, on soil surface raw soils, soil- or rock-mosses, plant detritus, commonly on base-rich substrates (geologically subsoil calcareous rocks or SiO₂ poor silicate rocks); neutroph.-basiph., phymoph. − arct-mieur-alp-(med-alp) − v.rare; Al, Vog

Catapyrenium micheli (Massal.) R.Sant. (Dermatocarpon m. (Massal.) Zwackh)
On fine soil and loess, like C. squamulosum − mieur-smied − v.rare (0); Ne, Do

Catapyrenium pilosellum Breuss
Like IC. squamulosum (†) − mieur-subatl-med − rare, overlooked (1); süHü, Do

Catapyrenium psoromoides (Borrer) R.Sant. (Dermatocarpon p. (Borrer) DT. & Šarnt.)
Penetrating on deciduous trees with subneutral bark, but also (in the region) over mosses on limestone or soil surface raw calcareous soils on well lighted habitats; subneutroph.-m.basiph., r.-v.photoph. − mieur-med − v.rare (1); FrJu, Ju, SJu

Catapyrenium rufescens (Ach.) Breuss (Dermatocarpon r. (Ach.) Th.Fr.)
Up into alpine sites on limestone, rarely calcareous silicate rocks, preferably on steep surfaces and on fragmented sites on well lighted habitats, often on sporadically irrigated surfaces, also on soil encrusted rocks, upon/with blue-green algae, rarely on mosses or soil, like Lecidea lurida (†), Toninia cand., Synalissa symph., predominantly in Collemation fuscov. − bor-med − r.rare; SJu-Ju-FrJu, Al, v.rare süHü süSch, Ne, Mn, Ts, MRh, Lahn, Th

Catapyrenium squamulosum (Ach.) Breuss (Dermatocarpon hepaticum auct, non Endocarpon hepaticum Ach.)
Up into the montane, rarely alpine zone on calcareous soil, on naked loam soils, loess, on garden soils, in surface based rock soils, in regions of gravel surfaces on gravel pits, on soil layers on rock terraces etc., even going over to mosses and plant detritus, pioneer plants on open rich garden soils, weakly competitive, in openings of (semi)dry turfs, Alyso-Sedion, on mostly warm, moderately to very well lighted sites, subneutroph.-basiph., xeroph., in the Toninio sed. − (bor)mieur-med − r.rare: above all Ne, Hü, Mn; SJu-Ju FrJu, Eif, Ts, He, Th, Al

Catapyrenium tremniacense Massal. (Dermatocarpon t. (Massal.) J.Steiner)
In hilly and submontane sites on calcareous garden soils in lacunae of dry trufs and gardens soils of gravel surfaces, on base rich soils in well lighted, warm habitats, e.g. in the Toninio-
Psoretum – s’ mieur-med – v. rare (1); Mn (Taubertal), FrJu, Do, Av

Catapyrenium waltheri (Krempelh.) Körber (Dermatocarpon w. (Krempelh.) Blomb. & Forss.)
In alpine sites on naked soil and raw humus over calcareous subsoil – arct-alp – v. rare; Al; scattered in the Alps

Lit: BREUSS 1990

Catillaria Massal.
(Keys include Catinaria, Cliostomum, Megalaria, Micarea p.p.)

Introduction

In the broad sense one places in Catillaria crustose lichens with two-celled colorless spores and various colored apothecia without thalloid margins. Catinaria, Cliostomum, Megalospora and Micarea were separated from this unnatural group genus according to various characteristics in the construction of the apothecium. Catillaria in the narrow sense includes species with generally thin, gray to nearly indistinguishable thalli living in the interior of the substrate, usually black to brown-black apothecia with lecideine proper margin, paraphyses unbranched to singly branched in the upper part with capitate thickened, provided with a brown apex capped ends and two-celled elongate spores.

C. atomarioides and C. chalybeia occur on (mostly mineral rich) silicate rock; C. lenticularia lives on calcareous rocks and C. nigroclavata on bark. C. chalybeia frequently invades man made substrates. The indigenous rock dwellers are distributed in the south and central Europe and penetrate above all in the west widely into the boreal zone. C. nigroclavata occurs up into central Fennoscandia. C. detractula, C. erysiboides, C. minuta and C. picila do not belong to Catillaria s.str. The latter two live on shaded limestone on vertical and overhanging surfaces on humid habitats. C. detractula is found on well lighted, warm sites on limestone, C. erysiboides on tough old wood, e.g. deciduous tree stumps. C. erysiboides is distributed in the boreal and summer green deciduous region. The area of C. alba, C. anomaloides, C. detractula, C. picila and C. minuta stretches over south and (predominantly to the south) central Europe; finally an occurrence (Gotland) in south Scandinavia.

Genus Characteristics and Determination

Thallus crustose, clearly developed to living in the substrate, whitish, gray, brown, blackish, with various coccoid and filamentous green algae. Ap. variously colored (in Catillaria i.e.s. black to dark brown), without thalloid margin, with or rarely without definite proper margin. Exc. usually clearly developed. Paraphyses simple to sparsely branched, capitate above, with brown cap (Catillaria i.e.s.) or colorless to pigmented above. Hyp. colorless to brown-black. Asci almost cylindrical to clavate, in the case of Catillaria i.e.s. with uniformly I+ (K/I+) blue tholus and exterior with thin I+ (K/I+) blue gelatin layer, in the case of Catillaria i.w.s. to the part Biatora- and Bacidia- type. Sp. 2-celled. Ch-.


Micarea melaenida (Nyl.) Coppins 2* On mosses, plant detritus, raw humus, humus soils 3 3 Hyp. light, mostly colorless. Ap. whitish, yellowish, rose, brown, discolored gray 4 4 Sp. 10-17 x 4-5 µm, with definite episporae, 2- to rarely 4-celled. Ap. brown-rose, orange, rose-yellowish, yellowish, beige, convex from the first, -0.9(1.1) mm, sometimes coalescing, margin rapidly disappearing. Epithym., hyp., hym., and exc. colorless to slightly yellowish, exc. strongly developed, paraplectenchymatous. Paraph. scarcely branched, strongly cemented, 3-4 µm. Thallus greenish-gray, thickly fine granular to erupting sorediate, the sorediate region greenish, soredia 30-70 µm. Zeorine . .

5 Ap. marginless from the first. Exc. reduced, of paraph. like hyphae.

5* Ap. with margin for a long time, dark brown to black (then brown tinged when moist), -0.8(1.2) mm. Margin thin, often wavy. Exc. clearly developed. Hyp. red-brown to black-brown (often flecked), in the upper part (and in the hym.) often with scattered blue-violet, blue-green to brown, K+ green granules. Epiphym. red-brown to pale brown. Subhym. sometimes blue-green. Sp. 8.5-17 (19) x 3.5-6(7) µm, (-)2-celled, rarely 4-celled. Thallus indefinite or gray to brown tinged. Ch-.

6 On rock

6* Not on rock

7 On silicate rock. Paraph. simple to strongly branched.

7* On limestone. Paraph. simple, only occasionally short branched above. Thallus R-, Ch-

8 Paraph. only little thickened above, frequently branched and reticulate (KOH), cemented. Exc. of paraphyses like hyphae. Ap. marginless (M. subnigrita, M. prasina, Carbonea intr.)

8* Paraph. strongly capitately thickened above (6 µm) and dark colored (with sharply bordered dark brown cap), occasionally short branching only above. Ap. with margin. Epiphym. dark brown to (olive)black. Exc. clearly developed. R-, Ch-

9 Hyp. colorless. Hym. 30-40 µm, colorless. Ap. very small, -0.2 mm, black, when moist with brown-gray to dark brown disk and black margin. Thallus dark gray to black coalescing or warty to areolate. Sp. 8.5-13.5 x 3-4 µm.

9* Hyp. light to dark brown, hym. often above all in the upper part blue-green 45-60 µm. Ap. 0.2-0.5(1) mm, dark brown to black, even when moist. Thallus usually olive-gray, olive-brown, gray to black, rarely light, mostly coalescing to cracked. Sp. (8)9.5-12.5(15) x (2.5)3-4 µm.

C. atomarioides

10 Paraph. only little thickened above (-3 µm), weakly colored. Thallus indefinite R-.

10* Paraph. strongly capitately thickened above, -6(8) µm.

11 Hyp. colorless to pale yellowish. Ap. light orange brown to red-brown, margined, with at first deeply seated, later convex disk, -0.4 mm. Sp. 10-18 x 4-6.5 µm, ± slightly shrunk at the septum

C. minuta

11* Hyp. and exc. dark red-brown(violet), K+ purple-violet. Ap. (dark)brown to black, when moist red-brown with a dark margin, ± marginless, flat to later strongly convex, -0.8 mm. Sp. 10-16(20) x 3-4.5(5) µm, elongate, 1-2 cells.

C. picila

12 Hyp. colorless to slightly yellowish or slightly brownish.

12* Hyp. red-brown to brown-violet, (usually also the epiphym. and exc.) K+ purple-violet. Ap. black (even when moist).

13 Ap. black, not lighter even when moist. Thallus strongly developed, lumpy-squamulose, often of blackish blue algae under crust, dark brown, red-brown when moist, with cortex (in section diffuse violet in the region of the hyphae ends). Paraph. scarcely cemented, with pressure ± easily freed. Pigment producing the cap of the paraph. head not sharply delimited, but ± diffuse in the surrounding hymenial gelatin. Epiphym. and exc. exterior dark violet, rarely greenish-black. Hym. 50-55 µm. Sp. 8-12 x 3-5 µm.

Toninia pennina

13* Ap. red-brown, dark brown, black, with a clearly lighter disk when moist, sessile to slightly sunken, margin indefinite. Thallus generally indefinite.

14 Paraph. cemented, without sharply delimited brown pigment cap. Pigment in the ephymenium diffusely dispersed, red-brown to brown-violet. Ap. brown to black, ± shiny, when moist brown with black margin, -0.3 mm, moderately to strongly convex. Hym. 50-75 µm. Sp. 9.5-13 x 4-5.5 µm.

C. detractula

14* Paraph. under pressure ± easily freed, above with sharply delimited brown pigment cap. Ap. red-brown, (dark)brown to black, when moist yellowish to red-brown with darker margin, -0.4(0.5) mm, flat to moderately (strongly) convex. Hym. 40-60 µm. Sp. 8-12 x 3-4 µm.

C. lenticularis

15 Exc. and hyp. carbonaceous violet-black. Hym. dirty green, rarely colorless, epiphym. black-green, often abraded. Sp. 9-13.5 x 3.5-5.5 µm. Ap. 0.3-0.5(1.5) µm, ± shiny. Thallus indefinite or coalescing or squamulose areolate, whitish to ochre. Alps.

C. tristis

(Müll.Arg.) Arnold

15* Exc. and hyp. not carbonaceous black (thin section). Hyp. (flecked) red-brown to brown-violet. Epiphym. olive-brown to greenish-black.

16 Thallus unclearly developed, rarely definite. Sp. 2-2.5 x as long as wide, 10.5-13.5 x 3.5-7 µm. Ap. 0.3-0.5(0.8) mm.

Toninia athallina

16* Thallus usually clearly developed, cracked to lumpy-squamulose or warty areolate, areoles flat to convex of uneven, (yellowish) gray to gray-green, brown, rust-brown. Ap. 0.2-0.8 mm, flat to moderately convex, indefinitely margined. Sp. 11-16.5 x 4-7 µm.

Toninia philippea


17* Ap. dark brown to black

18 Usually on thin branches and needles of conifers. Ap. -0.3(0.4) mm, light rose-brown to yellowish or beige, flat to convex, with thin whitish margin. Hyp. colorless, epiphym. very pale. Sp. 10-15 x 3-
Fellhanera bouteillei

18* On other substrates

19 Ap. with raised margin for a rather long time, flat for a long time .

19* Ap. completely marginless or not a raised margin or margin very rapidly disappearing

20 Ap. -0.3 mm, waxy whitish to pale yellow-orange, with sunken disk. Thallus smooth, dark green to indefinite. Pycn. hemispherical, brown yellowish. Sp. 10-14 x 2-3.5 \( \mu \)m. Algae Trentepohlia .

20* Ap. generally larger. Thallus with black pycn., K+ yellow. Pycn. wall purple-brown (K+ more strongly purple). With true green algae. Sp. 8-16 x 2.5-4 \( \mu \)m. Atranorin .

21 Ap. lead gray, rose-gray, brownish to blackish, - 0.8 mm. Epiphy. rather light or dark, then K+ violet. Pycn. -0.2 mm. Roccellic acid .

21* Ap. -0.5 (0,6) mm, often shrunken at the septum. Thallus R-. Pycnosp. 6-10 x 2-3 \( \mu \)m.

22 Ap. often with pale margin, disk rose-brown to yellow-brown, weakly convex. Paraph. branched, reticulate. Sp. 9-16 x 3-5 \( \mu \)m. Thallus pale greenish to green-gray, with apothecia like structures having pycnosp. Pycnosp. 3.5-4 x 1.5-2 \( \mu \)m.

22* Ap. without lighter margin. Without apothecia like containing whitish pycnosp

23 Ap. brown-rose, orange, rose-yellowish, yellowish, beige, 0.5-1 mm. Sp. 11-17 x 4-5 \( \mu \)m. Epiphy. hym, hyp. and exc. colorless to slightly yellowish

Mycobilimbia sphaeroides (4)

23* Ap. smaller, -0.4 mm .

24 Ap. whitish, yellowish, yellow-brown, reddish-yellow, ochre. Thallus R-.

24* Ap. otherwise colored, but very variable, pale to dark gray, brown-gray, lilac-gray, blackish. Thallus usually definite, of green ± spherical granules. Exc. reduced, made up of paraphyses-like hyphae. Paraph. branched and reticulate. Sp. 8-14 x 2.5-4 \( \mu \)m.

↑ Micarea prasina

25 Pycn. frequent, white, pruinose, finally light yellowish, sessile to short stalked. Pycnosp. bacillar to ellipsoidal, 3.3-5 x 0.8-1 \( \mu \)m. Ap. whitish to (old) pale ochre, ± pruinose, hemispherical to almost spherical. Epiphy. pale yellowish, with the finest crystals throughout (in K solution). Asci (1-)2 celled (6.5)8-10(11.5) x 2.3-3 \( \mu \)m. C. alba


26* Ap. marginless from the first .

26* Ap. at least at first clearly margined and ± flat, later even convex marginless .

27 Exc. clearly developed, swollen, as though paraplectenchymatous. Paraph. simple (generally only slightly branched above), often strongly capitata. Ap. brown-black to black, 0.2-0.6 mm. Epiphy. gray, brown, olive, green-black, K± greenish. Hyp. light. Sp. 8-15 x 2-3 \( \mu \)m. Ch.-

Often on oak Bacidia globulosa

27* Exc. reduced in the case of a completely developed ap, composed of paraph. like hyphae. Paraph. branched and reticulate, not strongly capitata. Epiphy. often violet. Commonly on wood, see (Micarea (denigrata, misella, elachista)

28 Sp. 20-30 x 10-15 \( \mu \)m, ellipsoidal, thick walled. Ap. -1(1.8) mm, flat, thickly margined, later convex marginless, rather like Lecidella elaeochroma, disk rough. Hyp. red-brown to green-blackish. Epiphy. dark green. Hym. 120-140 \( \mu \)m. Thallus very thin, with (often incorrectly identified) Trentepohlia algae.

Megalaria grossa

28* Sp. clearly smaller .

29 Sp. 2-3.5 \( \mu \)m wide, elongate

29* Sp. at least 3.5 \( \mu \)m wide, ellipsoidal, rarely fusiform

30 Paraph. not capitata above. Thallus usually clearly developed, thickly granular to warty, whitish to light gray, K+ yellow, often with black, -0.2 mm wide pycn. (wall K+ purple). Ap. often various colored on one thallus, rose-gray, gray-brown, brown to blackish, often slightly pruinose, if dark, then epiphy. K± violet, at first concave, later flat to moderately convex, 0.4-0.8(1) mm. Pycnosp. 3.5-4 x 1.5-2 \( \mu \)m.

Atranorin, Roccellic acid

30* Paraph. strongly capitata thickened. Thallus generally thin, Ch-.

31 Paraph. cemented, not easily freed by pressure, without sharply delimited pigment cap. Sp. 8-15 x 2-3 \( \mu \)m, elongate. Ap. -0.5 (0,6) mm, often even when young scarcely margined, at first flat, very soon highly convex marginless, thallus usually scarcely recognizable .

Bacidia globulosa (27)

31* Paraph. weakly cemented, rather easily freed by pressure, with brown pigment cap above. Hyp. light brown above (rarely dark brown), light below. Sp. (7)8-10 x (2)2.5-3.5(4) \( \mu \)m. Ap. -0.4 mm, flat, thin margined, finally convex marginless, dark brown to black, thallus thin., gray, gray-brown .

C. nigroclavata

32 Hyp. brown, red-brown, black-brown, even flecked green to brown-green .

33
Hyp. colorless to pale brownish
Epihym. scarcely colored to yellow-brown.
Thallus usually crustose coalescing or thin warty, rarely granular, gray, brown tinted gray.
Hyp./exc. red-brown to black-brown, hyp. even green flecked. Algae protococcoid. Ap. red-brown, brown to almost black (then rust tinged with moistened), -0.8(1) mm, at first concave, then for a long time flat to moderately convex and with a little projecting, finally disappearing, same colored or darker, often shiny margin. Hyp. and hym. sometimes with scattered brownish to greenish or bluish granules. Sp. 1-2-celled, (8)10-15 x 3.5-6 µm. Ch-

Mycoblimbia sanguineoatra
Epihym. dirty bluish, black-blue to violet-brown, K+ green or violet. Hyp. light brown or red-brown. Algae Trentepohlia (cells relatively large). Ap. black to brown, at least at first clearly margined.

Megalaria laureri
Thallus thin, not sorediate, pale yellowish, P-, C-
Epihym. dark purple-brown to blackish green(-violet), K+ red-violet. Hym. colorless or ± red-violet. Sp. 12-17 x 6-8 µm. Ap. flat to slightly convex

Megalaria pulverea
Sp. 8-16 x 2.5-4 µm. Ap. rose-gray, gray-brown, brown to blackish, often slightly pruinose, if dark, then epihym. K+ red-violet, at first concave, later flat to moderately convex, 0.4-0.8(1) mm. Thallus usually clearly developed, white-gray to gray, K+ yellow, often with black pycn.

Chistostomum griffithii (30)
Sp. (9)10-15 x 4.5-7 µm, relatively thick walled. Ap. dark red-brown, brown-black, red-black, black, concave, later flat to slightly convex, margined, 0.2-0.6 mm, margin finally disappearing. Epihym. yellowish to brown, hyp. slightly brownish. Paraph. easily freed by very slight pressure. Thallus thin, often finely granular.

Asci predominantly 12-16 spored. Sp. 9-13 x 5-6 µm.

Catillaria atomarioides (Müll.Arg.) Kiliias
In hilly to montane, rarely higher sites on hard, often mineral rich silicate rock on m.-r. well lighted habitats, e.g. in open forests, pioneer, on slightly irrigated rocks, m.acidoph.-subneutroph. – s’bor-atl-mieur(subatl)-med – rare (R); Sch, additionally Ofr, Obay, Westf

Catillaria chalybeia (Borrer) Massal.
Up to the tree line on silicate rock, at least on subneutral and moderately acid substrates, thus on rocks of basic or slightly lime impregnated silicate rocks, frequent on walls, but not overgrowing mortar, also on tiles, also on sometimes flooded or short time overflowing boulders in brooks, usually on semi-shadowed surfaces, subneutroph.-m.acidoph., mesoph.-hygroph., (r.skioph.)m.-r.photoph., a-/m.- r.nitroph. – bor(atl)-mieur-med(mo) – r.rare, on anthropogenic substrates scattered in the silicate regions; near naturally occurring e.g. Sch, Vog, Eif

Catillaria lenticularia (Ach.) Th.Fr.
Up into the alpine zone on carbonate rocks, rarer on calcareous or dunged silicate rocks, usually on steep- to overhanging surfaces on well lighted to radiation protected sites, basiph., r.skioph.-r.(s.)photoph., m.nitroph. – mieur-med – r.rare: SJu, Ju, FrJu, Hü, Ne, H Rh, MI, Saar, Th, Al

Catillaria nigroclavata (Nyl.) Schuler
Up into the montane sites above all species on mineral- or nutrient-rich bark of deciduous trees on the branches and trunks, above all on free-standing avenue- and garden trees, toxic tolerant, also endures eutrophication by dung emitted dust, e.g. even on green algae sites with Scolioiosp. chlor., subneutroph.-m.acidoph., xeroph. -mesoph., photoph., m.-r.nitroph., e.g. in the Physcietum adscend. – s’bor-med – r.rare (3); e.g. Sch, SJu, Ju, Bo, Ne, SFW, Rh, O, Sp, Bit, Th

Catillaria s.str.

Catillaria alba Coppins & Vèzda
In submontane and montane, high precipitation sites on old debarked deciduous tree stumps on ± rain sheltered flanks in open forests (e.g. oak-beech forests) – mieur-med – v.rare (1); süSch (Säckingen)

Catillaria detructula (Nyl.) Oliv.
Usually on lime-rich rocks up into montane sites on sunny, warm habitats, basiph., photoph. – s’meur-med – rare (R); Ju

**Catillaria erysiboides** (Nyl.) Th.Fr.
In montane-high montane sites on decaying wood, e.g. on the cross-section of old tree stumps, like e.g. *Xylographa par.* – bor-mieur – rare (1); süSch, Vog, Ju, Eif, ThW

**Catillaria minuta** (Massal.) Lettau
Up into the montane zone on lime-rich rocks, above all limestone, prefers sites away from the sun on vertical surfaces and overhangs, usually in valleys and ravines; basiph., r.skioph.-m.(r.)photoph., m.-r.hygroph., e.g. with *C. picila* – (s’)meur-smed-mo – rare; SJu-Ju-FrJu, süHü

**Catillaria picila** (Massal.) Coppins (Lecidea p. (Massal.) Nyl., C. anomaloides auct.)
Up to the tree line, rarely above, ecology very like *C. minuta* and often associated with it – meur-med – rare; SJu-Ju-FrJu, süHü, Al

**LIT.:** KILIAS 1981, PURVIS ET AL. 1992, VAINIO 1934

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**Catinaria Vainio**

(Determination ↑ Catillaria)

**Introduction**

The *Catinaria* species are crustose lichens with a simple thallus with green algae, light brown to blackish apothecia with a later often pressed back proper margin and two-celled colorless spores. The indigenous species are rare, possibly strongly threatened wood- and bark dwelling (deciduous trees, fir) humid forests. They are already for a long time no more to be found. They occur from the boreal zone to central Europe and partly up into the mountains of the mediterranean region.

**Genus Characteristics**

Crustose lichens with a thallus with green algae definitely sessile into the substrate. Ap. with ± definite biatorine proper margin, light brown to black, concave to flat. Exc. interior rather light, exterior colored, of cemented hyphae. Hyp. colorless to pale brown. Hym. blue. Epithym. colorless to brown. Paraphyses simple to forked and sparsely reticulate, slightly thickened above. Asci clavate, exterior with I+ blue gelatin layer, with I+ (K/I+) uniform blue tholus or with apparent non-amyloid axial mass, with often indefinite ocular chamber. Sp. 8 to 16, ellipsoidal. Ch.-

**Ecology and Distribution of the Species**

**Catinaria atropurpurea** (Schaeer) Vèzda & Poelt (Catillaria a. (Schaeer) Th.Fr.)
Up into high montane sites on wood and bark especially old deciduous-, rarely conifer trees, on the trunk and trunk base, also on tree stumps, on humid, usually not sunny habitats, subneutroph.-m.(r.)acidoph., hygroph., a(-m.) nitroph., e.g. in the Lobarion – bor-med-mo – rare (0); Sch. Vog, Ju, Do, Av, Al, Eif, ThW

**Catinaria neuschildii** (Körber) P.James
(Catillaria n. (Körber) Th.Fr.)
Like *C. atropurpurea* (↑) – bor-smed – v.rare (0); süSch

**LIT.:** PURVIS ET AL. 1992, VAINIO 1934

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**Catolechia Flotow**

(Determination ↑ Buellia)

**Introduction**

*C. wahlenbergii*, the single species of the genus, is distinguished by the brilliant citron yellow, thick squamules to foliose, lobed at the margin, black underside thallus, that is attached by strong black rhizine strands. The black lecideine apothecia sit between the squamules. The lichen resides on moist soil filled fissures of silicate rocks on cold, habitats away from the sun in high precipitation high mountain sites. The arctic-alpine species has continued to live between the northern part of the area and the alpine mountains (Carpathians, Alps, Pyreneese) as a small relict population in the high central mountains, in the Harz, in the Bohemian Forest, in the Riesen mountains and the high Black Forest. In the Black Forest only a single
individual has been found; here they are threatened with extinction.

**Genus Characteristics**

Thallus squamulose-foliose, folded-lobes (squamules elongated) at the margin, green-yellow, underside black, attached to the substrate with strong black rhizine strands, very thick structure, with a thick epinecral layer, photobiont coccoid green algae. Ap. black, with thin, later disappearing proper margin, sitting between and at the margin of the squamules. Exc. dark red-brown. Hyp. dark brown, out hyphae lying radially. Hym. I+ blue. Epihym. dark olive green to blackish. Paraphyses richly branching and reticulate, scarcely thickened above. Asci clavate, exterior with I+ blue gelatin envelope, the young with a strong tholus, of which the part toward the ascus lumen I+ weak blue, at the tip directly underneath the outer wall layer a disk shaped I+ intensively blue structure. Sp. 2-(4-) celled, without perispore. Ch: Pulvinic acid derivatives.

**Ecology and Distribution of the Species**

Catolechia wahlenbergii (Ach.) Körber (Buellia w. (Ach.) Sheard, B. Pulchella (Schrader) Tuck.)

In alpine, very high precipitation sites, very rare on high central mountain peaks, in garden rich humus, moist fissures of silicate rocks, on thin soil layers over rock, on cold shaded, but often well lighted habitats, r.-v. acidoph., hygroph., m.photoph. 00 arct-mieur-alp – v.rare (1) süSch (Feldberg), BayW*, Hz*, Al

**Ecology and Distribution of the Species**

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Cecidonia umbonella (Nyl.) Triebel & Rambold (Lecidea u. Nyl.)

In alpine sites on silicate rock parasitic on Lecidea lapicida (↑), on ± exposed rocks – Arct-alp – v.rare (R); süSch (Belchen), Alps

**Genus Characteristics**


**Ecology and Distribution of the Species**

Cecidonia umbonella (Nyl.) Triebel & Rambold (Lecidea u. Nyl.)

In alpine sites on silicate rock parasitic on Lecidea lapicida (↑), on ± exposed rocks – Arct-alp – v.rare (R); süSch (Belchen), Alps

**Cephalophysis** (Hertel) Kilias

(Determination ↑ Lecidea PT 3)

**Introduction and Genus Characteristics**

C. leucospila, the single European species of the genus, is an arctic-alpine crustose lichen of calcareous rock, which earlier was counted as Lecidea because of their lecideine black apothecia and single celled spores. The species is distinguished from others, e.g. by Caloplaca species by the ascus type (Teloschistes type). Paraphyses clavate-capitate, septate, shrunken at the septa, loose. Epihym. blue-green. Hyp. olive-brown to brown-black. Exc. reddish to wine-red, exterior brown-black. Thallus whitish to endolithic.

**Cephalophysis** (Hertel) Kilias

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**Cetraria Ach.**

**Cetraria** Ach.
(Key includes Cetrulia, Cornicularia, Platismatia, Vulpicicida)

Introduction

*Cetraria* includes quite various appearing foliose and fruticose lichens with mostly olive- to dark brown or pale greenish thalli. The fruticose lichens have in part band-form surface to channeled or almost round stalk thallus segments. The brown or black lecanorine apothecia sit as well as the partially stalked pycnidia marginally. Many species remain generally sterile; the propagation occurs in these cases by thallus fragments or soredia. The genus is cosmopolitan, but is distributed primarily in the cold and temperate regions of the northern hemisphere. The deep yellow species *(Vulpicicida)* was recently separated from *Cetraria*. In Baden-Württemberg 11 species, of the 12 of those existing in Germany today. An ongoing classification shows the independence of the pale greenish species the *C. cucullata/C. nivalis*-group (Flavocetraria), the *C. commixta/ hepatizon*-group and other groups, which are represented in Germany respectively by *C. laureri* (Tuckneraria), *C. oakesiana* (Allocetraria) and *C. sepicolor*. *Cetraria* in the narrowest sense, erect growing brown fruticose lichens, includes only 15 species.

Several Cetrarias grow on acid bark especially in cool mountain sites, thus *C. chlorophylla*, *C. laureri*, *C. oakesiana* and *C. sepicolor*. While later many are present on cold, continental sites (above all in the Moors), *C. laureri* and especially *C. oakesiana* remain restricted to oceanic, high precipitation regions. The silicate lichens *C. commixta* and *C. hepatizon* belong to the arctic-alpine floral element; which exhibit in central Europe a disjunct area with occurrences in a few central mountains, where they dwell on exposed rocks on high lying sea boulders. *C. islandica*, *C. ericetorum*, *C. aculeata*, *C. muricata*, *C. cucullata* and *C. nivalis* are fruticose erect growing species of the dwarf shrubby heath and thin turf commonly over silicate rock, *C. islandica* and *C. aculeata* commonly also over lime. While *C. cucullata*, and *C. nivalis* occupy wind exposed sites and commonly do fall short of the tree line, one finds the “Iceland moss” (*C. islandica*) and *C. aculeata* on rocky clearings, in open forests, coastal boulders and thin turfs of high mountain to into lowlands. *C. muricata* takes a between site and reaches its highest distribution in montane to alpine sites.

Like many near natural oceanic species, *C. oakesiana* and *C. laureri* are extremely threatened in the region of richly structured forests. Necessary for their preservation are specific measures in dispute with the forest authorities. Also very threatened is *C. sepicolor* dwelling predominantly on birch. *C. cucullata*, *C. ericetorum* and *C. muricata* must remain as very threatened outside alpine Germany because of the insignificant number of isolated occurrences outside of alpine Germany. The occurrence in the Ries and in the East Alp are obliterated. Of the three previously occurring a short time ago in the Black Forest, two populations are extinct because of afforestation. In Baden-Württemberg *C. aculeata* is also threatened, while it is somewhat frequent in west Germany. Even the populations of *C. islandica* decrease conditioned by soil enrichment and afforestation of thin turf. On the other hand, the area of *C. chlorophylla* has increased in recent years.

*C. cucullata* is arctic-alpine distributed, as is *C. nivalis*; they are except in the central European Alps occurring in very isolated in a few high central mountains. The area of *C. islandica* reaches from the arctic to central Europe with south Germany offshoots. Almost as widely distributed are *C. aculeata* and *C. muricata*, yet in recent years in southern central Europe and south Europe they are largely limited to mountain sites. *C. ericetorum* is a boreal-central European lichen quite lacking in the arctic and south Europe. *C. chlorophylla* and *C. sepicolor* are distributed in boreal conifer forests and penetrating into mountains in central Europe; also these species advance into the higher mountains at least isolated in the northern Mediterranean region. *C. laureri* and *C. oakesiana* are in the alpine mountains of central Europe (up into the Caucasus) and their environs and lacking in north Europe.

Genus Characteristics and Determination

Thallus foliose to erect fruticose, with concave or almost tubular or almost cylindric-angular thallus segments, rarely almost cushion-like and flat lobed, brown, olive, greenish-white to pale

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yellowish, sometimes sorediate or isidiate on the lobe margins, dorsiventrally constructed and the underside often differently colored, or bilaterally to ± radially symmetrical, underside or marginally often with pseudocyphellae, both sides (all sides) with cortex (cortex paraplectenchymatous or prosoplectenchymatous), coccoid green algae. Ap. ± marginal, brown to brown-black with thallloid margin. Hyp. colorless. Epihym. red-brown, brown, dark brown. Paraphyses branched, rarely reticulate bound, often thickened above. Asc. ± clavate, Lecanora-type. Sp. 1-celled, ellipsoid to spherical. Pycn. sunken, projecting to stalked, pycnosp. short cylindrical to bacillar, dumb-bell form, fusiform. Ch: Protolichesterinic acid widespread, isolated Fumarprotocetraric acid, Alectoronic acid above all, in a few species Usnic acid. In the narrowest sense Cetraria includes brown to olive-brown fruticose lichens with band-form to almost cylindric segments and paraplectenchymatous upper cortex as well as point- to short linear pseudocyphellae on the lower side.

1 Sitting loosely on soil or raw humus and mosses, fruticose, ± erect, occasionally even loosely on mossy silicate rock. Segments band-like flattened to almost tubular or ± cylindric. Ap. generally lacking .

1* Thallus on bark or rock, foliose, decumbent or erect or small shrubby-cushion like .

2 Thallus pale yellow-greenish to yellowish-white or strongly yellow, 2-4(5) cm high, medulla R-.  

3 Thallus deep yellow, with yellow medulla, erect, not channeled. On wind exposed alpine calcareous turfs. Usnic acid, Vulpinic acid, Pinastrinic acid. – n’meur-mieur-alp – Alpine * Vulpicida tubulosa Schäffer) Mattson & Lai (C. tubulosa (Schaerer) Zopf)

3* Thallus pale yellow-greenish, yellowish-white, greenish-white, with white medulla, rigid-cartilaginous, ascending to erect. Usnic acid, Protolichesterinic acid

4 Thallus segment channeled in curving to tubular, smooth, often violet to reddish at the base.  

* C. cucullata

4* Thallus segment not or only weakly channeled, ± flattened, but wrinkled-pitted, yellow-brown at the base .  

C. nivalis

5 Thallus segment at least partially ± channeled, broader lobes even band-like flat, with stalk-like outgrowths at the margins, light to dark brown, on shaded habitats even olive to partly brownish-white, often reddish colored at the base, 2-6 cm high. Protolichesterinic acid

5* Thallus segment tubular to slightly flattened, never channeled, becoming ± symmetrical, -1 mm thick, covered with thorny projections, shiny brown to black-brown, -4 cm high, producing turfs, strongly branched. Thallus/medulla R-. Lichesterinic acid, Protolichesterinic acid. Sometimes difficult to separate .

6 Medulla R-. Thallus segment very narrow, -1 mm wide, strongly channeled to rolled tubular, dark brown to brown-black. Whitish pseudocyph. commonly limited to the margins of the thallus segment.  

* C. ericetorum

6* Medulla P+ yellow to orange, K-, C-. Thallus segment (1)2-10(20) mm wide, usually weakly enrolled, brown to dark brown, in the shade very light (olive to pale brownish). “Underside” usually lighter, often whitish. Pseudocyph. on the combined underside, white, elliptical to rounded. Fumarprotocetraric acid, ± Protocetraric acid

* C. islandica

7 Thallus segment usually rather uneven, irregularly angular pitted, ± flattened, -1 mm thick, loosely branched. Medulla in the older branches very loose * .

C. aculeata

7* Thallus segment not irregularly angular pitted, commonly ± rounded in cross section, but even flattened, -0.5 mm thick, relatively thickly branched, therefore (young) often almost cushion-like. Medulla remaining solid * C. muricata

8 Thallus on rock, brown to black-brown, ± shiny, often with ap

8* On bark, wood, only exceptionally on rock (above all 13).

9 Thallus dwarf shrubby (almost shrubby cushion), tightly attached, ± ascending from the substrate, -2 cm high, black-brown, with both sides flattened, sparsely forked branched, -1 mm wide (widened toward the ends) thallus segment, without marginal warts, without rhizines. Ap. terminal, thallus colored. Ch- Cornicularia normoerica

9* Thallus ± decumbent, thallus segments narrow, usually about 1-1.5(2) mm wide, 5-15(20) mm long, irregularly pinately branched and growing over one another, margins somewhat enrolled, thereby slightly concave, with scattered marginal, clavate to spherical black “warts” (Pycn., pycnosp. 4-6 x 1 µm). With scattered rhizines

10 Undeside usually dark brown. Medulla K-, P-, C-, KC+ rose/KC-. Pycnosp. ellipsoid to fusiform. Ch- or ± α-Collatolic acid, ± Alectoronic acid

C. commixta


C. hepatizon

11 Thallus upper side brown to dull olive, ascending. Medulla R-. Protolichesterinic acid

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Thallus thickly covered with brown ap., without isidia, thickly dwarf shrubby to almost cushion-like, round, usually up to 2 cm wide and 1(1.5) cm high, brown to dark brown, usually shiny, underside only a little lighter. Almost always on branches of birch, on planted Scots pine, wood. * C. sepincola

Thallus usually without ap., with marginal isidia or isidiate border soralia, usually of little erect irregularly curved, flat to concave, at the margin consisting of undulating lobes, brown-olive to dark brown, when moist olive-green, underside light brown to whitish, wrinkled. * C. chlorophylla

Thallus deep yellow to citron yellow, medulla yellow, at the margin with swollen yellow border soralia, with close lying, ascending margins, ± 5 mm wide lobes. Usnic acid, Vulpinacid, Pinastrinic acid

Vulpicida pinasti

Thallus pale yellow-greenish or gray, bluish-gray, brown-gray. Medulla white.

Thallus yellow-greenish to pale gray-greenish, thallus segment usually rather close lying. Pycnosp. 7-11 x 0.8-1 µm. Caperatic acid, (Lichesterinic acid). * C. oakesiana

Thallus grey, bluish-gray, on exposed sites even browned, underside brown to black, with age also white, usually large, lobes 0.5-2 cm wide. Cortex K+ yellow. Atranorin

Thallus undersides brown, without pseudocyph., often with border soralia at the margin, robust, rather close lying. Pycnosp. 7-11 x 0.8-1 µm. Caperatic acid, (Lichesterinic acid) * C. laureri

Thallus underside whitish to light brownish, with isolated rounded pseudocyph., border soralia often scarcely developed, thallus segment usually clearly ascending at the margin. Pycnosp. 3-4.5 x 0.5-0.8 µm.

Platismatia glauca

Thallus upper side with scattered white puncti, smooth to often unevenly wrinkled, sometimes dark flecked, lobes broad, often curved, commonly not uniformly rounded, strongly incised, often strongly ascending, at the margins with soralia and/or coralloid isidia (then often crinkled) or naked, underside dark brown to black or black flecked, in moist sites even white flecked or almost entirely white, with only isolated rhizines. Medulla R-. Caperatic acid *. Very variable species, commonly with Pseudocetraria and Hypogymnia physodes.

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Thallus underside whitish to light brownish, with isolated rounded pseudocyph., border soralia often scarcely developed, thallus segment usually clearly ascending at the margin. Pycnosp. 3-4.5 x 0.5-0.8 µm.

Platismatia glauca

Thallus upper side with white puncti or short elliptical flecks (Pseudocyph.), smooth, with broad, regularly rounded lobes, at times bordered with white swollen border soralia and above all here ascending, undersides black, with scattered rhizines, brown at the margin, without rhizines (Cetrelia olivetorum s.l.).

Medulla C-, KC or KC+ rose, K-, P-. ± Perlatolic acid, ± Imbricatic acid.

Cetrelia cetrarioides

Medulla C+/KC+ rose-red, K-, P-. Olivetoric acid * . Cetrelia olivetorum

Medulla C-, KC+ rose, K-, P-. α-Collatolic acid, Alectoronic acid * . Cetrelia chicitae

Ecology and Distribution of the Species

(Allocetraria) Kurokawa & Lai

Cetraria oakesiana Tuck. (Allocetraria o. (Tuck.) Randl. & Thell)

In high montane, oceanic, very high precipitation sites usually on conifer trees (spruce, fir), commonly at the trunk base, on relatively constant, v.-e.humid, cool, rather long time snow covered habitats in the interior of beech-spruce and spruce-fir forests, mostly in the neighborhood of brooks and water falls, r.acidoph., m.photoph.(-r.skioph.), substrathygroph., anitroph., e.g. with Menegazzia, Bryoria bic. (†) - mieur-pralp – v.rare (1); süSch (2x), Al

(Cetraria s. str.)

Cetraria aculeata (Schreber) Fr. (Cetraria s. str. a. (Schreber) Ach., C. tenuissima (L.) Zahlbr., Coelocaulon aculeatum (Schreber) Link)

In hill and montane, usually low precipitation to moderately high precipitation sites on sandy soil, level, sandy or fine gravel acid loam and stony soil, even on calcareous soils, in openings in silicate and lime turfs (Nardo-Callunetea, Festuco-Brometea), in rock debris community. (Seslerio-Festucion), in sandy meadow (Corynephorion), in open Scots pine forest, stony oak forest (Luzulo-Quercetum), always on well lighted usually warm summer, sunny sites on dry soil with sparse vegetation, v.acidoph.-subneutroph., r.xeroph., r.-v.photoph., Char. Cladonion arb., above all in Cladonietaea fol. – bor-med-mo – rare (2); above all RhSch and Pf, also Vog. He, Th, Fr, v.rare nöRh, Rh-Mn-T, Sch, O, Sp, Ju, Ries etc.

Cetraria ericetorum Opiz (C. crispa (Ach.) Nyl., C. tenuifolia (Retz) R.H.Howe)

Like C. cucullata (†), yet also on less extreme wind exposed sites and more often even in

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Cetraria islandica (L.) Ach. – Icelandic Moss
From Lowland up to well above the tree line on usually rather to very acid, low nutrient sand and sandy loam, turf and stony soils, but also on level lime rich soils, usually on well lighted habitats, as in silicate and calcareous turfs, dwarf shrub heaths, open Scots pine forest, high moors and moor forests, but also surviving on moderately well lighted sites, of rather wide ecological amplitude, in lower sites like C. aculeata, in higher sites even on very wind exposed ridges and such things (e.g. like C. cucullata) as well as on rather long time snow covered sites, the habitat amplitude includes all reindeer lichens, acidoph.-euryion (on calcareous subsoil very loosely attached), (r.)m.hygroph.-r.xeroph., anitroph., Peltigetalia (Char.) and others – arct-mieur(-med-mo) -r.rare (3); Al, Sch & Vog moderately frequent, Erz, BayW, but rare to v.rare (e.g. Ts, Eif)

Cetraria muricata (Ach.) Eckfeldt (Cortinia muricata m. (Ach.) Ach., Coelocalon muricatum (Ach.) Laundon)
In montane and high montane, high precipitation sites in cool-moist peat bogs and on silicate rocks over moss cover and humus as well as in very open to the wind, in winter almost permanently snow-free openings in meager turf in central mountain high sites (like C. cucullata), in north Germany also on habitats with C. aculeata, m.-r.(s.)acidoph., r.-v.photoph., in the “Cladonietum mitis and related communities. – arct-bor-med-alp – rare (1); Rhön, Eif, Vgb, Ts, Sch, Vog, BayW, ThW, Erz, Hz

(Flavocetraria Kärnef. & Thell)

Cetraria cucullata (Bellardi) Ach.
Above the tree line in very wind exposed meager turfs and openings of dwarf shrub heath, on ridges and rock margins, commonly on very acid silicate soils, isolated also on coarse limestone soils, on cold, early-snow free, high precipitation, but often desiccated habitats, relict (or distributed by birds?) also in low sites in openings in vegetation, m.-v.acidoph., v.anemoph., anitroph. – arct-alp – v.rare, beyond the Alps (1); süSch (Feldberg, Bernau+, Wittenschwand+), Vog, Ju (Herbrechtingen +), Ries ?+, BayW, Hz, Al

Cetraria nivalis (l.) Ach.
Like C. cucullata, yet more strongly limited to extremely wind exposed locations, Char. Cetrarion niv. – arct-alp – BayW, ThW, Lüneburger Heide*, Al

(Tuckneraria Randl. & Thell)

Cetraria laureri Krempelh. (Tuckneraria l. (Krempelh.) Randl. & Thell)
In montane and high montane sites on cool to cold, high precipitation, heavy snow habitats on conifers, on the trunk and on the branches, usually in spruce-fir forests, rather like Bryoria bicolor, yet also on decidedly cold air accumulating sites, e.g. like Hypogymnia bitteri, r.acidoph., r.-m.photoph., anitroph., in the Pseudevernietum, Thelotremetum with Menegazzia – mieur-pralp – v.rare (1); süSch, Al (r.rare)

Other Species

Cetraria chlorophylla (Willd.) Vainio
Above all in montane-high montane sites, but today also even in lower sites in addition, on acid (even though made acid by air pollution) bark of deciduous trees and conifers on rather well lighted to rather poorly lighted, usually cool to cold, temperate often continental influenced habitats, on trunk and branches, in higher sites above all on conifers, like Hypogymnia farin. (†), on lower sites usually on free-standing deciduous trees, above all oak, linden, e.g. like Hypog. tubulosa (†) and Pseudevernia (†), Char. Pseudevernietum – bor-smed-mo(-med-mo) – r.rare; above all Sch, Al, O, SFW, RhSch, HeBgl

Cetraria commixta (Nyl.) Th.Fr. (C. fahlunensis sensu Vainio)
Like C. hepatizon (†), but supposedly more limited to cold-moist very high precipitation sites – arct-bor-mieur-alp – v.rare (1); süSch, nöSch, Vog, BayW, Erz, Hz, Alps

Cetraria hepatizon (Ach.) Vainio
In high montane and alpine (more rarely montane) high precipitation sites on silicate rock on usually rather to very open to the wind
habitats, like *Parmelia stygia* (†), Char. Umbilicarion cyl. – arct-bor-h'mo/alp – rare (3); süSch, Vog, BayW, Erz, Hz; v.rare nöSch, Rhön, ?Ts, ThW, also Al

**Cetraria sepicinola** (Ehrh.) Ach.
In montane to subalpine, mostly high precipitation sites on temporarily very cold, late frost endangered, high snowfall, rather variable humidity habitats on acid bark and wood, in cold air accumulating basins, in high and moss overgrown, on peat bogs, below the tree line almost only on bog-birch (rarely on alder), above the tree line on dwarf pine with *Parmeliopsis hyp.* (†), r.-v.acidoph., r.-v.photoph., hygroph., v.ombroph., anitroph., in the region in the Parmeliopsidetum and Pseudevernietum – boric-mieur-mo(-smed-subalp) – rare (2); Sch, Vog, Rhön, BayW, Av; v.rare O, Sp, Ju, Hu, Eif. Saierl, Erz.

**Cretrelia W.Culb. & C.Culb.**

(Determination ↑ Cetraria)

**Introduction**

The *Cetreria* species are light to bluish gray foliose lichens with broad, rounded lobes with black, marginally brown underside and few attachment threads. Characteristic are fine, punctiform to short streak-form white pseudocyphellae on the upper side. The apothecia are rarely produced; they stand near the lobe margins and are perforated in the center. Several species produce border soralia.

The genus (ca. 15 species) is predominantly distributed over the northern hemisphere, especially eastern and southeastern Asia. The three occurring in Germany, are closely related, but genetically isolated species – they are also chemical races – occurring in west Europe up into southern Fennoscandia and in oceanic regions of central Europe especially on deciduous trees in near natural forests. They are clearly in regression in the last decade.

**Genus Characteristics**


**Ecology and Distribution of the Species**

*Cetrelia cetrarioides* (Del. ex Duby) W.Culb. & C.Culb. (*Parmelia c.* (Del. ex Duby) Nyl.)
In montane and high montane, rarely even submontane sites, above all in high precipitation, relatively oceanic regions, on the bark of deciduous trees and spruce, in lower sites like *Parmotrema chinense* (†), in higher sites like *Menegazzia* and *Lobaria pulm.* (†), m.-r.acidoph., m.-r.photoph., r.-s.hygroph., anitroph., in the Parmelietum revol., Thelotremetum with *Menegazzia*, Lobarion – s’bor-subatl-med(subatl) – rare (3); Vog, Sch, Al & SJu r.rare, at times (v.)rare, today strongly in regression: Ju, Ne, SFW, Bo, Do, Av, PfW, Hu, We, *Eif*, O, Sp, Ts, He, ThW, Mn

*Cetrelia chicitae* W.Culb. & C.Culb.
In submontane, mild sites on the bark of deciduous trees in forests, e.g. like *Pertusaria hymenea* – atl – v.rare (1); SFW (1x)

*Cetrelia olivetorum* (Nyl.) W.Culb. & C.Culb. (*Parmelia o.* Nyl.)
In montane and submontane sites, probably bound less to high precipitation and oceanic regions than *C. cetrarioides*, e.g. in the Parmelietum rev., Pertusarietum amarae – (v.)rare (3); süSch, Ju, Do, Bo, Ne, nöSch, O

**LIT.: CULBERSON & CULBERSON 1968**

**Chaenotheca (Th.Fr.) Th.Fr.**

(Key includes Sclerophora)
**Introduction**

*Chaenotheca* is distinguished by a stalked fruiting body with spherical to almost top-shaped, black, often yellow-green or whitish pruinose capitulum, which bears a brown dusty mass of spores and ascus remnants, a so-called mazaedium. The thallus develops at times as an almost squamulose, warty to mealy crust, at times scarcely visible contained in the substrate.

The species lives on bark and wood, *Ch. furfuracea* even on mosses, stone and silicate rock. Typical they are in humid habitats protected from rain, such as overhanging tree flanks and bark cracks. Most of the species are sensitive to alteration of the microclimate or to air pollution and regress. Only *Ch. chrysocephala* and especially *Ch. ferruginea* are relatively less sensitive and have benefited as acidophytes also by the significant increase of conifer forests. *Ch. brachypoda, Ch. brunneola* and *C. xyloxa* are found usually on decaying conifer wood (stumps and debarked stems), *Ch. gracilenta* on old deciduous tree stumps. *Ch. phaeocephala, Ch. chlorella, Ch. cinerea, Ch. hispidula* and *Ch. laevigata* grow most frequently on old oaks and ash, *Ch. subroscida* and *Ch. stemonea* on fir and spruce.

The genus is mainly indigenous to the temperate and cool regions of the earth. Of the 20 species occurring in a greater part of both hemispheres, 15 are known from Germany and the region. *Ch. cinerea* is a species of the summer green deciduous forest. All others are above all in the boreal zone and distributed over central Europe. In south Europe these lichens are not lacking, however they have their in most cases in the mountains are rare.

**Genus Characteristics and Determination**

Thallus crustose, in the substrate to clearly developed and usually granular, warty or squamulose, gray, brownish, yellow, with various green algae. Ap. stalked, with spherical to top-shaped capitulum, with or without margin, black, often pruinose on the capitulum underside and margin, sometimes the mazaedium pruinose. Stalk constructed of periclinal hyphae. Exc. scarcely to clearly developed. Paraphyses sparsely branched. Sp. 1-celled, spherical, brown to pale brown, rarely ellipsoidal to cylindrical and one or multi-septate. Ch: in a few species Pulvinic acid derivatives in the mature, rarely in the thallus, rarely other substances.

Key Hints: Capitulum spherical means: Exc. or visible margin indefinite; conic = top-shaped, margin and exc. usually well developed. Ch- indicated in the thallus. Lichen substances also in the ripe ap.

3. Thallus bright yellow to green-yellow, R- .
4. Thallus not bright yellow to greenish, Ch-.
5. Thallus mealy, green-yellow to citron yellow.
7. Thallus not mealy, algae coccoid .
9. *Ch. laevigata* (6)
11. *Ch. chrysocephala*
12. Sp. predominantly ellipsoidal to cylindric .
14. Sp. 6-15 x 3-4 μm, mature almost cylindric, often curved, 1-celled or with 1-3 indefinite septa, with irregular upper surface. Ap. -1.5(2.5) mm high. Sp. stalk green-yellow pruinose. Thallus olive-yellow to gray-green, granular to warty, with chlorococcoid algae.
15. *Ch. laevigata*
16. Sp. 5-7.5 x 2.5-3.5 μm, ellipsoidal, 1-celled. ap. -1.2 mm high. Ap. stalk only green-yellow pruinose above. Thallus gray-green, usually clearly developed, granular, with *Stichococcus* algae.
17. *Ch. chloroella*
18. Thallus indefinite, in the substrate .
20. Sp. 2.3-4 μm. ap. capitulum ± spherical to ± hemispherical or top-shaped. Algae *Trentepohlia* or *Stichococcus* .
22. Stalk extensively green-yellow pruinose above, otherwise black. Ap. 0.5-2.5 mm high, yellow-green pruinose, ± spherical capitulum. Algae...
**Stichococcus.** Exc. indefinitely developed. Sp. 2.3-3.5 \( \mu \text{m} \).

9* Stalk pale brown, nonpruinose reddish-brown in the core, exterior with transparent “envelope” (reddish-brown core easily visible in the original condition). Ap. 0.5-0.8 mm, when young yellowish pruinose, later underside sometimes slightly violet to red brown. Algae *Trentepohlia*. Exc. well developed, one species producing a collar at the base of the capitulum around the stalk end. Sp. 3-3.6 \( \mu \text{m} \). Capitulum ± spherical to top-shaped

**Sclerophora peronella**

10 Ap. capitulum conic to egg-shaped, stalk green-yellow pruinose above, black in the under part. Ap. 0.5-1.0 mm high. Sp. 5.0-7.5 \( \mu \text{m} \). Exc. or margin well developed

**Ch. hispoida**

11 Thallus mealy-sorediate (granules 0.04-0.12 mm in diameter), light gray to brownish. Ap. capitulum lens-shaped. Stalk 0.05-0.07 mm thick, usually green-yellow pruinose above and in the part

**Ch. subroscida**

11* Thallus usually thick, squamulose to warty, light yellow pruinose, later lens-form to hemispherical, underside pale yellow to when older (sometimes even sp. mass) whitish pruinose, stalk light yellow, transparent when moist, white with age. Ap. -0.8 mm high. Sp. 7-8.5 \( \mu \text{m} \). Exc. well developed

**Sclerophora nivea**

17 Thallus white-gray to gray-green, often partially or entirely yellowish-ochraceous to rust colored and here K+ deep red, granular to warty (upper surface rough), otherwise R-. Ap. undersides/margin and stalk black, nonpruinose, mazaedium ± cinnamon brown, sp. mass K+ red (microscope). Ap. relatively coarse and broad capped, -0.5 (0.8) mm wide, 1.7 mm high. Capitula conic. Sp. 5.5-7.5 \( \mu \text{m} \), when ripe coarse cracked. Algae spherical, chlorococcoid.

Chinonoides pigment

**Ch. ferruginea**

17* Thallus not partially yellowish to rust colored and K+ red. Sp. smooth or with little weak cracks.

18 Thallus with coccoid green algae, granular-mealy, greenish, gray-green, K-, C-, P± yellow/orange (Baeomycesic acid, Squamatic acid), on wood, see rare forms of *Ch. brunnea* (15) with developed thallus.

18* Algae not spherical, but elongate to approaching rectangular, often in short chains (*Stichococcus*).

19 Sp. 2.5-3 \( \mu \text{m} \), almost colorless to pale brown. Ap. 2.5-3.5 mm high, 20-50 times as long as the stalk is thick, stalk often curved here and there. Stalk black, light gray pruinose at least above as well as the capitula underside. Capitula gray to light brown, ± spherical. Thallus thin, mealy, gray-green to gray. Unknown lichen substances.

**Ch. gracilenta**

19* Sp. larger, ± brown. Ap. clearly shorter

20 Ap. capitula spherical, underside (and going over to the upper part of the stalk) as well slightly whitish-brownish pruinose, lower stalk brown-black. Ap. 0.5-1.0(1.4) mm high. Thallus thin, finely mealy, light bluish-green, P+ yellow-red, K-, C-. Sp. 3.5-5 \( \mu \text{m} \). Unknown substances.

**Ch. stemonea**

20* Ap. capitula lens-form to conic to narrowly conic. Thallus Ch-

21 Ap. short, 0.6-1 mm. Stalk pale brown below, darker above. Capitula long-conic, underside thickly and relatively coarsely white pruinose, pruinosity going over to the upper part of the stalk. Thallus warty-granular, occasionally indefinite. Sp. 4.5-55 \( \mu \text{m} \)

**Ch. cinerea**

21* Ap. often over 1 mm (up to 2mm) long. Stalk dark brown to black, weakly whitish pruinose above. Capitula lens form to conic, underside or
margin slightly whitish pruinose to nonpruinose. Thallus mostly fine squamulose to granular, squamules relatively smooth (rough in the case of Ch. ferruginea), sometimes erupting sorediate, variable, sometimes little developed. Sp. 3-5 µm.

**Ch. trichialis**

(in the case of poorer development, e.g. influence of air pollution, the species is sometimes not very easily separated from Ch. ferruginea); then it is important to observe the algae)

### Ecology and Distribution of the Species

**Chaenotheca brachypoda** (Ach.) Tibell (Coniocybe sulphurea (Retz.) Nyl.)

Penetrating into submontane and montane, usually high precipitation sites on debarked, often already very decayed conifer stumps with ± devastated outer surface, rarely on old bark or on wood of deciduous trees, mostly in near natural regions, old forests on very humid, ± rain sheltered habitats, r.(-s)acidoph., (m.photoph.) r.-v.skioph., anitroph., usually without consorts or with Ch. furfuracea – (bor-)s’bor-med-mo – v.rare (2); süSch, Bo, Ne, Sp, Rh, Rh-Mn-T, Vog, SFW

**Chaenotheca brunneola** (Ach.) Müll.Arg.

Above all in montane-high montane sites on decayed to very decayed, usually already relatively softened wood of old stumps and debarked trunks with nearly intact to devastated upper surface (above all on conifers), typically through the spongy-fibrous wood characteristic rotting stage, commonly on rather poor light, rain sheltered habitats, mostly without other consorts – bor-med-mo – rare (3); Sch, Vog, SJu-Ju-FrJu, SFW, O, Sp, PfW, RhSch, ThW, Ál

**Chaenotheca chlorella** (Ach.) Müll.Arg. (Ch. carthusiae (Harm.) Lettau)

In hilly and submontane sites in the bark cracks on trunks above all older oaks, rarely other trees, also on debarked trunks and stumps, in the interior of forests, in the region of deciduous forests in humid (heavy snow) valleys, m.acidoph., (m.h-photo.-)r.skioph., r.anombroph., v.hygroph., anitroph. – bor-mieur – v.rare (1); Ju, SFW, Rh-Mn-T, Fr, PfW (Bitsch), MI

**Chaenotheca chrysocephala** (Turner ex Ach.) Th.Fr.

Concentrated in montane and high montane, high precipitation sites, like *Calicium vir.* (?), yet of broader ecological amplitude and commonly also in the hilly zone in addition, in lower sites above all on acid deciduous tree bark (oak, black alder, birch, above all in the Chaenothecetum ferr.), in higher sites above on conifers (above all Calicietum vir.), Char. Calicion vir. – bor-med-h’mo – r.rare; above all Sch, Vog, RhSch, SFW, Do-Av, Al, Sju, rarer e.g. PfW, O, Sp, Ne, extensively lacking in dry-warm regions

**Chaenotheca cinerea** (Pers.) Tibell

In montane sites in lofty deciduous forests (ravine forests) on humid, cool habitats on deciduous trees with subneutral (-m.acid) bark (e.g. ash, elm), m.photoph.-r.skioph., anitroph. – mieur – v.rare (1) - Ju, Fr

**Chaenotheca ferruginea** (Turner & Borrer) Migula (Ch. melanophaea (Ach.) Zwackh)

Up into the high montane zone, in the region above all in lower, low precipitation, relatively continental influenced sites, here limited to Scot’s pine, larch, rarely on other trees with r.-v.acid bark (usually oak), above all in strongly altered forests on forest margins and roads, in higher sites mostly on fir and Scot’s pine in cold air accumulating basins, valleys, on rather to very rain protected sites on the trunk base up to the middle of the trunk, benefited by anthropogenic alteration by Scot’s pine and larch and today more frequent than formerly, v.acidoph., r.photoindiff., a-(m.) nitroph., hygrophytically least demanding species of the genus, mesoph. - v.hygroph., Char. Chaenothecetum ferr., often with *Hypocenomyce scal.* – bor-med-mo – moderately frequent, even in epiphyte poor regions

**Chaenotheca furfuracea** (L.) Tibell (Coniocybe f. (L.) Ach.)

Up into the montane, rarely high montane sites on r.v. light poor, very humid, completely rain sheltered habitats, very substrate variable, on trunks of trees, usually at the base on elder or in deep bark cracks, on roots, on decayed wood, on silicate rock (above all sandstone), over mosses, even overgrowing naked soil (overhanging slopes), high point on rather acid substrate, anitroph., in the Calicion vir., often without consorts, Char. Chaenothecetum furf. – bor-med-mo – r.rare (-m.frequent), yet in dry-warm regions (v.)rare
Chaenotheca gracilenta (Ach.) Mattson & Middelborg (Cybebe g. (Ach.) Tibell, Coniocybe g. Ach.)
Above all in the montane zone on rotting wood, old stumps and decaying bark of elder at the stem base of older trees, on roots, in uniform humidity, rather low light, often somewhat fresh substrate habitats, usually without consorts or with Lepraria lob. —bor-mieur-med-h’mo – (v.)rare (1); Ju, Ne, O, Vog, Al, MI

Chaenotheca hispidula (Ach.) Zahlbr.
In hilly and submontane sites in the bark cracks of older trunks of oak, elm, ash in old near natural, cool oak-hornbeam forests and old-growth deciduous forest, in moist valleys, in the Calicicion vir., e.g. in Chrysotrichetum cand. —mieur-med(mo) – v.rare (2); süH-Rh, süRh, Ju, Ne (above all Sb), Sp, O, PW, Vog, Rh-Mn-T, Ts, Th

Chaenotheca laevigata Nèdv.
In submontane and montane sites in the bark cracks of older deciduous trees, above all ash and old, rarely on bark/wood of conifers, in humid forests, r.-m.acidoph.(-subneutroph.), (r.-)v.hygroph., anombroph., m.photoph. -r.skioph., anitroph., in the Calicicion vir., usually with Ch. trichialis — bor-mieur-mo(-med) – v.rare (1); Ju, O, süSch

Chaenotheca phaeocephala (Turner) Th.Fr.
Especially in submontane, rarely montane sites, above all on deeply cracked bark of older oak trunks in open oak-hornbeam forests, at the forest margin and in park-like stands, rarely on other deciduous trees (above all linden), very rare on conifers, on sunny, usually m.-r well lighted, r.-v.humid, temperate climate somewhat continental influenced sites, m.-r.acidoph., r.anombroph., anitroph., in the Calicicion vir., usually with few consorts, above all Ch. trichialis or Chrysothrix cand. — bor-mieur(-med) – rare (3); Mn, Sp, O, Fr, Ne, SFW, Ju, FrJu, Do, Sch. Rh, Rh-Mn-T, Mos-Eif

Chaenotheca stemonea (Ach.) Müll.Arg.
Up into montane, rarely high montane sites, above all base of trunks of old conifers, more rarely deciduous trees with acid bark (above all oak), deep in bark cracks or elder and nitches at the stem bases, even on debarked stumps, usually on r.-v.light poor, completely rain sheltered small habitats in the interior of forests, r.-v.acidoph., v.hygroph., anitroph., usually without consorts or with Ch. furfuracea — bor-mieur – rare (2); Sch, süHü-Rh, SJu, Ju, Ne, Bo, SFW, O, Sp, Hu, Mos

Chaenotheca subroscida (Eitner) Zahlbr.
In montane and high montane, rather to very high precipitation sites on cool to cold, moderately well lighted to rather (to very) light poor habitats on not rained upon sites on trunks of older conifers (fir and spruce) in fir- and fir-spruce forests, r.v.acidoph., v.hygroph., anitroph., e.g. in the Calicetum vir. with Ch. chrysoceph., Calicium vir., C. glaucellum — bor-mieur-mo – v.rare (1); süSch

Chaenotheca trichalis (Ach.) Th.Fr.
Up into the high montane zone above all deep in the cracks of acid bark, in higher sites limited to fir and spruce, in lower sites on oak and ash, even on elder in the root region and on stumps, commonly in forests, m.-v.acidoph., (r.)v.hygroph., anombroph., m.photoph.-v.skioph., anitroph., often only with Chrysothrix cand. — bor-med-mo – r.rare-m.frequent (3); in dry-warm strongly altered forest regions or debited regions v.rare to lacking or in strong regression

Chaenotheca xylooxena Nádv.
In montane sites in humid forests on decaying wood of debarked tree stumps and trunks, above all of conifers, r.acidoph., r.-v.skioph., anombroph., anitroph. — bor-mieur-mo (-med-mo) – v.rare (1); Bo, Lux Niedersachsen


Chaenothecopsis Vainio
(Keys include Mycocalicium)

Introduction

The Chaenothecopsis species are living saprophytically on wood and bark or on lichens or algae covered living fungi with stalked, brown-black to black fruiting bodies. On account of the morphologic and ecological similarity with the “calyx” or “dust fruiting” lichens they were traditionally considered with lichen studies. The spherical, egg- or lens form capitula – in contrast to the similar
Chaenotheca- or Calicium-species – produce no dusty spore mass (mazaedium).

The genus is distributed in the temperate and cool-temperate regions of both hemispheres. Of the ca. 35 species only a few have been collected in Germany. Many species may have been overlooked. The species are almost entirely on moist, undisturbed or forest preserves. All are very rare and to a high degree threatened. Ch. rubescens lives on old oaks, Ch. consociata, which is parasitic on Chaenotheca chrysocephala, and Ch viridialba occur in near natural and natural old conifer forests on trunks above all of fir. Ch. pusilla resides at least on wood or stumps and debarked trunks. Ch. exserta is parasitic on crustose lichens on scarcely rained on surfaces of silicate rocks. These as well as Ch. rubescens are species of the summer green deciduous forests region. Ch. consociata, Ch. pusilla and Ch. viridialba occur predominantly in the boreal conifer forest zone and montane sites of the temperate zone.

Genus Characteristics and Determination

Thallus lacking or very indefinite. Saprophytic or living on lichens and algae colonies, sometimes loosely associated with algae (coccoid green algae, Trentepohlia). Ap. elongate, rarely short stalked, with spherical, egg-shaped to lens form capitula, black, stalk also brown-black or yellow at the base, rarely whitish. Central stalk of irregularly intertwined hyphae and relatively light, in the region of the margin of periclinal hyphae and dark colored. Without paraphyses (-like hyphae). Asci \pm cylindric to narrowly clavate, half-ripe above with definite, fine canal bored through thickening. Sp. 1- to 2-celled, brown, ellipsoidal to fusiform-ellipsoid, with smooth to finely warty upper surface. In the case of Myccocalicium the thickened upper ascus wall has no canal and the hyphae in the aggregate stalk are dark and arranged parallel.

1 On whitish crusts on overhanging silicate rocks (above all Haematomma). ap. -0.5 mm high, capitula spherical to lens form, -0.3 mm wide. Stalk light to black. Sp. 6-8(10) x 3-4 \(\mu\)m, 1-celled

Ch. exserta

1* On bark, wood, bark-dwelling crustose lichens or Cladonia .

2 On crustose lichens or Cladonia .

2* On growing on other lichens (or not recognizable

3 On thallus squamules of red fruited Cladonia species. Sp. 2-celled, 6-10 x 2.3-3 \(\mu\)m. Ap. -0.7 mm high

Ch. parasitaster

3* On crustose lichens (Arthonia, Chaenotheca, Calicium)

4 Sp. 1-celled, 5-9 x 2.5-3.5 \(\mu\)m, somewhat pointed at the end, ornamented. On whitish crust with Trentepohlia algae (Arthonia byssacea), ap. -0.9 mm high, stalk 0.05-0.08 mm thick, interior yellowish to reddish, K+ red. Capitula spherical to lens form, -0.35 mm wide. On deciduous trees, above all old oaks (see also Ch. pusilla).

Ch. rubescens

4* Sp. 2-celled. On cup lichens (Chaenotheca, Calicium) with algae of the genera Trebouxsia or Stichococcus. Ap. -1 mm high

5 Stalk in squash preparations with greenish yellow tint, K+ purple (reaction rapidly disappearing). On wood-dwelling Chaenotheca brunneoela. Ap. black throughout (rarely stalk brown at the base), capitula -0.4 mm wide. Sp. 5.5-9 x 2.2-3 \(\mu\)m, smooth – bor-med

Ch. pusilla

5* Stalk in squash preparations K- or K+ greenish or brownish .

6 Sp. septum clearly lighter colored than the sp. wall. On Calicium and Chaenotheca species and various other crustose lichens. Sp. 5-7(9) x 2-2.5(3) \(\mu\)m, smooth .

Ch. pusilla (9)

6* Sp. septum not lighter colored than sp. wall .

7 On the (green)yellow thallus of Chaenotheca chrysocephala. Ap. black throughout, capitula -0.4 mm wide, varying in form, finally lens form, sp. 6.5 x 2.5-3 \(\mu\)m. Epiphym., hyp. and stalk reddish-brown in the outer region, K+ often greenish .

Ch. consociata

7* On the (greenish) gray thallus of Chaeno-theca trichialis. Ap. black throughout or stalk base even brown, K- or K+ brownish, stalk in squash preparations red-brown – bor-med

Ch. epithallina Tibell

8 Stalk whitish, rather long, -0.15(0.2) mm thick. Ap. 0.5-2 mm high, capitula -0.5 mm wide, full grown ± spherical (to lens form), reddish region in the stalk and in hyp. K+ green (squash preparations). Sp. 6-10 x 3-3.5 \(\mu\)m, 1-celled, finely ornamented. On bark of conifer trees

Ch. viridialba

8* Stalk black to brown


9* Sp. (1-)2-celled, pale brown, septum much weaker colored than the outer wall. Full grown ap. ± lens form, -0.3 mm, black. Stalk ca. 0.04-0.08 mm thick, lighter toward the base (mostly green-brown to black-brown), squash preparations K-. Ap. -1 mm high, externally like Myccocalicium subtile. (Alien) thallus evident as lighter flecks, with chlorococcoid or Stichococcus algae (or with Trentepohlia) or without algae or on Calicium or Chaenotheca thallus. Sp. 5-7(9) x 2-2.5(3) \(\mu\)m, smooth .

Ch. pusilla
Usually growing on whitish crusts of Arthonia, above all A. byssacea. Sp. 5-9 x 2.5-3.5 µm, somewhat pointed at the end. Ap. -1 mm high, stalk brown to black, 0.05-0.8 mm thick, capitula spherical to lens form, -0.35 mm wide, (squash preparation) K+ red or K-. On deciduous trees, above all Ch. rubescens.

Not growing on Arthonia. Thallus not with Trentepohlia. Ap. -1 mm high. Stalk brown to black, 0.05-0.8 mm thick. Capitula spherical to lens form, -0.35 mm wide, (squash preparation) K-.

Sp. 5-7(8.5) x 2.5-3.5 µm, finely ornamented, brown to dark brown. Stalk 0.03-0.06 mm thick. Ap. -0.9 mm high. Capitula several spherical to lens form, -0.3 mm wide. Asci 5-35 µm.

In cool sites on the thallus of Chaenotheca brunnea (↑) or associated with algae – bor-med-mo – possible in the region.

Chromatochlamys Trevisan

The thallus of Chromatochlamys is crustose, inconspicuous, leathery to warty, gray-white to light brown. The perithecia are sunken into the thallus and have light to blackish apex. The spores are muriform. Ch. muscorum is the single species known in Germany of the three included in Europe. They occur predominantly on pleurocarpus mosses, mostly on Pterigynandrum filiforme. The fungus hyphae penetrate into the moss leaflets, which as a result bleach...
out and die. The species is found predominantly on the ground and at the base in the lower trunk region of old deciduous trees, above all beech, and commonly also on mossy rocks. They are distributed from north Europe up into the mountains of south Europe, but are usually rare. In the region they are found in montane sites. They are in regression and in Germany are strongly threatened. Directed protection measures are necessary.

**Genus Characteristics**

Thallus crustose, leathery to cracked, light gray, greenish to pale brownish, with *Trebouxia* like photobiont. Per. ± sunken, with light to blackish apex. Exc. light to browned, of narrow, streaked, oval cells under the exterior part. Paraphysoids reticulate, periphysoids in the region of the ostiolum. Ascii very thick walled, indented above, fissitunicate, 1-. Sp. 2 to 8, sparsely to richly muriform, thin walled (outer wall not clearly thicker than the inner wall), colorless to slightly browned. Ch-.

**Ecology and Distribution of the Species**

*Chromatochlamys muscorum* (Fr.) Mayrhofer & Poelt (Microglaena m. (Fr.) Th.Fr.)

In montane and high montane, high precipitation, often oceanic sites on dying, usually bark dwelling pleurocarpus mosses, above all at the trunk base of older deciduous trees (above all beech, sycamore) in open high mountain mixed forest (Aceri-Fagetum), old beech stands, in the best hygrometric relations also on free-standing trees, subneutroph.-m.acidoph., m.-r.photoph., substrathygroph., in the Lobarion, Rinodinetum conr., Antitrichion (above all on *Pterigynandrum, Leucodon, Antitrichia*) – borsmed-mo(-med-mo) – rare-v.rare (2); süSch, Vog, Ju, Ries, FrJu, Shu, Ml, Al, O+, Westf. He

Lit.: Mayrhofer & Poelt 1985

**Chrysothrix Mont.**

(Determination ↑ Lepraria)

**Introduction**

*Chrysothrix* produces thick pulverulent to thin mealy, yellow to green-yellow thallus, which very rarely fruit or are only known as sterile. The four species of the cosmopolitan distributed genus are adapted to the ecologically conditioned rain-protected humid habitats. The two species occurring in central Europe grow on overhanging silicate rocks (*Ch. chlorina*) and on tree trunk flanks or in bark cracks (*Ch. candelaris*) on humid habitats. They are distributed in Europe with the high point in the summer green deciduous forest region, *Ch. candelaris* from the mediterranean up into southern Fennoscandia, *Ch. chlorina* up into the high North.

**Genus Characteristics**


**Ecology and Distribution of the Species**

*Chrysothrix candelaris* (L.) Laundon (Lepraria c. (L.) Fr.)

Up to the tree line on completely rain sheltered sites on the trunk of older trees, above all in the bark cracks, most frequently on oak, in higher places on fir, also on debarked trunks and stumps, commonly in moist valleys and in forests, m.-v.acidoph., r.-v.hygroph., r.skioph.-m.(r.) photoph., anitroph., Char. Chrysotrichetalia cand. – s’bor-med – r.rare - m.frequent (3); becoming rare in low precipitation, under intensive agriculture, and in strong air pollution regions

*Chrysothrix chlorina* (Ach.) Laundon (Lepraria ch. (Ach.) Ach. ex Sm.)

Up into high montane sites, rarely higher, above all in high precipitation regions on completely rain sheltered over hangs and niches on lime free silicate rock on usually shady, humid habitats, above all in ravines, narrow valleys and forests, m.-r.acidoph., v.skioph. -m.(r.)photoph.,
Cladonia Hill ex Browne

(Determination incl. Pycnothelia)

**Introduction**

The species of the genus *Cladonia* are usually moderately conspicuous fruticose lichens. Numbered with them are the well known reindeer and cup lichens. The *Cladonia* plant consists, as a rule, of two parts, that spreading over the substrate “ground based,” squamulose or small foliose thallus and the more or less erect growing, higher podetia, whose many forms are known: horn- or peg-form, strongly bushy branching, trumpet- or coral-like. On the podetia develop brown, deep red or rarely yellowish apothecia without thalloid margin. Often no apothecia are produced; reproduction then occurs by thallus fragments or soredia, with which the upper surface of the may be entirely or partially covered. In the case of the richly branching, almost never fruiting reindeer lichens, the basic thallus is extremely reduced.

Many species are very variable. The species concept is in many cases not stable. They are frequently separated into several chemical races, sometimes even hybrid intermediate forms. The world wide distributed genus numbers perhaps 350 species. In the Federal Republic of Germany – according to species understanding – ca. 60 to 67 species recorded, in Baden-Württemberg 54 to 62.

The *Cladonia* species live on naked soil, raw humus, moss, decaying wood, rarely bark and weathered rock. They usually flourish under well lighted, humid conditions on acid soil, on sites, on which through great nutrient distress or soil surface features has inhibited the competition of higher plants or the vegetation layer has not yet closed after disturbance. They are frequently found on appropriate sites, e.g. rocky clearings, numerous unrelated species, as e.g. *C. rangiferina, C. arbuscula, C. protentosa, C. furcata, C. squamosa, C. gracilis, C. pyisidata, C. pleurota, C. unicalis* and others. Under more humid conditions reindeer lichens and other Cladonias may even compete in dwarf shrubby heath.

On decaying wood – almost all also on raw humus and peat – live especially *C. botrytes, C. cenotea, C. coniocraea, C. digitata, C. pyisicata ssp. chlorephaea, C. macilenta, C. norvegica, C. parasitica* (almost only on oak stumps), *C. polydactyla* and *C. squamosa*. *C. incrassata* over runs peat, especially on the walls of peat-cutting.

Calcareous soils are only typical for a few species, thus for *C. furcata* ssp. *subrangiformis, C. rangiformis, C. convoluta, C. symphycarpa, C. pyisicata ssp. pyisicata and ssp. pocillum*. They are found in dry turfs and rocky meadows.

Most of the indigenous species are distributed in the central European region and in the boreal zone, and isolated up into the arctic. The area is partially stretched into the mediterranean region; to these very widely distributed species belong *C. cariosa, C. cervicornis, C. cenotea, C. coniocraea, C. digitata, C. fimbriata, C. furcata, C. mitis, C. pyisidata, C. squamosa, C. subulata* and *C. symphycarpa*. Widely distributed in central and north Europe (mostly up into the arctic) are also *C. arbuscula, C. cornuta, C. deformis, C. gracilis, C. phyllophora, C. pleurota, C. rangiferina, C. rei and C. unicalis*; they penetrate however – often with the exception of the Pyrenees — scarcely toward south Europe. The area of *C. amaurocraea, C. bellidiflora, C. botrytes, C. carneola, C. macrophylla, C. metacorallifera, C. stellaris and C. sulphurina* stretches over the boreal zone and frequently up into the arctic; in central Europe these species occur only as disjuncts penetrating the mountains. In the region they live on overhanging rocks of the high places, cold boulder fields and peat moors. The central European habitat lies mostly in the Böhmerwald, in Fichtel- and Erzgebirge, in the Sudentes, in Harz, in the Vosges, in the Black Forest and in the Alps.

Many Cladonias reach the northern boundary in southern Sweden and Finland, penetrating however near the sea in western Scandinavia further toward the north. In the south stretching the distribution area usually to the sub-mediterranean or partially, as e.g. in the case of *C. ciliata and C. rangiformis*, into the mediterranean region. This group includes *C. caespitica, C. ciliata, C. portentosa, C. foliacea, C. ramulosa, C. rangiformis, C. rei and C. zopfi*. Many of these species show westward
distribution tendencies. *C. macilenta*, *C. parasitica* and *C. strepsilis* penetrate further toward the north, in central Sweden, in the west as far as northern Scandinavia. *C. peziziformis*, *C. incrassata*, and *C. polycarpoides* are distributed in western central European subatlantic and are rare. *C. convoluta* above all lives in dry turfs, is indigenous to central the mediterranean region, occurs isolated in the warm region of Central Europe and reaches the plant geographically so remarkable islands of Öland and Gotland.

The most frequent species in the region are *C. pyxidata*, *C. coniocraea*, *C. macilenta* and *C. furcata*. *C. digitata* spreads out and finds suitable conditions on acid trunk bases. Appearing more strongly limited in Germany *E. amaurocrea*, *C. stellaris*, *C. botrytes*, *C. metacorallifera*, also *C. carneola*, *C. convoluta* and *C. incrassata*, in Baden-Württemberg also *C. foliacea*, which in West Germany is considerably more frequent. Also the reindeer lichens and many other Cladonias are influenced by dunging of thin turfs and dwarf shrubby heaths and are clearly in regression. Significant or isolated occurrences of such species deserve notice and protection.

**Genus Characteristics and Determination**

Thallus of two parts, the basal primary thallus developed on the substrate and the usually erect, hollow secondary thallus, the podetia. The squamulose-small foliose primary thallus, in the species group of the reindeer lichens and a few other species is crustose and rapidly disappearing. Basal squamules are usually ascending, rounded to elongate, entire margined to incised, sometimes sorediate at the margin and the underside, pale greenish, gray, brownish, underside usually whitish, without rhizines. Upper side with cortex of dense vertical hyphae, underside without cortex. Photohiont Trebouxia-like. Podetia erect, rarely decumbent-ascending, hollow, blunt, pointed or cupped, unbranched to richly branched, whitish, gray, yellowish, brown, often sorediate, with cortex to partially or (in the case of reindeer lichens) entirely without cortex. Ap. usually terminal or on cup margins of the podetia, rarely sessile on the basal squamules, without thalloid margin, commonly with rapidly disappearing proper margin, usually light to dark brown or red, rarely yellowish. Exc. of radial lying hyphae, exterior often colored like the disk. Hyp. colorless to light brownish or reddish. Epihym. usually brown or red. Hym. colorless or brownish to reddish, I+ blue. Paraphyses simple or sometimes forked. Asci narrowly clavate to almost cylindric, with I+ blue tholus, exterior with I+ blue gelatin layer. Sp. 1-celled egg- to fusiform. Pycn. positioned and colored similar to ap., sessile of short stalked. Pycnosp. bacillar to filamentous, usually curved. Ch: Depside, depsidones (especially frequent Fumarproto-cetraric acid), Dibenzofurane, Terpenes; in red ap. Rhodocladonic acid.

Notice: The Cladonias are conspicuous lichens, but at times very variable. Not rarely they have even given leading Lichenologists difficulty, in unambiguous placing of a specimen. In many cases a knowledge of the lichen substance content is very helpful, in some indispensable. The indicated reaction shows on the thallus upper surface.

Basal squamules = primary thallus; axil = place between two or more branches; podetia = erect part; awl-like = pointed tip

**Overview of the Parts of the Key**

1  Lichens with red ap. and/or red pycnidia (hand lens)  PT 2
1* Lichens with brown ap. and pycnidia or without ap.  2
2  Podetia partially thickly sorediate .  PT 3
2* Podetia not sorediate  3
3  Primary thallus crustose-warty or lacking, without each basic squamules and lobules/ squamules on the podetia. Lichens richly to largely branched, rarely unbranched, always without cups .  4
3* Primary thallus squamulose/small foliose; commonly even the podetia at least with basal squamules .  5
4  Thallus crustose-warty, warts -0.5 mm, light gray to brownish-gray, K+ yellow, P-, C-. Podetia short, -6(10) mm, at first inflated, then clavate to cylindric, simple to sparsely branched, with terminal ap. or pycn. Sp. 1- to 4-celled, 9-15 x 2-3.5 µm. Atranorin, Protolichesterinic acid, Lichesterinic acid, ± Squamatic acid  **Pycnothelia papillaria**
4* Primary thallus lacking. Lichens richly to largely branched, generally growing rapidly  PT 1
5  Only primary thallus occurring (selection characteristic of species)  PT 4
5* Also podetia occurring .  PT 3

**Cladonia PT 1: Reindeer Lichens and Similar Fruticose Lichens**
1. Podetia (at least at the base) with isolated protruding squamules (leaflets), with pointed ends or with capitate ap. Podetia entire cylindric or even long splits or channels. Primary small folioid thallus often occurring.

2. Podetia entirely without squamules, cylindric, but often open in the axils. Primary thallus lacking.

3. K- or indefinite yellowish or brownish, P+ red, without Atranorin. Podetia without squamules to thickly squamulose, smooth cortex, in many forms long slits and then partially only channeled, little to strongly branched. Branches often rather also coming away twisted points, gray-white to gray-greenish to dark brown. Very variable forms. Fumarprotocetraric acid.

C. furcata ssp. furcata

4. Podetia densely shrubby branched (virtually reindeer lichens), usually 3-8 (12) cm.

5. Podetia weakly branching, often forked, smooth cortex, usually 1.5-10 cm. Always containing Usnic acid.

6. Podetia very closely branching, with cup-form curved (often almost cauliflower like) (lichens of the cemetery wreaths). Isotomic branching, i.e. all of the single branch points going out ± uniformly developed, predominantly to 4 (uniformly) star-form standing around the axil opening, without definite main stems. Pale yellowish, pale greenish-yellow, pale yellowish-gray, terminal branch not browned. P-. Usnic acid, Perlatoic acid. Lichens of cold sites (watch for confusion with densely branched C. portentosa).

C. portentosa

7. Podetia not conspicuously curved cup-form, with ± definite main stems. Branching anisotomic, i.e. branches not uniformly developed (rarely isotomic tendencies: C. portentosa). Branches predominantly 2 or 3 around the axil openings.

8. Branches predominantly 2, rarely 3 going out from one point (branching dichotomous). Podetia relatively slender and thin (in comparison to C. rangiferina/arbuscula), yellowish-gray to gray-green (with Usnic acid) or rarely whitish-gray to gray (without Usnic acid), branches mostly strongly curved, browned. Pycn. slime red (sometimes even with the hand lens recognizable at the pycn. mouth). ± Usnic acid, Fumarprotocetraric acid, (Protocetraric acid) et al.

C. ciliata

(when K+ yellow, with Atranorin, Rang-ormic acid, ± Fumarprotocetraric acid, end branches splayed, but not curved back, podetia gray flecked: C. rangiformis 3)

9. Branches usually going out 3 or 4.

7. Thallus gray-white to gray, K+ yellow, without Usnic acid, commonly with Atranorin, Fumarprotocetraric acid, (Protocetraric acid).

Branch ends browned.

8. Thallus with (sometimes only weakly) yellowish tint (whitish, pale gray-yellow, yellow-green), K-, with Usnic acid, without Atranorin.

C. rangiferina

9. Branch ends very moderately strongly curved. *.

C. stygia

10. Lower part of the podetia black, interior usually up to the upper part of the podetia center black. Pycn. slime red. Branch ends moderately strongly curved. *

11. Lower part of the podetia at best exceptionally black in a narrow basal part, interior not black. Pycn. slime colorless. Branch ends usually strongly curved. *

C. portentosa

12. End branch bushy aligned on all sides, thickly to sparsely branched, predominantly 3(4) standing around the axil opening, anisotomic to isotomic, P-. Upper surface of the podetia dull, usually not compact and dense, but very fine loosely felty (hand lens), often transparent when moist. Podetia sparingly branched. Usnic acid, Perlatoic acid.

C. portentosa

13. End branch usually definitely curved one sided, rarely aligned bushy all sided, P+ red or P-.

Upper surface of the podetia usually compact and dense, cartilaginous, not transparent, without Perlatoic acid.

C. arbuscula ssp. mitis

14. P+ yellow or P+ red, Usnic acid, without Rangiformic acid.


C. arbuscula ssp. arbuscula

16. P+ red (very rarely P-), without Psoromic acid, with Fumarprotocetraric acid, Protocetraric acid. * Podetia with mostly one sided branches, rarely more bushy branched. Widely distributed.

C. arbuscula ssp. squarrosa

17. Podetia blue-gray, gray, greenish-gray, repeatedly branched, with pointed ends, without cups, decumbent to ascending, very brittle. Axils closed. Pycnidial gelatin colorless (squash preparation).

C. zopfii

18. Podetia yellowish, gray-yellowish, pale green-yellowish, points often browned.