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)

Foreword

For Renatem, Gesine and Johannes

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 & VÉZDA 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. HARMS and Dr. J. Marx and the publisher ULMER with Miss U. STAMMEL, Mr. D. KLEINSCHROT, 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 indedpedent 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

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, extra-ordinarily 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 to frequently 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 growns 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 handlens, 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 ($Ca(OCl)_2$ / $NaOCl_2$) and para-Phenyldediamin ($H_2NC_6H_4NH_2$). 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 ascocarps. 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, epihymenium 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 epihymenium, therefore including the epihymenium. The hymenium height corresponds to the height of the paraphyses. Here the outermost colored region of the hymenium is designated as the epihymenium, 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, pycnospores (=pycnidiospores) are segmented off of specialized hyphae and expelled to the outside through a narrow opening (ostiole). The pycnospores 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 pycnospores,

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-Phenylediamine (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 only 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-Phenylendiamine 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 (Na_2SO_3) completely dissolved in distilled water + 3 g N^4,N^4-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.

Reagent	K	C	KC	P
α-collatolic acid	-	-	(red)	-
Alectorialic acid	yellow	red	red	yellow
Alectoronic acid	-	-	(red)	-
Angardianic acid	-	-	-	-
Aotearon	-	-	-	-

Argopsin	-	-	-	orange
Arthothelin	-	orange	orange	-
Aspiclin	-	-	-	-
Antranorin	yellow	-	-	yellow
Baeomycesic acid	yellow	-	-	yellow
Barbatic acid	-	-	-	-
Barbatolic acid	yellow	-	-	yellow
Bourgeanic acid	-	-	-	-
Caloploicin	-	-	-	-
Calycin	-	-	-	-
Caperatic acid	-	-	-	-
Capistraton	-	-	-	-
Chloratranorin	yellow	-	-	yellow
Confluentinic acid	-	-	-	-
Constictic acid	yellow	-	-	orange
Coronaton	-	-		-
Cryptochlorophaeia acid	(yellow-red)	(red)	red	-
Didymic acid	-	(green)		-
Diffractic acid	-	-	-	-
Diploicin	-	-	-	-
Diploschistesic acid	-	(blue)		-
Divaricatic acid	-	-	-	-
Epanorin	-	-	-	-
Erythrin	-	red	red	-
Eugenitol	-	yellow	yellow	-
Evernic acid	-	-	-	-
Fumarprotocetraric acid	yellow-brown	-	-	red
Gangaleoidin	-	-	-	-
Glaucophaeic acid	-	-	-	-
Glomelliferic acid	-	-	red	-
Granuloson	-	orange	orange	-
Grayanic acid	-	-	-	-
Gyrophoric acid	-	red	red	-
Hiascinic acid	yellow-red	red	red	-
Homosekicaic acid	-	-	-	-
Imbricaric acid	-	-	-	-
Isousninic acid	-	-	(yellow)	-
Jackinic acid	-	-	-	-
Lecanoric acid	-	red	red	-
Lepraric acid	-	-	-	-
Lesdainin	-	-	-	-
Lichesterinic acid	-	-	-	-
Lichexanthon	-	-	-	-
Lobaric acid	-	-	(red)	-
Merochlorophaeic acid	(yellow-red)	(red)	(red)	-
2’-O-Methylmicrophyllin.	-	-	-	-
2’-O-Methylperlatolic acid	-	-	-	-
Miriquidic acid	-	-	-	-
Murolic acid	-	-	-	-
Nephrosteranic acid	-	-	-	-
Norstictic	yellow/red	-	-	yellow
O-Demethyl-Planic acid	-	-	-	-
Obtusatic acid	-	-	-	-
Olivetoric acid	-	red	red	-
4-Oxypannaric acid				

-2-methyl ester	-			red-orange
Oxypannaric acid				
-6-methy ester	-			red-orange
Pannaric acid	-	(green)		-
Pannaric acid-6-methyl ester	-			-
Pannarin	-	-	-	orange
Parietin	red	-	-	-
Perlatolic acid	-	-	-	-
Physodic acid	-	-	(red)	-
Physodalic acid	yellow-brown	-	-	red
Picrolicheninic acid	-	-	violet	-
Pinastrinic acid	-	-	-	-
Placodiolic acid	-	-	(yellow)	-
Planaic acid	-	-	-	-
Porphyrilic acid	-	(green)		-
Protocetraric acid	yellow-brown	-	-	red
Protolichesterinic acid	-	-	-	-
Psoromic acid	-	-	-	yellow
Pulvinic acid dilacton	-	-	-	-
Rangiformic acid	-	-	-	-
Rhizocarpic acid	-	-	-	-
Rhodocladonic acid	dark red	-	-	-
Roccellic acid	-	-	-	-
Salazinic acid	yellow/red	-	-	yellow
Schizopeltic acid	-	-	-	-
Scrobiculin	(yellow-red)	(red0	red	-
Sekikaic acid	-	-	-	-
Skyrin	red	-	-	-
Sordidon	-	yellow	yellow	-
Sphaerophorin	-	-	-	-
Squamatic acid	-	-	-	-
Stenosporic acid	-	-	-	-
Stictic acid	yellow	-		orange
Strepslin	-	green	-	-
Thamnolic acid	yellow	-	-	orange
Thiophanic acid	-	orange	orange	-
Thiophaninic acid	-	yellow	orange	-
Thuringion	-	-	-	-
Usnic acid	-	-	(yellow)	-
Variolaric acid	-	-	-	-
Vicanicin	-	-	-	-
Vinetorin	-	-	-	-
Vulpinic acid	-	-	-	-
Zeorin	-	-	-	-

Oversight of the most important Pigments

Calycin	orange-red
Parietin	yellow-orange
Pulvinic acid	yellow
Pulvinic acid dilacton	yellow
Rhizocarpic acid	yellow
Skyrin	yellow-red
Sordidon	yellow
Usnic acid	light yellow
Vulpinic acid	yellow

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 OBERDORFERS 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:

very low precip.	*precip. poor*	*-600 mm/year*
moderately low precipitation		*600-750 mm*
moderately high precipitation		*750-1000 mm*
rather high precip.	*high precip.*	*1000-1400 mm*
very high precipitation		*1400- >2000 mm*

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:

Substrate		Plants
extremely acid	*- pH 3.3*	*extreme. acidophytic*
very acid	*pH 3.4-4.0*	*very acidophytic*
rather acid	*pH 4.1-4.8*	*rthr acidophytic*
moderately acid	*pH 4.9-5.6*	*mod acidophytic*
sub neutral	*pH 5.7-7.0*	*sub neutrophic*
neutral	*pH 7*	*neutrophic*
moderately basic	*pH 7.1-8.5*	*mod basic*
basic	*over pH 7*	*basic*
embracing a wide pH range		*euryion*

The non eutrophic and substantially unaltered by air pollution bark of conifers and birch is mostly very acid (stem); of spruce and black alder rather acid; of pear rather (-moderately) acid; of beech, ash, apple, and basswood moderately acid; while most poplars, Norway maples, sycamore, and elm, moderately acid to sub neutral; and black elder usually sub neutral.

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 character-ization 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.

Substrate:	Plant:
not eutrophic	*anitrophytic*
moderately eutrophic (m. nutrient-rich)	*m. nitrophytic*
rather eutrophic (rather-nutrient rich)	*rthr. Nitrophytic*
very eutrophic (strongly nutrient-rich)	*v. nitrophytic*
extremely eutrophic (extremely nutrient-rich)	*ext. nitrophytic*

Perhaps tree bark on the interior of extensive forests are not eutrophic, bark of field and avenue trees rather eutrophic, extremely etrophic 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 SiO_2 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 SiO_2 - rich rock (acid silicate rock e.g. quartzite, quartz-rich sandstone) bear an altered and poorer flora than SiO_2 -poor (basic and ultra-basic rock, e.g. basalt, melaphyrite, and serpentine). Rock with a content of more than 70% SiO_2 as crude true value was designated here as acid silicate rock, as neutral silicate were those with a SiO_2 content somewhere between 65-70 and 50%, as basic those with a SiO_2 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 ($CaCO_3$). 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.

Habitat:	Lichen:
very rain-protected	*very anom-bryophytic*
rather rain-protected	*anombrophytic*
moderately rained-on	*m. ombrophytic*
rather rained-on	*r. ombrophytic*
very (strongly) rained-on	*v. ombrophytic*

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:

Habitat:	Lichens:
extremely humid	*e. hygrophytic*
very humid	*v. hygrophytic*
rather humid	*r. hygrophytic*
moderately humid, or moderately dry air	*mesophytic*
rather dry air	*r. xerophytic*
very dry air	*v. xerophytic*

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:

Habitat:	Plants:	
v. poorly lighted	*v. skiophytic*	deep shade plants
r. poorly lighted	*r. skiophytic*	shade plants
m. well lighted	*m.photophytic*	half-shade plants
v. well lighted	*v. photophytic*	Full light plants

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

providing a process for this in the title. The retention of community names, which are made up following no longer familiar species names, gave information about the community, but does not make substantially more difficult the using of sociological evidence on systematic and nomenclatural problems holding interest for users of these books. In the cases, where the community names used here deviate as a result of taxonomic (not syntaxonomic) alteration from original names, the original name is placed in parenthesis with an "!".

Class: Chrysotrichetalia chlorinae Wirth 1972 (!Leprarietea chlorinae), community on rain sheltered silicate rock walls – Order: Chrysotrichetalia chlorinae Hadac 1944 (!Leprarietalia Hadac 1944)
Alliance: Cystocoleion nigri Wirth 1972 -- Association: Cystocoleo-Racodietum Schade 1932 ex Kelm. 1955 (!Coenogonio-Racodietum rupestris), Enterographetum zonatae (Degel. 1939) Wirth 1972 (!Opegraphetum horistico-gyrocarpae Wirth 1969)
Alliance: Chrysotrichion chlorinae Smarda & Hadac 1944 (!Leprarion chlorinae) – Association: Lecideetum lucidae Schade 1934 ex Klem. 1950, Chrysotrichetum chlorinae Schade 1934 ex Wirth 1972 (!Leprarietum chlorinae), Lecanoretum orostheae Hil. 1927

Class: Rhizocarpetea geographici Wirth 1972, community of rain exposed silicates
Order: Rizocarpetalia obscurati Wirth 1972 –
Alliance: Porpidion tuberculosae Wirth 1972 (!Lecideion tumidae) – Association: Porpidietum crustulatae Kelm. 1950 (!Lecideetum crustulatae), Lecideetum lithophilae Wirth 1969, Porpidietum tuberculosae Kelm. 1946 ex 1955 (!Lecideetum soredizae), Lecideetum erraticae James et al. 1977, Pertusarietum corallinae Frey 1922
Order: Aspicilietalia gibbosae Wirth 1972
Alliance: Pertusarion aspergillae Egea & Llim. 1987 (!Pertusarion leucosorae) – Ass.: Pertusarietum aspergillo-flavicantis Wirth 1972 (!Pertusarietum leucosoro-flavicantis)
Alliance: Umbilicarion hirsutae Cern. & Hadac 1944 – Umbilicarietum hirsutae Klem. 1931 , Umbilicarietum griseae (Masse 1964) Wirth 1972 (!Umbilicarietum murinae), Lasallietum pustulatae Hil. 1925 (!Umbilicarietum pustulatae)
Alliance: Parmelion conspersae Cern. & Hadac 1944 – Ass.: Aspicilietum cinereae Frey 1922, Buellio-Rhizocarpetum Wirth 1972, Lecanoretum rupicolae Hil. 1923 (!Lecanoretum sordidae), Candelarielletum corallizae Almb. 1955 ex Massé 1964, Parmelietum somloensis Klem. 1955 (!Parmelietum molliusculae, !Parmelietum stenophyllae), Lecanoretum argopholidis (Cern. 1940) Wirth 1980 (Lecanoretum garov.-argopholis (Cern. 1940) Wirth 1972), Aspicilietum serpentinicolae Wirth 1972 – Lecidelletum carpathicae Wirth 1981
Order: Acarosporetalia sinopicae Creveld 1981 –
Alliance: Acarosporion sinopicae Wirth 1972 – Ass.: Acarosporetum sinopicae Hil. 1924, Lecanoretum epanorae Wirth 1972 – Position unclear: Acarosporo sinopicae-Pleopsidietum chlorophanae (Wirth 1972) Creveld 1981 (!Acarosporetum sinopico-chlorophaenae)
Order: Umbilicareitalia cylindricae Wirth 1972
Alliance: Rhizocarpion alpicolae Frey 1933 ex Klem. 1955 – Ass.: Rhizocarpetum alpicolae Frey 1923, Lecideetum obscurissimae Frey 1933, Fuscideetum kochianae (Ullrich et Wirth 1969) Ullirch & Wirth 1972 (!Lecideetum kochianae)
Alliance: Umbilicarion cylindricae Gams 1927 – Ass.: Umbilicarietum deustae Hil. 1925, Umbilicarietum cylindricae Frey 1922, Umbilicarietum cinereorufescentis Frey 1933, Pertusario-Ophioparmetum Wirth 1972 (!Pertusario-Haematommatetum)
Order: Parmelietalia saxatilis Wirth 1972 – Alliance: Crocynio-Hypogymnion Wirth 1972 – Ass.: Parmelietum omphalodis Du Rietz 1921
Order: Rinodino confragosae-Xanthorietalia elegantix Creveld 1981 – Alliance: Dimelaenion oreinae (syn. Lecanorion rubinae Frey 1933 ex Klem. 1955) Ass.: Rhizoplaco chrysoleucae-Dimelaenetum oreinae (Frey ex Klem. 1955) Creveld 1981, Dimelaenetum oreinae Hil. 1925 (!Rinodinetum oreinae), Lecanoro rupicolae-Pleopsidietum flavi Mot. 1926 (!Lecanoro soridadea-Acarosporetum oxytonae)
Order: Physcietalia caesiae Mattick 1951 em. Creveld 1981 – Alliance: Ramalinio capitatae Rübel 1933 – Ass.: Ramalinetum capitatae Frey 1923 (!Ramalinetum strepsilis)

Class: Aspicilietea lacustris Wirth 1972, community of sweet water lichens. – Order: Aspicilietalia lacustris Drehwald 1993 (syn. Hydeoverrucarietalia Cern. & Hadac 1944 em. Wirth 1972
Alliance: Verrucarion funckii Wirth 1972 (!Verrucarion siliceae) – Ass.P Verrucarietum funckii Ullrich & Wirth 1972 (!Verrucarietum siliceae), Verrucarietum hydrelae ass. prov. (syn. Verrucarietum laevato-denudatae) – Position unclear: Verrucarietum elaeomelaenae ass. prov.
Alliance: Verrucarion praetermissae Cern. & Hadac 1944 em. Wirth 1972 – Ass.: Porpidietum hydeophilae Ullrich 1992 (!Lecideetum hydrophilae, syn. Aspicilietum lacustris Frey ex Wirth 1972, Ionaspidetum chrysophanae Frey 1922 (!Ionaspidetum suaveolentis)
Alliance: Porinion lectissimae Wirth 1980 – Ass.: Porpidietum glaucophaeae Wirth 1969 (!Lecideetum glaucophaeae)
Alliance? -- Ass.: Ephebetum lanatae Frey 1922

Class: Dermatocarpetea miniati Wirth class. nov., subneutrophytic silicate lichen community. – Alliance: Physcion dimidiatae Wirth 1972 – Ass.: Xanthorietum fallacis Schindler 1935 (Type, !Xanthorietum substellaris), Lecanoretum dimissae Wirth 1969 – Position unclear: Caloplacetum obliterantis Wirth 1972

Class: Aspicilietea candidae Asta & Roux 1977, class. prov., community of upper surface delimed limestone of the subalpine and alpine zones, with Aspicilion mastrucatae Asta & Roux 1977, all. prov., e.g. with Lecideetum confluescentis Asta & Roux 1977 – Position unclear: Stenhammarelletum turgidae Hertel ex Asta, Clauz. & Roux 1977

Class: Protoblastenietea immersae Roux 1978, class. prov., community of lime lichens of nutrient poor rocks (?Xeroverrucarietietea Hadac 1962
Order: Thelidietalia decipientis Roux 1978, ord. prov. – Alliance: Hymenelion coeruleae Roux 1978 (!Aspicilion coeruleae) – Ass.: Arthopyrenietum saxicolae Clauz & Roux 1975 ex Roux 1978, Hymenelio coerulae-Farnoldietum juranae Kaiser 1926 em. Klem. 1955 (!Aspicilio coerulear-Lecideetum juranae, "Lecedeetum juranae" Kelm. 1955, ? Encephalographetum cacuminum Asta & Roux 1978
Order: Verrucarietalia parmigerae Roux 1978, ord. prov.
Alliance: Rinodinion immersae Roux 1978 (? Verrucarion sphinctrinae Cern. & Hadac in Klika 1948) – Ass.: Farnoldio juranae-Verrucarietum marmoreae Kaiser 1926 em. Roux 1978 (!Lecideo juranae-Verrucarietum marmoreae, syn. Verrucarietum marmoreae Kaiser 1926 em. Roux 1978)
Alliance: Acrocordion conideae Roux 1978, all. prov. – Ass.: Gyalectetum leucaspidis Wirth & Roux 1980, Petractinetum hypoleucae Roux & Wirth 1980 – Position unclear: Gyalectetum jenensis Kaiser em. Roux & Wirth 1978

Class: Verrucarietea nirtescentis Wirth 1980, Soc: nutrient-rich limestone – Order: Verrucarietalia Klem. 1950
Alliance: Caloplacion decipientis Klem. 1950 – Ass.: Caloplacetum citrinae Beschel in Klem. 1955, Caloplacetum saxicolae (Du Rietz 1925) Kaiser 1926 (!Caloplacetum murorum), Caloplacetum teicholytae Wilm. 1966, Physcio nigricantis-Candelarielletum mediantis Nowak 1960, Caloplacetum cirrochroae Poelt ex Breuer 1971, Caloplacetum granulosae Clauz. & Roux 1975 ex Roux 1978, Verrucario velanae-Caloplacetum xantholytae Nowak 1960 – (?) Dirinetum stenhammari Du Rietz 1925 em. Roux 1978, Aspicilietum contortae Kaiser 1926 ex Klem. 1955, Placocarpetum schaereri Klem. 1955 em. Roux 1978 (!Dermatocarpetum monstrosi)

Class: Collematetea cristati Wirth 1980, Soc. irrigated limestone – Order: Collematetalia cristati Wirth 1980
Alliance: Collemation fuscovirentis Klem. 1955 corr. Wirth 1980 (!Collemation tuniformis, Collemion rupestrix Klem. 1955; not *Collema flaccidum = C. rupestris* but *C. fuscovirens*, which Klement misidentified as *C. rupestris* – Ass.: Toninietum candidae Kaiser 1926, Verrucario-Placynthietum nigri Kaiser 1926
Alliance: Peltulion euplocae Moreno & Egea all. prov. – Ass.: Peltuletum euplocae Wirth 1972
Alliance: Peccanion coralloidis Moreno & Egea all. prov. = Psorothchion schaereri all. prov. – Ass.: Peccanio-Thyreetum confusae Nowak 1960 (!Peccanio-Thyreetum pulvinatae), *Placynithium filiforme-P. subradiatum*-Soc., *Gonohymenia nigritella-Anema tumidulum*-Soc.

Class: Chrysotrichetea candelaris Wirth 1980 (!Leprarietea candelaris), Bark lichen-Soc. rain sheltered sites – Order: Chrysotrichetalia candelaris Wirth 1980 (!Leprarietalia candelaris)
Alliance: Calicion viridis Cern. & Hadac 1944 (!Calicietum hyperelli), Lecanactidetum abietinae Hil. 1925, Chaenothecetum ferrugineae Barkm. 1958 (!Chaenothecetum melanophaeae), Calicietum glaucelli Kalb 1969 corr. Wirth ("Caliceitum abietini", not *Calicium abietinum*, but *Calicium glaucellum*), Chaenothecetum furfuraceae Kalb 1969
Alliance: Leprarion incanae Almb. 1948 – Ass.: Chrysotrichetum candelaris Mattick 1937 ex Barkm. 1958 (!Leprarietum candelaris), Arthonietum pruinatae Almb. 1948 (!Arthonietum impolitae), Opegraphetum vermicelliferae Almb. 1948

Class? -- Order: Lecanoretalia variae Barkm. 1958, predominantly wood dwelling soc.
Alliance: Lecanorion variae Barkm. 1958 – Ass.: Xylographetum vitiliginis Kalb 1970, Hypocenomycetum scalaris Hil. 1925 (!Psoretum ostreatae, Lecideetum scalaris), Lecanoretum symmictae Klem. 1953
Alliance: Lecanorion conizaeoidis all.nov. (Char.: *Lecanora conizaeoides, Scoliciosporum chlorococcum*): Lecanoretum conizaeoidis Barkm. 1958 (Type) (!Lecanoretum pityreae), Pleurocoddetum vulgaris Hil. 1925

Class: Hypogymnietea physodis Follm 1974, foliose- and fruticose lichen rich soc. acid bark – Order: Alectorietalia Dahl & Hadac 1944 (syn. Hypogymnietalia physodo-tubulosae Barkm. 58)
Alliance: Cetrarion pinastri Ochsner 1928 – Ass.: Parmeliopsidetum ambiguae Hil. 1925
Association: Hypogymnion physodis Beschel 1958 (!Parmelion physodis, syn. Pseudevernion furfuraceae (Barm. 1958) James & al. 1977) – Ass.: Pseudevernietum furfuraceae Hil. 1925 (!Parmelietum furfuraceae)
Alliance: Usneion barbatae Ochsner 1928 – Ass.: Alectorietum sarmentosae Frey 1927 (syn. Usneetum capillaris Bibinger 1970), Evernietum divaricatae Frey 1952 ex Barkm. 1958 em Bibinger 1970 (!Letharietum divaricatae), Bryorio fuscescenti-Usneetum filipendulae Hil. 1925 (!Alectorio jubatae-Usneetum dasypogae, syn. Usneetum dasypogae sensu Bibinger 1970), Usneetum silesiacae Bibinger 1970

Alliance: Parmelion perlatae James et al. 1977 – Ass.: Parmelietum revolutae Almb. 1948 ex Klem. 1955

Class: Frullanio dilatatae-Leucodontetea sciuroidis Mohan 1978 em. Marst. 1985 – Order: Orthotrichetalia Hadac 1944 (syn. Neckeretalia pumilae Barkm. 1958) -- Alliance: Lobarion pulmonariae Ochsner 1928 – Ass.: Lobarietum pulmonariae Hil. 1925, Nephrometum laevigati Barkm. 1958

Class: Arthonio-Lecidelletea elaeochromae Drehwald 1993 – Order: Graphidetalia scriptae Hadac 1944 (syn. Arthonietalia radiatae Barkm. 1958)
Alliance: Graphidion scriptae Ochsner 1928 – Ass.: Pyrenuletum nitidae Hil. 1925 (syn.? Graphidetum scr. Hil. 1925), Pertusarietum hemisphaericae Almb. 1948 ex Klem. 1955, Pertusarietum amarae Hil. 1925, (?) Thelotremetum lepadini Hil. 1925, Arthopyrenietum punctiformis James et al. 1977 ass. prov., Opegraphetum rufescentis Almb. 1948 ex Klem. 1955 (!Opegraphetum herpeticae)
Allicance: Bacidion rubellae all.prov. – Ass.P Acrocordietum gemmatae Barkm. 1958; *Badicia rubella-Aleurodiscus*-Ass. Ritschel
Alliance: Lecanorion subfuscae Ochsner 1928 – Ass.: Lecanoretum subfuscae Hil. 1925

Class: Physcietea Tomaselli & De Micheli 1957 – Order: Physcietalia adscendentis Hadac 44 em. Barkm. 1958 – Alliance Buellion canescentis Barkman 1958 – Ass.: Buellietum punctatae Barkm. 1958 (!Buellietum punctiformis) – Alliance: Xanthorion parietinae Ochsner 1928 – Ass.: Physcietum adscendentis Frey & Ochsner 1926, Parmelietum acetabuli Ochsner 1928, Ramalinetum fastigiatae Duvign. 1942, Parmelietum elegantulae Almb. 1948 ex Klem. 1955, Parmelietum caperatae Felf. 1941, Xanthorietum candelariae Barkm. 1958. 1958 – Position unclear: Lecanoretum sambuci Wirth 1980 ass. prov.

Class: Cladonio-Lepidozietea Jecek & Vondr. 1962, Moss-Lichen-Soc. of decayed wood – Order: Lophocoleetalia heterophyllae Barkm. 1958 – Alliance: Tetraphido-Aulacomnion (Krus. 1945) Barkm. 1958 – Ass.: Ptilidio-Hypnetum pallescentis Barkm. 1958 – Alliance: Cladonio coniocraeae Duvign. 1942 ex James et al. 1977 – Ass.: Cladonietum coniocraeae Duvign. 1942 ex James et al. 1977, Cladonietum cenoteae Frey 1927 ex Frey 1959

Soil lichen-Soc. – The described soil lichen-Soc. may in part be organized into the sociological system of the society of higher plants, in part as free standing unit within the various societies of higher plant occurrence.

Class: Psoretea decipientis Mattick ex Follm. 1974— Order: Psoretalia decipientis Mattick ex Follm. 1974 – Alliance: Toninietum sedifoliae Hadac 1948 (!Toninion caeruleonigricantis), Soc. of lime soils – Ass.: Toninio-Psoretum decipientis Stodieck 1937 (! *Thalloedema coer.-Lecidea dec.*-Ass., syn. Fulgensietum fulgentis Gams nom. nudum), Endocarpetum pusilli Galle 1964, Cladonietum convolutae Kaiser 1926 (!Cladonietum endiviaefoliae), Cladonietum symphycarpae Doppelb. in Klem. 1955, Psoretum decipientis Frey 1922 (syn. Fulgensietum alpinum Poelt)

Class: Ceratodonto-Polytrichetea piliferi Mohan 1978 em. Drehwald – Order: Peltigeretalia Klem. 1950, Soc. acid soils
Alliance: Baeomycion rosei Klem. 1955 – Ass.: Lecideetum uliginosae Langerf. ex Klem. 1955
Alliance: Cladonion arbusculae Klem. 1950 (!Cladonion sylvaticae), Fruticose lichen-Soc. acid soils – Ass.: Cladonietum mitis Krieger 1937, Cladonietum foliaceae Klem. 1955 (!Cladonietum alcicornis), Cladonietum destrictae Kreiger 1937 (Syn. Cladonio destrictae-Cornicularietum aculeatae Langerf. 1939)
Alliance: Cetrarion nivalis Klem. 1955, alpine fruticose lichen Soc. – Ass.: Emperto-Cladonietum stellaris Du Rietz 1925 (!Empetro-Cladonietum alpestris, syn. Cladonietum alpestris Frey 1927 ex Klem. 1955), Loiseleurio-Alectorietum ochroleucae Du Rietz 1925 (Loiseleureitum Frey 1922)
Alliance: Solorinion croceae Klem. 1955 (? Salicion herbaceae Br. bBl. 26), Soc. long time snoo coveres site – Ass.: Lecidomatetum demissae Frey 1923 (!Psoretum demissae), Lecideetum limosae Klem. 1955, Stereocauletum alpini Frey 1937, Calopalcetum nivalis Kalb 1970
Alliance: Megasporion verrucosae Kalb 1970 (!Lecanorion verrucosae), alpine and dealpine soc. on plant detritus and mosses – Ass.: Megasporetum verrucosae Frey 1927 (!Aaspicilietum verrucosae), Caloplacetum tiroliensis Kalb 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-Württem-berg 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, (+): 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 both	Loess- and calcareous hilly land on sides of the Rhine plains (with Kaiserstuhl)
Hz	Hartz
Ju	Schwäbische Alp and surroundings (Brown Jura-Malm-region)
Lahn	Lahn valley
Lux	Luxenburg
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	Nothern 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	Schöbuch
Sch	Black Forest
SFW	Schwäbisch-Fränkischer Forest
Sju	Swiss Jura (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 km^2, 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-Württem-berg 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 under-taking, 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.
biatorin: 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.
bitunicate: fissitunicate.
blastidiate: with blastidia.
blastidia: (*sing. blastidium*) producing rounded diaspores by marginal budding of thallus areoles.
foliose 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.
calcicolous: lime-dwelling.
calciphytic: 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 rosetted.
proper margin: (exciple 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 ends 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.
euryök: occurring over a broad habitat regions, under various habitat conditions.
eutrophic: 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: bluegreen 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 asci 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 thalloid margin (set off).
spherical soralia: (capitate or laminal): ± spherical soralia on the upper surface of the thallus.
Kurzzweig: short unbranched side branches.
thalloid margin (thalline exciple): produced by the thallus and commonly ± thallus colored algae containing border of an apothecium.
Laubflechte : foliose lichen.
lecanorine: apothecium with thalloid margin.
lecideine: 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.
muriform: cross and longitudinally divided spore; weakly muriform: 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 spores: 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 diaspores.
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.
sceleroplectenchyma: 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.
stylospores: 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*-spores, 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.
central strand: in the case of *Usnea*: elastic, tough central hyphal strand in the filamentous thallus segment.
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.

7 Abbreviations and Clarification Marks

To reduce the size of the book, the use of numerous signs and abbreviations was imperative.

µm	micrometer (1 µm -0.001 mm)
±	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)
Epihym.:	Epihymenium
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
Pcynosp.:	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	**2**
1*	Thallus brown	**4**
2	Thallus with fruiting bodies	**Lichen A**
2*	Thallus without fruiting bodies	**3**
3	Thallus on bark	**Lichen B**
3*	Thallus on rock	**Lichen C**
4	Lichen underside black .	**5**
4*	Lichen underside whitish	**Lichen D**
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** (symbol) 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**

1* Cell content of the algae pure green, yellow-green, orange-green, orange, brown-orange, or yellow with defined chromatophore, sometimes with pyrenoids (green algae) **7**

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

2* Cells in branching threads **4**

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

3* 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"*) **Gloeocapsa**

4 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*) **Stigonema**

4* Threads made up a of single cell series, unbranched or false branching **5**

5 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*) **Nostoc**

5* Cells usually not uniformly round, broader than 5 µm, not rosary-like, sometimes branched (branching often not to be observed in the lichen) **6**

6 Threads not tapered toward the tips, cells oval, about 9-16 µm long, with isolated intercalated cells (heterocysts). E.g. in *Polychidium, Thermutis, and Petractis* **Scytonema**

6! Threads tapered toward the tips, heterocysts only basal (characteristic difficult to see) **Calothrix** and related genera

6* With other characteristics: algae not surely accessible.

7 Cell content orange, green-orange, orange-yellow, or red-brown, in the lichen thallus more often even yellow-green (to green). Cells very thick-walled, cylindrical to barrel shaped, rarely globose, to branching threads, but in the lichen thallus even occurring in single cells or short cell series. Lichen thallus in the case of abrasion often orange, gold-yellow, gold-brown, or brown-yellow. In crustose lichens or species with fine hairy thallus threads **Trentepohlia**

7* Cell content pure green to yellow-green. Abraded thallus not colored orange, gold-brown etc.: "pure green" algae of the order Chlorococcales and Ulotrichales **8**

8 Cells ± subcylindrical with rounded to slightly regenerated ends, single or united into short in short threads. Chloroplasts along the wall. In coniocarpic lichens **Stichococcus**

8* The majority of the cells spherical, ellipsoidal to egg-shaped, single or in clumps or in small packets, not in threads . **9**

9 Cells narrowly ellipsoidal to broadly fusiform, often curved (with only one convex side), with one chloroplast against the wall, without pyrenoid (e.g. the leading species of green algae of *Peltigera*, and *Solorina*, in addition *Dibaeis, and Omphalina)* . **Coccomyxa**

9* Cells spherical to short ellipsoidal **10**

10 Cells mostly in pairs, separated by a thin to normally thick wall, 4-7 µm in size, attacked by the lichen fungus in the form of haustoria . . **micareoid green algae**

10* With other characteristics, if paired, then larger: (other) **coccoid** (coccoid or chlorococcoid) **green algae** (e.g. **Trebouxia**, predominantly spherical, 1-celled, with central, ± lobed chloroplast; **Myrmecia**, spherical to ellipsoidal, peripheral chloroplast; **Gloeocystis**: cells rounded to egg-shaped, surrounded by a thick gelatin envelop and united into colonies (in *Bryophagus*).

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**

1 Fruiting body is not a cap-fungus or fruiting body is lacking **2**

2 Fruiting body is a nearly ephemeral, narrow club-like, unbranched, cream colored to above all slightly orange colored above, non lichenized, ± fleshy fungus, -2 cm. Thallus of closely overlapping green, sometimes coalescing into a knobby crust. Sp. 8-12 x 1,2-3.5 µm. On peat or sandy soil **Multiclavula vernalis**

2* Fruiting body otherwise, not a cap fungus, or fruiting body lacking . **3**

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**

3* Lichen not differentiated into a basal, ± horizontal and a vertical part . **4**

4 Lichen beard-like pendent or shrub-like spreading or ± growing erect of thread-like and decumbent, of ± narrow, terete, angular or ribbon-like, usually branched segments, dominantly growing rather long . **I: Fruticose Lichens**

4* Thallus covering the substrate, closely appressed to loosely attached (or the margins somewhat turned up), crustose, lobed to squamulose or very indefinite, never of cylindrical or relatively thread-like segments, dominantly a flat growing form . **5**

5 Thallus foliose or lobed, loosely attached or appressed, yet not with the entire underside growing smoothly attached to the substrate, but attached with stalk-like attachment organs, with the typical underside often ± undifferentiated from the middle, both sides or only one side with a cortex **II. Foliose Lichens**

5* Thallus entirely crustose to definitely lobed at the margin, with the entire underside growing attached to the substrate *or* squamulose and ± free at the squamule margins *or* the thallus indefinite. Without typical attachment organs such as rhizines, the underside usually without a cortex, commonly consisting only of fragments or a single squamule **6**

6 Thallus with blue green algae (devoid of green algae), usually dark colored, gray to blackish, brown, at times gelatinous swollen; if on rock, then often growing on water streaks (in the keys the blue green lichens are considered fruticose and foliose lichens) **III: Blue Green Lichens**

6* Thallus with green algae (Algae green, yellow green, yellow, or orange), at times additionally with blue green algae in discrete organs. The moist thallus only very rarely swelling, then green .**7**

7 Lichens without fruiting bodies (Includes frequently sterile species, usually with soralia or isidia . **VIII: Sterile Crustose Lichens**

7* Lichens with fruiting bodies . **8**

8 Fruiting bodies delicate and small, ± short needle-form (with a thin stalk and a thickened capitulum), usually -1, rarely -2 mm high or sessile to sunken, then usually covered with a dusty mass (mazaedium). Generally on rain protected sites. The indigenous species predominantly on bark and wood, if on soil, rock and mosses, than the thallus mealy and yellowish, green-yellow to whitish . **IV: Coniocarpic Lichens**

8* Fruiting bodies otherwise (if otherwise stalked, then the stalk robust, whitish to gray greenish, the capitulum brown or rose) . **9**

9 Fruiting bodies are perithecia and opening with a fine dot-like mouth, usually visible only under 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**

10 Apothecia long streaks to shortly elliptical or lobed or star shaped, simple or branched . **VI: Fleck or Streak Fruiting Crustose Lichens**

10* Apothecia predominately rounded to somewhat wavy at the margins **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 a ± erect to ascending, peg-, lance- or cup form or ± shrubby branched part (vertical thallus or podetium). Apothecium generally biatorin. . **2**

1* Thallus not differentiated into two types **5**

2 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**

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**

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 . L**eprocaulon microscopicum**

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. **6**

5* Thallus not with yellow or pale greenish tint . **19**

6 Thallus yellow to orange, K+ deep red . **7**

6* Thallus not K+ deep red, not orange. **8**

7 Thallus with ciliate apothecia or lobes. Found in Central Europe..

Teloschistes chrysophthalmus

7* Thallus not with ciliate/lobed apothecia

Xanthoria

8 Thallus ± erect (to inclined) on soil (or over moss covered rock) **9**

8* Thallus not on soil. . **12**

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-greenish . **Cladonia**

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**

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**

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. . **13**

12* Thallus branch substantially broader than thick, clearly flattened, equally rounded and colored or with the underside otherwise colored, weakly to richly branching . **17**

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**

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**

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**

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 capitate 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

Letharia vulpina

17* Thallus not intensively yellow to yellow-green, without isidia **18**

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 **20**

19* Thallus part not tubular, without a sharply defined hollow space, yet the medulla sometimes truly loosely structured **21**

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 . **Thamnolia**

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

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. . . **GS Polychidium**
(If gray to (gray)brown, underside whitish to slightly brownish, with flattened, -0.3 mm wide marginal granular segments, with isolated rhizines, with green algae ↑. **Phaeophyscia nigricans**)

21* Not on limestone **22**

22 Thallus white, gray, olive, occasionally lightly browned **23**

22* Thallus brown, dark brown, black, gray-black **30**

23 Thallus segment clearly wider than thick, band like flattened to channeled, ± branched . **24**

23* Thallus segment/branch ± cylindrical to weakly flattened, scarcely wider than thick **27**

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**

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, therefor the underside slightly channeled. Ap. very rare **26**

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 . **Pseudevernia 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**

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**

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 felty layer. Ap. brown, dark brown, often lacking. Sp. 3- 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 coraloid, 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**

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**

32 On peat, raw humus, or soil mosses. Thallus decumbent to bushy erect, commonly 1.5-6 cm high **33**

32* On tree bark, wood, or rock . **34**

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 Barbatolic 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-

cyphellae. Lichesteric acid, Protolichesteric acid, ± Fumarprotocetraric acid **Cetraria**

34 Thallus thread-like, richly branched, decumbent to beard-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 . . **Spherophorus (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**

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 chrysophthalmus**

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) **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-gray to pale (ocher) yellowish or pale green yellowish, surface rough with blue-gray 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 balk, 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 thalloid 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

yellowish-green to olive green, P+ red. Ap. lacking. On soil in dry warm sites (if undersides white, small foliose (C*ladonia*) . **Cladonia foliacea s.l.**

14* Thallus ± rosette, lobed at least at the margin, closely appressed or ascending at the margins, upper side pale yellowish-green, whitish green, or yellowish, undersides ± whitish, P-, medulla P- or P+ yellow. Commonly with ± brown ap. with thalloid margin . **Lecanora PT 1**

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. **Parmeliopsis ambigua**

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 . **Parmelia**

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

16* Moist thallus not gelatinous . **17**

17 Lichens attached to limestone, mortar, or concrete . **18**

17* Lichens on other substrates **19**

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 **GS Physcia**

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) . **20**

19* Thallus not attached by a ± central navel, on rock, bark, mosses or peat . **21**

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

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 Umbilicaria**

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

21* Thallus otherwise . **22**

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 . **23**

22* Thallus lobes without such terminal ap. . **24**

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 30µm 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 . **Solorina crocea**

24* Underside of the thallus not orange-red . **25**

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**

26 Lichen lobes over 5 mm wide. Relatively large lichens **27**

26* Lichens with narrower lobes **37**

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**

28 Thallus underside bald, without rhizines (examine carefully!), without hairs, smooth to engraved or felty **29**

28* Thallus underside with distinct rhizines or densely hairy **31**

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

29* Thallus upper side smooth to slightly wrinkled **30**

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 **32**

31* Underside not densely short-hairy, but often with rhizines **34**

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**

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, dark brown or gray-brown (to almost gray), smooth or slightly wrinkled **Nephroma**

34 Thallus olive to brown, without gray areas **35**

34* Thallus colored otherwise, usually gray-white to gray, but sometimes gray at the margin, even dusty green (GS *Parmelia)* **36**

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 . **Cetrelia**

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) **38**

37* On other substrates **39**

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 Physia**

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 **40**

39* Thallus with green algae, moisture not clearly discoloring or more greenish **41**

40 Thallus underside paraplectenchymous (cellular) cortex, beige, pale to dark brownish, without rhizines, but occasionally with finely short hairy, 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, biatorine 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**

42 Thallus underside completely without definite rhizines . **43**

42* Thallus underside with (at times sparse) rhizines . **47**

43 Thallus upper side with cylindrical to coraloid 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**

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**

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-

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**

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 . **48**

47* Ap. lacking or occurring. Key without sp. characters **50**

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**

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**

51 Thallus shiny brown to shiny black-brown, not pruinose (only pruinose abnormally). (Sp. 1-celled) **52**

51* Thallus not shiny brown/black-brown . **54**

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**

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 . **GS Parmelia**

54* Medulla of the thallus not C+ orange to red. **55**

55 Thallus brown, sometimes also (partially) pruinose **56**

55* Thallus usually whitish, gray, gray-green or green, without definite brown tint, only occasionally somewhat browned at the margins **62**

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 pruninose **57**

57 With laminal isidia and warts **58**

57* Without or only with laminal isidia **59**

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 . **60**

60 Without soralia, often with ap . **Parmelia**
(If at the seacoast, thallus compressed, ± rosetted, lobes elongated, brown, not pruinose, olive-green when moist, ap. black-brown, with crenate margins, sp. 2-celled, brown: **Anaptychia runcinata** (With.) Laundon)

60* With soralia **61**

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**

62* Thallus without laminal isidia . **65**

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**

64 Thallus white to gray-white, P- or slightly yellowish, isidia often becoming soredia, 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 . **Imshaugia aleurites**

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

65* Thallus without such pseudocyphellae and collection of ridges **66**

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**

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**

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**

2 Thallus foliose, with definite lobes (at least at the thallus margin), broad lobed to small lobed dissected . **3**

2* Thallus truly crustose or squamulose **20**

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 **4**

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) . **7**

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

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**

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**

6 Sp. 1-celled. Thallus crustose to foliose to almost dwarf fruticose. Ap. disk clearly ("pitcher-like") deep. Rare lichens . **Lempholemma**

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**

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**

9 Ap. at the ends of the lobes, not sitting up, but "lengthening" the lobes, undersides free . **10**

9* Ap. not at the lobe ends or ap. lacking . **11**

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 felty .

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 felty. Thallus relatively coarse . **Peltigera**

11* Underside without such veins . **12**

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. **13**

12* Underside bald and ± smooth or at best uniformly felty-rough or extensively attached by the surface . **15**

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 . **Sticta**

13* Underside without such pits . **14**

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

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 green when moist. Underside (except the margins) largely black-brown to black, felty, 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 . **Peltigera**

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**

16 With apothecia . **17**

16* Without apothecia . **18**

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) x 4.5-7(8.5) µm

Massalongia carnosa

17* Thallus commonly rosetted, barely lobed to deeply divided, bluish-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 thalloid margin. Sp. 1-celled, 7-10 µm wide

GS Pannaria

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**

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 . **5**

20* Thallus not with scattered, necklace-form *Nostoc*-algae (if with *Nostoc*, then in dense coils) **21**

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

21* Thallus not upon bark and bark mosses . **22**

22 On peat or soil mosses, and plant remains . **23**

22* On rock . **28**

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**

24 Thallus granular to finely coraloid . **25**

24* Thallus small squamulose to nearly lobed . **27**

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**

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 (algae 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 . **Heppia**

27* Not on dry calcareous soils. Algae: *Nostoc* in thick coils (algal cells regularly globose, -8µm). Thallus gray, blue-gray, or brown, granular to small squamulose, granules of the squamules densely crowded. Ap. usually densely crowded, with crenate or granular thalloid margin, usually red-brown to dark brown. Sp. with perispore 25-30 x 9-12 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 **Peltula euploca**

28* Without soralia **29**

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**

30 With ap. **31**

30* Sterile lichens **34**

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**

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**

32* Sp. 1-celled. Ap. usually not pure black, with proper or thalloid margin . **33**

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**

35 With *Scytonema*-like algae. Thallus not pruinose or bluish-white pruinose. Upper surface smooth or with cylindric to coraloid 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**

1* Ap. definitely stalked **5**

2 On silicate rock. Ap. blackish. Sp. brown, 1-2 celled **GS Cyphelium**

2* On bark or wood . **3**

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**

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**

5* As a rule on bark and wood as well as bark and wood dwelling lichens or on *Cladonia* squamules . **10**

6 Stalk whitish (to slightly rose), the base even greenish, usually over 0.6 mm thick, coarse. Ap. capitate usually 0.8-2(3) mm wide, shield shaped to globose, brown or rose, smooth, without mazaedium. Thallus warty 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**

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. Sessile or on the algae layer of a whitish or yellow-green to yellow, finely sorediate thallus . **8**

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**

9 Ap. 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* Ap. -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**

10 On twigs and branches of alder and poplar. Ap. black, capitula usually globose to ± top shaped, without mazaedium. Sp. 1-4 celled, brown **GS Stenocybe**

10* Not on alder or popular branches **11**

11 Sp. 1 celled . **12**

11* Sp. septate . **13**

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, underside 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**

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 disintegratin **Calicium**

14* Capitula without bulging mazaedium, shiny blackish. Sp. brown, or light brown. Ascus persistent **15**

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**

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

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 **2**

1* Fruiting body not yellow to greenish yellow . **3**

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

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, attacked 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**

4 Thallus squamulose or indefinitely lobed at the margin, on soil, mosses, or rock. Per. Black. Paraph. In ripe per. indefinite or lacking . **5**

4* Thallus entirely crustose, coherent to areolate (to clod-like) or granular or indefinite **8**

5 Sp. muriform-multicellular, colorless to brown, usually 2. With or without hymenial algae **6**

5* Sp. 1-celled to cross-septate multicellular, colorless. Without hymenial algae . **7**

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 **Endocarpon**

7 Sp. 2(4) celled **GS Placidiopsis**
7* Sp. 1-celled **Catapyrenium**
8 Sp. muriform. 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 tristicula (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 **Mycoporum**
12* Fruiting body is a normal perithecium 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 muriform, at most 18 x 10 µm. With green algae with a thick gelatin envelope. On mosses, soil, soil and silicate rock **GS Prototelenella**
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 Leptorhaphis: Cresporhaphis**
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. . **Verrucaria (bryoctona)**
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. Asci soon deliquescing. Thallus indefinite or endolithic **Sarcopyrenia gibba**
23* Sp. ellipsoidal to globose . **Verrucaria**
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 **Mycoporum quercus**
25* Sp. with 1-3 cross-septa, without longitudinal septa, colorless to brown, 18-27 µm long, somewhat globose to slipper-shaped (one cell larger). Per. with fine pore-like mouth, 2-20(50). Paraph. Branched. A nonlichenized fungus **Tomasila**
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 leucoplaca**

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 hemispherical 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 **Polycoccum 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**

32 Per. red-brown to yellow-brown or rose. **33**

32* Per. black, at times pruinose and ± gray **35**

33 Thallus with coccoid green algae, light greenish, or light yellowish, or elongated, cylindric 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 cylindric to branched light green granules. Paraph. permanent **34**

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 **36**

35* On bark . **40**

36 Sp. fusiform to narrowly fusiform (to almost acicular), at best 4 celled. Paraph. Permanent **37**

36* Sp. ellipsoidal, 2-4 celled, if fusiform, then 2 celled. Paraph. Permanent or lacking in ripe per **38**

37 Per. on white rock-dwelling thallus with green algae and dispersed soralia (*Porpidia glaucophaea),* black, -0.6 mm. Sp. 25-38 x 3-5 µm, mostly 4-5 celled. Paraph. branched. Parasymbiont. Rare: southern Black Forest and Vosges Mountains. **Sagediopsis barbara** (Th.Fr.) R. Sant. &Triebel (=*gongylia nadvornikii* Servit)

37* 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 involucre. 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**

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-lake, 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 ellipsoidal **41**

41 Sp. 2 celled, ± ellipsoidal . **GS Arthopyrenia**

41* Sp. with at least 4 cells . **42**

42 Asci clearly thickened above. Paraph. ± branched, permanent or soon swelling and scarcely recognizable. Sp. ellipsoidal to 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 **2**

1* Sp. 2 to multicellular, colorless or colored. Thallus usually with *Trentepohlia* algae, often golden brown to orange yellow at the crevices. . **4**

2 On rock. Thallus K+ red. Ap. streaked, with crack-formed disks. Receptacle black brown **Lithographa tesserata**

2* On wood, rarer on bark . **3**

3 Ap. black, angular to rounded, with broadened disks. Exc. And Hyp. (“receptacle”) brown-black, carbonaceous. Sp. 5-8 x 3-4 µm . **Ptychographa flexella**

3* Ap. brown to black. Exc. Brownish, hyp. ± colorless. Sp. larger **Xylographa**

4 Sp. muriform, i. e. with longitudinal and cross walls. On bark . **5**

4* Sp. 2 celled to cross septate multicellular **6**

5 Exc. Strongly reduced. Sp. I-, up to 36 x 12 µm. Ap. without margin . **Xylographa**

5* Exc., as a rule, definite, black. Sp. I+ violet, as a rule, larger. Ap. indefinite to definite with margin. NW Germany . **Graphina** Müll.Arg.

6 Sp. 2 celled . **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 tholus. With coccoid green algae .**Poeltinula cerebrina** (DC.) Haf. (*Encephalographa c.*(DC.) Massal.)

7* With other characteristics. If on calcareous rock, then ap. with sp. otherwise and not with crevice form disks . **8**

8 Exc. Usually clearly developed, dark brown to black. Ap. black, bordered to very indefinitely bordered. Paraph. filamentous, simple to sparsely branched and bound. Sp. colorless for a long time, brown when mature. With *Trentepohlia* or algae loosely associated . **Melaspilea**

8* Exc. Reduced, not blackish. Ap. brown to black, without margin. Paraph. sparsely to richly reticulate branched. Sp. colorless, to brownish when over aged. With *Trentepohlia*, coccoid green algae, or without algae **Arthonia**

9 Sp. fan rounded to oval in aspect. Sp. fusiform, (4)6-16 celled, colorless to brown. Ap. ± long streaked, simple or branched, with carbonaceous receptacle. Paraph. simple. With *Trentepohlia* **GS Graphis**

9* Sp. fan ± rectangular to quadrate **10**

10 Thallus with fleck soralia, brown, with black prothallus. Ap. rounded, with punctiform disks . **Enterographa zonata**

10* With other characteristics . **11**

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 thalloid margin. Hyp. strongly developed, dark red-brown. Thallus whitish .**Schismatomma 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 **Enterographa** (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 . **2**

1* Thallus truly crustose to the margin, not appearing lobed or squamulose **49**

2 Thallus true yellow, citron yellow, orange, light red, or rust red . **3**

2* Thallus not true yellow, orange, or red . **9**

3 Thallus K+ deep red. Ap. yellow to orange-red . **4**

3* Thallus K- . **5**

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 . **6**

5* On rock, usually rosetted and effigurate . **7**

6 Squamules light red, whitish margins, on calcareous soils. Ap. black. Sp. 1 celled, colorless .. **Psora decipiens**

6* Thallus citron yellow, somewhat lobed at the margin, on acid soils in alpine regions. Ap. black. Sp. 2 celled, brown **Catolechia wahlenbergii**

7 On calcareous, often dusty or manured rock. Thallus light yellow, granular-warty to sorediate in the ± gray-yellow center. Ap. rare, yellow. . **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. . **8**

8 Ap. yellow, disk form. Thallus yellow **Pleopsidium**

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 calcareous 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 adblutinata**

14* Thallus without patterned underside, entirely crustose, not as easily loosened, underside without cortex. On rock **15**

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. Predominately on walls **Caloplaca 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**

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 capitate. On peat **Trapeliopsis percrenata**

18* Ap. lacking **19**

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 soredia, 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, lecideine .**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 ± asteroid, 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 calcareous soil over mosses **Key V**

24* Thallus without per . **25**

25 Ap. black, but sometimes whitish pruinose, without thalloid margin, with/without proper margin **26**

25* Ap. not black or a;. lacking . **28**

26 Sp. brown, 2-celled **GS Buellia**

26* Sp. colorless **27**

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

27* Sp. 1-celled. . **GS Lecidea**

28 With apothecia **29**

28* Without ap. (an assortment of frequently sterile species) **32**

29 Ap. clearly stalked, brown, or rose-brown . **Baeomyces**

29* Ap. not stalked **30**

30 Ap. without thalloid margin, biatorine **GS Lecidea PT1**

30* Ap. with thalloid margin **31**

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**

31* On calcareous soils. Ap. usually brownish occasionally pruinose. Sp. 1-celled. Thallus usually pale greenish or ± thickly white pruinose, squamulose to rosetted . **GS Lecanora PT1: Squamarina**

32 Thallus clearly rosetted, lobed at the margin, the interior of ± continuous, coalescing squamules **33**

32* Thallus squamulose throughout to small lobules, not rosetted and lobed . **35**

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

33* On lime-rich soil or lime-mosses **34**

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 **Toninia**

35* Squamules flat to concave . **36**

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**

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 **Psora testacea**

38* Ap. not K+ deep red **39**

39 Sp. small (up to about 6µm), spherical to elongate, 1-celled, to very numerous per ascus **40**

39* Sp. commonly 8 per ascus, larger . **41**

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 . **42**

41* Thallus without yellowish tint . **43**

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 red-brown, sometimes pruinose, with thalloid margin. Spores colorless, 1-celled . **GS Lecanora PT 1**

43 Ap. without thalloid margin. Thallus squamulose . **44**

43* Ap. with thalloid margin, or without definite margin and sunken into the thallus. Thallus usually rosetted and effigurate (placoid), interior areolate to squamulose **48**

44 Sp. brown, 2-celled. Ap. black, lecideine. Thallus grayish to dark brown . **Buellia badia**

44* Sp. colorless **45**

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

45* Sp. 1-celled . **46**

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

46* On calcareous rock. Ap. black, rarely slightly pruinose **47**

47 Squamules whitish, moderately convex to almost flat. Sp. 10-18 x 3-5 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) or 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**

50 Sp. one-celled **108**

50* Sp. multicellular **51**

51 Sp. muriform, i.e. with cross- and longitudinal walls **52**

51* Sp. not muriform **60**

52 Ap. sorus-like, covered with whitish granules, gray to whitish, sunken in the white-gray thallus. Thallus K- red, on bark. Sp. ellipsoidal, to 1-2 . **Phlyctis (agelaea)**

52* Ap. not sorus-like, not covered with whitish granules **53**

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

53* Ap. blackish, but also gray pruinose **54**

54 Sp. soon clearly brown to green colored. . **55**

54* Sp. remaining colorless or (over mature) slightly colored . **57**

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. muriform, 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 thalloid margin. Thallus almost always C- . **56**

56 Sp. at least when young with a perispore, often over 28 µm long. Cell lumen not rounded. Paraph. richly branched and reticulate bound, glued together. Hyp. dark. Ap. black, without thalloid margin. Thallus usually clearly developed, often areolate. On rock **Rhizocarpon**

56* Sp. without perispore, usually -28 µm long, weakly muriform (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. R- . **Thelotrema lepadinum**

57* Ap. not deeply sunken in hemispherical thallus warts, without thalloid margin. Sp. without lens form lumina **58**

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 . **59**

59 Sp. 48-120 x 20-46 µm, 1 per ascus, usually weakly muriform multicellular. Hyp. brown, exc. Brown-black. Ap. with proper margin, -1 mm. Thallus warty to almost squamulose, olive, brownish, or dark gray-brown. With coccoid green algae. On mosses, plant detritus, or bark . **Lopadium disciforme**

59* Sp. smaller, usually 4-8 per ascus, mostly weakly muriform. 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 . **61**

60* Sp. colorless (sometimes the older ones slightly colored) **65**

61 Thallus with *Trentepohlia* algae, when scraped or scratched often orange to golden brown. Sp. commonly at first slowly brownish **62**

61* Thallus with true green (coccoid) algae. Ap. rounded to irregular **63**

62 Ap. without margin, brown to black, likewise pruinose. Exc. Reduced, very narrow. Paraph. reticulate bound. Sp. 2-munticellular, at first slowly brown **Arthonia**

62* Ap. margined to indefinitely margined, black, nonpruinose. Exc. Usually clearly developed, dark. Paraph. simple to sparsely branched. Sp. 2-celled. **Melaspilea**

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**

63* Paraph. simple to forked. Sp. without perispore. Hyp. colorless to dark brown. On rock and bark . **64**

64 Ap. with thalloid 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 thalloid 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**

66 Thallus with *Trentepohlia* algae, when scratched or scraped often orange to gold brown (in problem cases check alternatives!) . **67**

66* Thallus not with *Trentepohlia*, commonly with true green algae **80**

67 Sp. 2-celled . **68**

67* Sp. with more than 2 cells . **71**

68 Paraph. reticulate bound. Exc. Reduced, very thin to lacking. Ap. without margin. Hym. I+ (yellow)orange, dirty gray-blue or blue. Asci thickened above **Arthonia**

68* Paraph. simple to sparsely forked. Exc. Clearly developed. Ap. with or without margin. Hym. I- or I+ blue . **69**

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 scruffy, on bark and mosses **Dimerella**

69* Ap. dark. Hyp and exc. dark or light **70**

70 Sp. at first colorless then brown, cells sometimes unequal in size. Ap. rounded to streaked, black. Thallus indefinite. Asci I- **Melaspilea**

70* Sp. remaining colorless, cells equal in size. Ap. rounded, black or dark red-brown. Asci I+ blue at least above. **GS Catillaria**

71 Ap. Not black . **72**

71* Ap. black, however sometimes pruinose. . **74**

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. Epihym. Brown. Hyp. colorless. On bark. **Pachyphiale**

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 **GS Gyalecta**

73* Ap. without margin, exc. reduced. Asci broad, wall strongly thickened above . **Arthonia**

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 **GS Lecanactis: Bactrospora**

74* Sp. shorter, not disintegrating into small pieces, usually fusiform . **75**

75 Paraph. simple or with scattered branches, in other parts occasionally bound. Sp. 4-celled, with perispore, 12-28 x 6-9 µm. Asci thin walled, with thick tholus, not fissitunicate, wall I+ blue. Exc./hyp. dark brown. Ap. black (red-brown when fresh), often with split margin. On calcareous rock . **Sagiolechia**

75* Paraph. branched and reticulate bound. Asci thick walled, fissitunicate . **76**

76 With strongly developed dark receptacle/exc., without thalloid margin. **77**

76* Receptacle/exc. reduced, with or without thalloid margin . **79**

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. . **Enterographa zonata**

77* Ap. with wide open disks. Dark exc. even the underside developed, producing a cup-like receptacle . **78**

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 thalloid 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 . **Schismatomma abietinum**

79* Ap. without thalloid margin, uniformly to irregularly rounded or short lobed, without margin, brown to black, sometimes thickly white pruinose. Sp. -25 µm long . **Arthonia**

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 *Scytonema* algae **Petractis clausa**

80* Ap. margin not set off star-like from the center. Not with *Scytonema* algae, but with green algae **81**

81 Ap. disk yellow, orange, or brown-orange, K+ immediately deep red. Sp. 2-celled. . **Caloplaca**

81* If ap. disk yellow to orange colored, then not immediately K+ deep red . **82**

82 Ap. margin with algae (in section), externally almost always colored as the thallus **83**

82* Ap. margin without algae, generally colored like the disk, or without a margin . **86**

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**

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**

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. Thalloid margin often soon shrinking back (if thallus somewhat squamulose, white, see *Solenopsora*). **Lecania**

86 Thallus of convex, rarely flattened squamules. Ap. black, sometimes pruinose. Sp. fusiform to needle-like, 2-8 celled. On soil, mosses, or calcareous rarely silicate rock **Toninia**

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 magrinless . **107**

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

90* Ap. dark red-brown to black, -0.3 mm, margin not hairy-felty. 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. multicellular; if sp. needle-like to threadlike, then septa at times indefinite. **99**

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

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**

98* Hym. I+ yellow-brown, orange or I-. Ap. unbordered, black. Sp. with two ± unequal partitions. Exc. ± lacking. Algae not micareoid . . **Arthonia**

99 Sp. very long, thread-like, 140-180 x 6-8 µm, with 30-40 cross septa. Nearly extinct lichens with deep "urn-form" sunken, black, whitish pruinose disks, at first punctiform, then opening wider, -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, dicks 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**

103 Hyp. and exc. lacking. Hym. without hymenial gelatin, I- (asci I+ blue at the tips). Ap. appearing hairy in the vigorously growing young. Paraph. sometimes strongly entwining the asci. Inconspicuous short-lived species . **Vezdaea**

103* Hyp. clearly developed. Hym. gelatin occurring. Ap. not hairy. Paraph. not entwining the asci. **104**

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 pachycarpa)* **Rhizocarpon**

104* Sp. elongate bacillar, (ellipsoidal-) fusiform, needle-like, straight or curved, generally without perispore . **105**

105 Exc. (at least when young) strongly developed. Ap. bordered at least when young. Paraph. simple to isolated branched or only branched above **106**

105* Exc. reduced to (weakly) developed, or paraph.-like hyphae. Ap. without margin or indefinitely margined when young. Paraph. richly branched and bound . **107**

106 Thallus and ap. K+ orange. Ap. 1-3 mm, rose, rose-beige, or orange-rose, sometimes slightly whitish pruinose, early with a whitish margin, later convex marginless, sessile or very short stalked. Thallus blue-green, gray-greenish to whitish, ± granular. Acidophytic lichens on decayed wood, peat, raw humus, soil or acidophilic mosses. Sp. 2-4 celled, 13 - 24 x 4-6 µm. Hyp. colorless . **Icmadophila ericetorum**

106* Thallus K-; ap. not K+ orange. If ap. rose to orange, then lichens 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 margined at first.. **GS Bacicia**

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 **Scoliciosporum**

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 . **109**

108* Sp. 1-16 (rarely -32) per ascus, usually 8 **113**

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**

110 On rock . **111**

110* On bark, wood, soil, plant remains, or resin **112**

111 Ap. disk usually brown, dark brown, or red-brown, ± sunken to hollowed out, with (often indefinite bordered) thalloid 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 thalloid 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 Sarcogyne**

112 Ap. with definite thalloid 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 thalloid 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**

114 Sp. very large, usually over 30 µm long, broadly ellipsoidal to spherical. Ap. usually large (over 0.5 mm) . **115**

114* Sp. up to 30 µm long, if longer, then narrow . **18**

115 Ap. black, convex, marginless, lecideine, 1-2 mm. Hym. blue-green to blue-black above. Medulla sometimes red. Sp. to 1-2(3) . **Mycoblastus**

115* Ap. otherwise, with thalloid margin or sunken in thallus warts. Hyp. not blue-green to blue-black above, usually very high, paraph. richly branching and bound **116**

116 Ap. with broader, usually rose-brownish, sometimes whitish pruinose disk and thick thalloid margin, sessile, usually ± flat. Sp. ± thick walled . **Ochrolechia**

116* Ap. otherwise **117**

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 ellipsoidal. 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 Baeomyces**

118* Ap. not stalked . **119**

119 Ap. yellow, citron-yellow, rarely olive-yellow, usually the thallus also yellow. Hyp. 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, ellipsoidal. Ap. lecanorine, pale yellow, pale greenish-yellow, or brown-yellow. Thallus fissured-areolateor 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. Calcareous-/silicate rock **Ionaspis**

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, in high places on acid soils and plant residue. Sp. with warty-ribbed upper surface (epispore), 22-34 x 9-12 µm, with a short appendage on one end (or both ends).
. .**Psoroma hypnorum (31)**

124* With other characteristics **125**

125 Epihym. K+ violet. Hym. over 150 µm high, with strongly branching and strongly reticulate bound paraph. Sp. thick walled (the wall over 1.5 µm thick). Ap. disk black to dark brown, very rarely dark red. Thallus usually whitish to gray. Very rare species on plant residue, mosses in alpine regions or on basic silicate rock **Pertusaria**

125* Epihym. Not K+ violet. Paraph. commonly not strongly reticulate, hym. low to over 150 µm high. Sp. relatively thin walled. **126**

126 Ap. disk commonly concave, ap. extensively sunken into the thallus, rarely compressed sessile. Hym. above often verdigris or brownish(olive). Commonly on rock. Medullar hyphae often thin walled **GS Aspicilia**

126* Ap. disk flat to convex. Ap. sessile, rarely sunken. Medullar hyphae thick walled **GS Lecanora**

127 Hyp. and exc. lacking. Hym. gelatin lacking, hym. I-, only the asci I+ blue above. Paraph. branching, very sparsely or the asci enclosed tightly. Very short-lived species with granular greenish thallus . **Vezdaea**

127* Hyp. well developed. Hym. gelatin occurring. Hym. as a rule I+ blue **128**

128 Ap. convex-marginless from the first (rarely with insignificant receding margin). Exc. in developing ap. lacking or strongly reduced, of few paraphyses-like hyphae, rarely ± well developed. Paraph. branching, reticulate bound. Thallus usually thin, K-. Algae small, 4-7 µm, often paired (micareoid), or large 7-20 µm. Ap. Variously colored. Often on overhanging rock, small stones, wood, old bark, or mosses **Micarea**

128* Not with these characteristics. Exc. generally clearly developed. Ap. with or without margin, flat to convex. Algae not micareoid . **GS Lecidea**

Key VIII: Sterile Crustose Lichens

Note: Normally fruiting, only young sterile species are disregarded

Overview of the partial key

1 Thallus with radially elongated marginal areoles (placoid) to a clearly lobed margin or thallus squamules . **Key VII**

1* Thallus true crustose, not placoid, not lobed, and not squamulose . **2**

2 Thallus with conspicuous pycnidia and similar conidia producing structures **Key a**

2* Thallus not with conspicuous pycnidia .. **3**

3 On rock . **VIIIb**

3* Not on rock . **4**

4 On bark, or bark dwelling moss **VIIIc**

4* On soil **VIIId**

Key VIIIa: Sterile crustose lichens with conspicuous pycnidia and similar conidia producing organs

1 Pycnidia or pycnidia bearers black **2**

1* Pycnidia(bearers) not black **9**

2 With cylindric, at least in part branching, 50-400 µm thick pycnidia bearing structures. Pycn. Wall (squash preparation) K-. Pycnosp. 3.5-5 x 1-1.5 µm, often with 2 oil droplets. Thallus scruffy to finely granular, pale greenish to dark green. On mosses, bark, or silicate rock. . **Micarea botryoides**

2* Pycnidia(bearers) unbranched. On bark or wood . **3**

3 Pycnidia(bearers) cylindric to conic pointed . **4**

3* Pycnidia short, warty projecting to sunken. . **5**

4 Pycnidia conic, pointed, up to 150 µm high, squash preparation K-. Pycnosp. 3.5-4.5 x 1.8-2 µm, united in ± cylindric gelatin packets and occurring free. Thallus whitish to indefinite, with *Trentepohlia* algae. On base-rich bark **Anisomeridium nyssaegenum**

4* Pycnidia otherwise, not conic, 70_320 µm high. Squash preparation K+ violet. With true green, 4-7 µm thick algae. On wood. (See also *M. denigrata*) . **Micarea misella**

5 Pycnidia 0.2-0.6 mm wide, squash preparation K+ purple. Pycnosp. 3.5-4 x 1.5-2 µm. 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* .**Cliostomum corrugatum**

5* Pycnidia generally smaller. Pycnosp. Longer. With *Trentepohlia* . **6**

6 Thallus not white, often brown, or rose-brown . **Opegrapha**

6* Thallus white **7**

7 Pycnidia delicate white bordered, flat to convex, -0.3 mm. Pycnosp. 4-6 x 1.2 µm. Thallus P-. **Arthonia byssacea**

7* Pycnidia not white bordered **8**

8 Thallus KC+ red, P-. Pycnosp. 10-16 x 0.5-0.7 µm. Arthoniaic acid **Arthonia pruinata**

8* Thallus KC-, P+ orange. Pycnosp. 4.5-6 x 0.7-1. Psoromic acid **Arthonia cinereopruinosa**

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**

9* Pycnidia nor so colored, not hairy, hemispherical to short cylindric **10**

10 Thallus with *Trentepohlia* algae (if scraped often ± orange to golden yellow), gray-white to gray. Pycnidia hemispheric to short peg-form **11**

10* Thallus with true green algae, when scraped not ± orange to golden yellow **12**

11 Heads of the pycnidia C+ red. Pycnosp. 12-17(20) x 2-3.5 µm. 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 µm. Above all on ash, oak or hornbeam in mild sites. **Opegrapha vermicellifera**

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 mm wide pycnidia. Pycnosp. (3.2)3.7-4.6 x 1.4-1.7 µm **Fellhanera subtilis**

12* On other habitats **13**

13 On calcareous rock See **Bacidia arnoldiana**-Group **(17*)**

13* On bark, wood or silicate rock . **14**

14 On silicate rock, thallus gray, white-gray, or gray rose . Key **VIIIb/15**

14* On bark or wood **15**

15 Pycnosp. 6.5-9.5 x 2.3-3 µm. Thallus smooth to scruffy granular, with up to 0.3 mm wide whitish, cream- to ochre-colored pycnidia, R- . **Micarea adnata**

15* Pycnosp. Over 20 µm long . **16**

16 Thallus with clearly projecting, 0.1-0.2 mm 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) µm, more narrow at one end (when pycnosp. 6-8 x 1.8-2.6 µm, elongate, constricted in the middle, with 2 droplets, thallus flowing-smooth, see *Dimerella pineti*) . **Fellhanera vezdae**

16* With ± sunken, whitish to greenish (rarely red tinted whitish) pycnidia . **17**

17 Thallus gray-green to gray, scruffy 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 µm), R-. Pycn. hemispherical, however with age even bowl-shaped, 0.1-0.2 mm wide, white, rose-white, rarely even brownish. Pycnosp. Filamentous, curved, 20-50 x 1-1.5 µm . **Bacidina arnoldiana (-Group)**

Key VIIIb: Sterile Crustose Lichens on Rock

1 Thallus citron yellow, yellow, or orange . **2**

1* Thallus not definitely yellow or orange . **8**

2 Thallus K+ promptly deep red . **Caloplaca**

2* Thallus K- (or very weakly reddish) **3**

3 Thallus completely mealy disintegrating ("leprose"). **GS Lepraria** (When over mosses and lichens see also *Arthrorhaphis*

3* Thallus only partially sorediate or entirely without soralia **4**

4 Thallus C+ yellow to orange, KC+ orange, UV+ orange, with soralia . **5**

4* Thallus C-, with or without soralia . **6**

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 . **Lecidella scabra**

5* Thallus strongly developed, fissured to warty, light yellow to gray- or greenish-yellow, with irregular, sometimes coalescing, lighter soralia. P+ orange-red, K+ (weakly) yellowish. Soredia over 35-90 µm. Thiophanic acid, and Stictic acid . **Pertusaria flavicans**

6 Without soralia. Thallus yellow, deeply fissured, thick, consisting of closely compressed cylindric to coraloid structures, therefore with a very uneven upper surface. On bird rocks **Candelariella coralliza**

6* With soralia . **7**

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**

8* Thallus with soralia or entirely sorediate disintegrating . **16**

9 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**

10 Thallus K+ (yellow, then) blue-red **11**

10* Thallus K- or K+ yellow **12**

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**

12* Thallus whitish to gray or gray-rose, possibly isidiate with brown points, C- . **14**

13 Thallus covered with very fine coraloid to isidiate granules, black-brown to brown, in the shade light greenish-brown, C+ red (usually only seen on abraded thalli or microscopically in squash preparations), granules 25-150 x 25-50 µm. On acid substrates **Saccomorpha icmalea**

13* Thallus areolate to fissured areolate, gray-brown to brown, areoles with single isidia-like, occasionally erupting sorediate papillae or thallus of areoles with granular, almost isidiate upper surface. Above all on steep- and vertical surfaces **Rimularia**

14 Thallus whitish, K+ yellow, thickly covered with cylindric, simple to branching isidia . **Pertusaria corallina**

14* Thallus K- . **15**

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. Pycnosp. 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. Pycnosp. 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 . **17**

16* Not with *Trentepohlia*, with true green algae. . **22**

17 On limestone or calcareous rocks . **18**

17* On silicate rock. Thallus gray-brown, brown, brown-red, brick-red or gray, violet-gray . **19**

18 Thallus whitish to weakly brown tinted, coherent to fissured, irregularly erupting sorediate, C+ red, K-, P-. With Erythrin, ± Lecanoric acid. **Dirina stenhammari**

18* Fresh 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**

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**

21 Fresh thallus red-brown to almost brick-red, in the herbarium usually yellow-brown to brown, upper surface scruffy 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 Schizopeltic 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. Schizopeltic acid **Lecanactis umbrina**

22 Thallus upper surface entirely leprose, 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 leprose. .. . **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 whitish prothallus. Soralia rounded, whitish(gray). Sordidon, Rocellic 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, Arthothelin, Thuringion . **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 . **Amygdalaria panaeola**

30* Thallus without cephalodia . **31**

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**

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**

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. **Rinodina aspersa**

33* Thallus without black prothallus **34**

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**

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 . **39**

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 . **Miriquidica nigroleprosa**

38* On more sheltered, often shaded places also on lower sites. Thallus fissured, soralia gray. Medulla K+ blue. Medulla/soralia P-. Confluentic 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

see **Porpidia soredizodes**

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

41 Thallus K+ yellow with Atranorin **GS Lecanora/PT2**

41* Thallus K- (possibly soralia K+ yellow) **42**

42 Medulla I+ blue **GS Lecidea/PT5**

42* Medulla I- **43**

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 . **Lecanora**

43* Thallus white to gray, KC- **44**

44 Thallus extensive, coherent, ± fissured, with large round soralia, often with clearly defined zones, gray to greenish prothallus . **Pertusaria albescens**

44* Thallus without definite prothallus or with black prothallus **GS Lecidea/PT 5**

Key VIIIc: Sterile Crustose Lichens on Bark

1 Thallus sorediate . **2**

1* Thallus not sorediate **63**

2 Thallus C+/KC+ (yellow)orange or red . **3**

2* 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) **17**

3 Thallus usually yellowish, green-yellowish, gray-yellowish, yellowish-green, or ochre, C+ yellow-orange to orange .**4**

3* Thallus C+ rose to red (orange-red) . **7**

4 Thallus finely isidiate, the isidia sometimes becoming partially sorediate . **Pertusaria flavida**

4* Thallus not isidiate . **5**

5 Thallus with defined soralia, gray-white to pale yellowish, gray-yellowish to slightly greenish. Soralia pale yellowish. Arthothelin, Granulosin Thiophanic acid, Capistraton **GS Lecidella**

5* Upper surface of the thallus generally soon entirely sorediate . **6**

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. Isoarthothelin, Thiophanic acid . **Pyrrhospora quernea**

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 **Trapeliopsis pseudogranulosa**

7* Thallus not flecked orange. K-/K+ slightly yellowish **8**

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 cylindric (to coraloid), -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**

9 Thallus P+ yellow(orange), C+ (often fleeting) red, with alectorialic acid . **10**

9* Thallus P-, without Alectorialic acid, with Gyrophoric or Lecanoric acid . **12**

10 Thallus of mostly scattered, ascending, convex, often indefinite squamules with lip soralia, whitish **Hypocenomyce leucococca**

10* Thallus not of ascending squamules **11**

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**

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

12 Thallus with lichexanthon, gyrophoric acid, thin, smooth, whitish. Soralia UV+ orange, flat to slightly concave, rounded, whitish, cream colored to slightly greenish, 0.3-0.7 mm wide, soredia -70 µm . **Ochrolechia arborea**

12* Thallus without Lichexanthon, UV-/± white. Soralia ± flat to convex **13**

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**

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**

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. * **Trapeliopsis flexuosa**

14* Soralia lighter, whitish, greenish-white, light gray, somewhat yellowish, yellowish-green, or light green . **15**

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-greenish, -2 mm, sometimes coalescing. Soredia often very large, reaching over 80 µm. *, ± fatty acids . **Ochrolechia androgyna**

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 µm **16**

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. * **GS Trapelia**

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 µm. * .**Biatora chrysantha**

17 Thallus or soralia intensive citron-yellow, yellow, or orange-yellow **18**

17* Thallus/soralia not intensive citron-yellow to orange-yellow . **21**

18 Thallus and/or soralia K+ deep red **Caloplaca**

18* Thallus and/or soralia not K+ deep red **19**

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**

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., Psilolechia lucida, Chaenotheca fufr.*). Often in bark crevasses or rain-sheltered surfaces **GS Lepraria**

21 Thallus with completely sorediate upper surface . **22**

21* Thallus upper surface with delimited, regular or irregular sorediate regions, not entirely sorediate **24**

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, Porphyrilic acid, ± Usnic acid. . **Haematomma ochroleucum**

22* Thallus without fibrous prothallus . **23**

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- **25**

24* Thallus with true green algae, scratch marks ± (often indefinitely) greenish **26**

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. . **Schismatomma decolorans**

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) . **27**

26* Thallus K- or K+ yellow to orange or brownish **31**

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**

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 orange (red). Norstictic acid **29**

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 **30**

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 coccodes**

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 . **Phlyctis argena**

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-isidiate or sorediate or blastidiate, even with an entirely granular-sorediate upper surface, sometimes up to 1.2 mm. Soredia/granules/blastidia often large and up to over 100 µm **Caloplaca chlorina**

30* Thallus fissured-areolate to fissured-clumped, with granular-warty to scurfy upper surface, blastidiate, 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**

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**

33 Thallus and/or soralia K+ yellow to orange (red-brown) or P+ definite yellow to red . **34**

33* Thallus/soralia K-, P- (or P+ slightly yellowish) **49**

34 Commonly living on wood. Thallus indefinite (usually in the substrate), only soralia conspicuous, C- **35**

34* Commonly living on bark . **37**

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**

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 . **38**

37* Thallus and/or soralia P+ yellow-orange, orange-red to rust-red . **41**

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**

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, Planaic acid. Very rare on acid bark in the mountain regions **Mycoblastus alpinus**

39* soralia without definite yellow tint, without Usnic acid, smaller **40**

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 trachythallina* and *P. multipuncta*

41* Soralia without fruiting bodies **42**

42 Thallus and/or soralia P+ orange, with Thamnolic acid or Norstictic acid . . **43**

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 . **44**

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, ± elatinic acid,

±(Squamatic acid). Above all on Confers 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. Widespread. . **Buellia griseovirens**

44 With Argospin or Pannarin. Thallus and soralia K-, C-. Soralia pale greenish to yellow-greenish, rarely yellowish **45**

44* With Fumarprotocetraric acid. Thallus (so far as developed) and soralia P+ yellow, then (orange) red, K- to K+ yellow or dirty brownish-red. **46**

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**

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**

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 pulverea**

49 Thallus with rounded black soralia, on wood, gray, warty areolate, medulla I+ blue. **Thelomma ocellatum**

49* Soralia not black, if dark, then lichens not on wood. Medulla I- . **50**

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- . **51**

50* Soralia otherwise, not encircled by a frayed margin consisting of erupting thallus pustules **52**

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

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

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**

54 Sorediate regions green to yellow-green or brownish. With Usnic acid or Perlatolic acid or Divarcatic acid. On nitrogen-poor habitats **55**

54* Sorediate regions whitish or blue-gray, gray, or greenish-gray. Without those substances. On nitrogen-poor or eutrophic habitats . **57**

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**

55* 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, -2.5 cm, greenish, light greenish, yellowish-green, warty, in the case of good development with a brownish prothallus, UV+ white . **56**

56 With Divaricatic acid. Thallus usually only -1 cm . **Fuscidea pusilla**

56* With Perlatolic acid. Thallus often also larger . **Ropalospora viridis**

57 With sphaerophorin. Soralia 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**

58 Soralia/soredia dark blue-gray, lead-gray, dark gray to gray (to greenish-gray). On nitrate-rich habitats and base-rich bark. **59**

58* Soralia ± whitish. Thallus whitish to gray. **60**

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 . **Rinodina griseosoralifera**

59* Soralia not convex. Upper surface entirely or partially granular-sorediate to granular-isidiate. Single ap. are generally to be found in the case of longer searches. Ch- . ↑ **30**

60 Thallus with sharply defined, rounded to rarely elliptical, concave to flat, rarely convex, only isolated to coalescing soralia. . **61**

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 albescens*). C± yellow. Sometimes difficult to isolate . **62**

61 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 alboflavescens**

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 albescens** (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 **Ochrolechia turneri**

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

63 Thallus with isidia or thallus at least partially of elongated, partially of rounded granules . **64**

63* Thallus without isidia, not of such granules.. . **73**

64 "Isidia" black, cylindrical **Key VIIIa/1**

64* Without black isidia **65**

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 .**Key VIIIa/11**

65* Thallus with true green algae, on scraped places not gold-brown to orange-yellow. Isidia, if occurring, commonly without pycn **66**

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**

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**

68 Thallus C+ orange or C+ red . **GS Pertusaria**

68* Thallus C-, K- . **69**

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 isidia-like granules or 40-120 µm thick or of very finely branched, almost dwarf fruticose segments or 12-35 µm thick. . **70**

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 coraloid, 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**

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*). ↑ **Candelariella**

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 caradocenis**

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 Lopadium disciforme*)

Key VIIId: 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 scarps, under root hollows (*Psilolechia, Chaenotheca furf.*) **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 fleck-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 fleck-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- to C+ 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

slimy. Soralia pale greenish, soon irregular to coalescing **Trapeliopsis gelatinosa**

11* Thallus definite . **12**

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**

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 baeomyces**

13* Thallus gray, gray-green, or brownish gray, when moist light green, P+ orange **14**

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 Genera and Their Species

The genera are ordered alphabetically. The descriptions of the genera and their species are divided into three sections: 1. Introduction, 2. Genus characteristics and determination, and 3. Ecology and distribution of the species. The introduction gives a short characterization of the genus and a cursory summary view of the habitat (biotype) where the species occur in Baden-Württemberg; it is especially thought of as an opportunity for a few notable facts. The introduction includes also a detailed description of the diagnostic and systematically significant sources of genus characteristics followed by keys for the species of the genus. In the third section is given the ecology, frequency and endangered status of the species as well as their distribution in Europe and in southwestern Germany and surroundings. Remarks about the literature forms the conclusion.

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 pycnospores (pycnidiospores). With them are the many still unknown functions of the slow to be recognized structures. Pycnospores 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. Epihymenium colorless or slightly colored. Asci cylindric to narrowly clavate, thin-walled, with tholus, I+ red-brown. Spores elongate ellipsoidal, fusiform or almost needle-like, 2- to multicellular, cross-septate.

1 Sp. 4-celled, fusiform, 20-28 x 5-6 µm. 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. Thallus thin, gray-greenish, R- . **2**

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. (Hegetschw.) 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. Bormieur – 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*

Lit: POELT & VÉZDA 1977, VÉZDA 1965b.

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. glaucocarpa, 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 several per areole, usually sunken or hollowed out, rarely crowded sessile, with brown red-brown to brown-black disk and indefinite to projecting thalloid margin. Hyp. colorless to pale. Exc. usually only weakly developed. Hym. I+ blue. Epihym. usually ± brown. Paraphyses very numerous, thin, stuck together, simple to branching and bound. Asci with usually more than 100 sp., clavate, with tholus (I-, KI-, very rarely I+ blue). Sp. 1-celled, spherical to elongate-ellipsoidal. Pycnospores ellipsoidal to spherical. Usually Ch-, rarely Gyrophoric- or Norstictic acid.

Many Acarospora species are still insufficiently worked, accordingly the species concept is not established; especially the breadth of variation is at this time not adequately known; pruinosity which is diagnostically important in the classical key is at best partially modified (lime content of the substrate) to strongly altered.

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- ↑ **Pleopsidium**

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**

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**

4* 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, warty 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**

5* Ap. definitely larger, 0.7-2(3) mm, mostly whitish pruinose, flat, raised margin, round or flattened on opposite sides. .↑ **A. glaucocarpa**

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 thalloid margin. Algae layer ± uniformly coherent . **A. macrospora**

6* Sp. 4-8 x 1.5-3 µm, to more than 100 per ascus. Ap. -1.5 (2.5) mm, red-brown, squamules 0.5-5 mm. Probably not a clearly separable species (*A. glaucocarpa* s. l.) **7**

7 Ap. not pruinose, to 1-4, usually sparse, sunken. Squamules light to dark chestnut brown, brown-red, gray-brown, often (partially) whitish pruinose, with whitish margin, ± flat, commonly running together. Algae layer ± closed or breaking into groups and with very uneven upper surface . **A. cervina**

7* Ap. ± white pruinose or non-pruinose, usually single, ± sunken, finally protruding, often engaging the greatest part of the squamule, usually numerous. Thallus very variable. Squamules olive-, gray-, light-brown, olive- gray, non-pruinose, rarely pruinose, often light at the margin, sometimes nearly lobed, usually convex or uneven, scattered to growing together, even overlapping shingle- like. Algae layer commonly disintegrated into groups or with very uneven upper surface . **A. glaucocarpa**

8 Thallus rust-red to rust-brown, areolate, marginal areoles often clearly enlarged and then thallus radiate-rosetted (placoid), ap. puncti-form, dark, ± sunken, usually to 2-6 per areole. Sp. 3-3.5 x 1.2-1.6 µm. R-, Ch- **A. sinopica**
(Compare a. rust-brown form of *A. smaragdula* var. *lesdainii* (harm.) H.Magn.: Ap. usually

larger, thallus not radiate- rosetted with enlarged marginal areoles, rust- brown to ochre)

8* Thallus not rust-red to rust brown **9**

9 Thallus or ap. K+ red (crystals), C-. Norstictic Acid **10**

9* Thallus and ap. K-, C- or C+/KC+ red . **11**

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 **12**

11* Thallus KC- **16**

12 Thallus pruinose . **13**

12* Thallus not pruinose . **14**

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 05-3 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**

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, undersides 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**

17 Thallus pruinose **18**

17* Thallus not pruinose **19**

18 Thallus ± thickly pruinose, under the pruinosity light brown to light red-brown, squamulose areolate, squamules flat to convex, rounded to angular, 0l5-2mm. 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 . ↑ **A. nitrophila (31)**

19 Ap. -1.5(2) mm, red-brown to brown-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. badiofusca**

19* Ap. rarely over 0.8 mm. Hym higher. Paraph. -2µm **20**

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. scabrida**

20* Ap. disk usually not warty-rough . **21**

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**

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 . ↑ **A. heppii (5)**

22* Thallus clearly developed, squamulose to areolate. Areoles with from time to time 1 up to several ap. Paraph. thicker. Lichen not limited to calcareous or basic silicates . **23**

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. . **24**

23* Ap. as a rule ± rounded . **26**

24 Thallus cracked-areolate. Areoles 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, hollowed 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**

25 Squamules red-brown, ap. to 2-5 per squamule. Medulla granular because of crystals. E.g. on *Aspicilia* species **A. hospitans**

25* Squamules red-brown to gray-brown. Ap. to 2-10 per squamule. Medulla without crystals . **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**

27 Thallus cracked areolate. Areoles 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**

28 Parasitic. Ap. mostly up to 2-10 per squamule **29**

28* Not parasitic **30**

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 (hollowed 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**

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, subneutrophic-neutrophic, extreme to very photophytic, moderately nitrophytic, 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.* (↑), Char. Placocarpetum schaereri – mieur (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 sloping and horizontal surfaces, high point 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, (subneutrophic-) moderate- extreme acidophyte, moderate-very phototrophic, anitrophytic to extremely nitrophytic, predominantly in crustose lichen stands, in pioneer habitats and permanent regions, Char. Rhizocarpetea geogr. – 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, Hü, 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 marlly 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.skioph.-)m. -extremely phototrophic, e.g. with *Arthonia lap.* -- bor bor-smed(?-med) – very rare, overlooked; SJu, Ju, FrJu, süHü-HRh, Ne, Mn, He, Th, süRh, O, Eif, *Ml*

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 toped 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 Asicilietum cin., Umbilicarion cyl. – (bor-)mieur-smed – rare; süSch, Vog, Rhön, 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 sloping 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 Lecidelletum 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 synanthrop 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 cyl, 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 FeS_2-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

Acarospora tongletii Hue (A. rehmii H.Magn., A. variegata H.Magn.
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 Lecidelletum 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 Lecidelletum 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

LIT: MAGNUSSON 1929, 1935, CLAUZADE & ROUX 1981, 1985

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, ellipsoidal to elongate ellipsoidal, with usually rounded ends, 2- rarely 4-celled, with thick septum and with finely ornamented upper surface, not shrunken at the septum. Pycnosp. (narrow) ellipsoidal. 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 (Wallr.) 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)

LIT: COPPINS 1988*, POELT & VÉZDA 1977, PURVIS et al. 1922, SWINSCOW 1970

Adelolecia Hertel & Haf.

(Determined ↑ Lecidea PT 4)

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

Thallus crustose, whitish, often indefinite, with coccoid green algae. Ap. sitting up with a narrow base with a proper margin, black. Exc. of of radial lying hyphae, K+ purple-red or K-. Hyp. colorless, light brown, light greenish. Hym. colorless to slightly greenish, I+ blue. Epihym. green. Paraphyses ± simple, strongly cemented. Asci clavate-cylindrical, of the *Biatora*-type. Sp. 1(-2) celled, narrowly ellipsoidal. Ch- or Atranorin.

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 Mediterreanean 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 & VÈZDA 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 Mediterreanean 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 relicts 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

loose hyphae (arachnoid). Photobiont *Trebouxia*-like. Ap. with brown to black disk, with thalloid margin. Asci clavate, thick-walled, *Lecanora*-type. Sp. 1-celled, brown, to 2-4 in the asci. Ch: except in the black species Usnic acid, frequent depside.

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. Alectorialic acid, Barbatolic acid. – arct-alp – Alps, Sudenten **A. nigricans** (Ach.) Nyl

1* Thallus pale yellow to light yellow-green. (Usnic acid) . **2**

2 Thallus without pseudocyphellae, delicate, with small punctiform soralia on the short tips, often curved back side branches. (Usnic acid) . ↑ **Ramalina thrausta**

2* Thallus with streak-form pseudocyphellae, rather robust. Medulla K-, P- C-. Usnic acid **3**

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. ± Alectoronic acid, Squamatic acid. * **A. sarmentosa**

3* Thallus on soil, mosses, erect shrubby to decumbent, -10(12) cm, ± anisotomic-dichotomously branched. Principal axis not clearly flattened. Branch tips often gray-blackish. Medulla KC- UV-, CK+ yellow. Diffractic acid. * **A. ochroleuca**

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.-e.acidoph., v.ombroph., anitroph., Char. Loiseleurio-Alectorietum ochr. – arct-mieur-alp – v.rare; Vog (Rotenbachkopf), Rhön*, BayW (Arber), Erz, Hz; frequent in alpine sites

Alectoria sarmentosa (Ach.) Ach.
In high montane, rarer in montane, very high precipitation and snow-rich oceanic places above all on branches of pine and deciduous trees in near natural pine thickets and Spruce-Fir forests, above all older pine thickets, (rarer) on Spruce, on v.-e.humid, cool oceanic habitats, sensitive to forestry practices. Utilization, 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+

LIT.: BRODO & HAWKSWORTH 1977, HAWKSWORTH 1972.

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

Thallus crustose, gray to brown, with coccoid green algae. Ap. sessile, black, with proper margin. Exc. dark brown. Hyp. light to dark brown. Epihym. brown. Paraphyses simple or branched toward the end, thickened above and with brown pigmented cap. Asci clavate, *Lecanora*-type. Sp. 2-celled, brown, with equally thickened walls or the median wall thickened, smooth to finely warty. Pycnospores thread-like curved. Ch-, rarely with Norstictic acid.

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.

LIT: SCHEIDEGGER 1993.

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 shrunken toward the ends and at the septae. Epihym. brown to brown-black. Asci 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., anitroph., 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, periclinal 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 thalloid margin and darker, sometimes pruinose disk. Hyp. colorless to yellow-brown. Epihym. brown. Paraphyses branching above and ± thickened, scarcely cemented. Asci 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 Lobarion – s'bor-med-mo – rare (3); in not reduced specimens almost only still in SJu, Ju, süSch, Av, Al, besides SFW, Bo, Ne; Mn, Rhön, Eif, O and süRh almost +; formerly in the entire region, e.g. in Th, frequent.

LIT: LYNGE 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 schield-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. Asci clavate, often regenerated at the tips, with a very thick gelatin envelop in the upper part. Sp. to 8 or less, 1-celled, ellipsoidal. 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)

LIT.: HENSSEN & JORGENSEN 1990, MORENO & EGEA 1992b.

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. – mieur-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 Acrocordion gemm. – mieur-subatl-med – r.rare (-m.frequent), overlooked; e.g. Rh, O, Sch, Ne, SFW, Eif

LIT.: COPPINS 1988*, HARRIS 1975, PURVIS ET AL. 1992.

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. zwackhii* "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 eutrification 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 area in central European, summer-green deciduous forest region to partially in the Mediterreanean region are *A. arthonioides, A. caesia, A. cinnabarina, A. elegans, A. endlicheri, A. fuliginosa, A. insulata* (where the northern-most boundary in the region is reached), *A. medusula, A. byssacea* and *A. spadicea*; with exception of the two 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. cinereopruinosa, 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. Epihym. colorless to red-brown or dark brown. Hym. colorless to yellowish, brownish or reddish, I+ orange, red or blue, K/I+ blue. Paraphysoids richly branching and reticulate bound, ends often thickened and with pigmented cap. Asci 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. Pycnosp. 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**
1* Thallus on bark, rarely on wood . **6**
2 On lime-rich rock. Thallus with pure green algae, indefinite to scruffy-warty, gray to brownish. Ap. black, almost sunken to protruding, rounded to irregularly angular, flat to convex, -0.5 mm. Epihym. 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**
3 Hyp. brown-black, Epihym. brown-blackish to carbonaceous. Ap. black, not pruinose. Thallus C-, KC-,K-/± yellowish, P-, Ch- . **4**
3* Hyp. light. Ap. pruinose, flat, thallus yellowish-white, C+/KC+ red, K-/± yellowish, P- **5**
4 Sp. 2-celled, 10-16(19) x 4-6 µm, 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 µm. 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 µm . **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-

6celled, 14-20 x 5-7 µm. Pycn. numerous, 0.1-0.2 mm wide, sunken to wart-like, pycnosp. 15-25 x 1 µm. Lecanoric acid **A. endlicheri**

6 Sp. 2-celled. Ap. dark brown, brown-black, or black, oftentimes pruinose. . **7**

6* Sp. at least 3-celled . **15**

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. excipienda** (Nyl.) Leighton)

7* Ap. rounded to fleck form . **8**

8 Hym. K+ red, purple or violet . **9**

8* Hym. without this reaction . **12**

9 Ap. black, round, rarely elliptical, -0.8 mm, flat. Thallus without algae (algae possibly occurring very isolated), whitish, K+ yellowish, without prothallus. Epihym. 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**

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). Hyp. reddish. 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**

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. Epihym. 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-. Pycn. rare, 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. Epihym. scarcely developed, hym. reddish-yellow to brownish, K+ purple. Thallus mostly ochre to orange (K+ red), more rarely yellowish to yellowish-gray. Pycn. frequent, pycnosp. 4-6 x 1 µm. ?Anthraquinone . **A. vinosa**

12 Thallus with *Trentepohlia*-algae. Ap. red- brown to brown-black, rounded to appearing boxed, fleck-form, ± flat, mostly not projecting above the thallus. Sp. 12-18 x 5-7 µm **A. didyma (11)**

12* Thallus with true green (protoccoid) algae, sp. narrower, with unequal sized cells. Ap. black, round. R- **13**

13 Paraph. ends not or slightly colored, erect (not bent over). Hyp. brown-black. Hym. usually yellow-green. ap. ± flat, -0.7 mm. Sp. 9-15 x 3-5 µm. Thallus very thin gray-whitish **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**

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. apat1etica**

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. . . **16**

15* Ap. dark brown, brown-black, or black, sometimes whitish pruinose. Hym. K- or K+ olive **18**

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, epihym. ± red-brown, K+ red to purple. Thallus whitish to ochre. Anthraquinone . **17**

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). Hym. -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. Epihym. K+ red to

violet. Hym. and Hyp. colorless to brown-red. Sp. (15)18-28 x 5-9 µm, 5-6(7)-celled **A. cinnabarina**

18 Ap. pruinose, underneath blackish or brown **19**

18* Ap. nonpruinose. Thallus R-, at best K+ slightly yellowish . 2**6**

19 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. Epihym. and hyp. dark red-brown. Sp. 4-celled, shrunken at the septa, 15-20 x 4-6 µm. ?Zeorine **A. caesia**

19* Thallus with *Trentepohlia*-algae, whitish, gray- to yellowish-white, not granular- leprose **20**

20 Hyp. brown-black. Thallus K-/± yellowish, C-, KC-, P- **21**

20* Hyp. colorless or light colored. **23**

21 Ap. margined, flat, thickly white pruinose, ± sunken to closely depressed sessile. Sp. 4-celled, 14-27 x 2-3 µm. Unknown lichen substances ↑ **Lecanactis amylacea** (When sp. longer, thallus with whitish pycnidia, see *L. abietina*)

21* Ap. without margin **22**

22 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 **A. byssacea**

22* 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)4-4.4(5) µm, upper sp. cell not enlarged. Without pycn. Thallus whitish, cream colored, cobweb-like to scruffy or indefinite. Unknown lichen substances . **A. leucopellaea**

23 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. Epihym. 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. (Arthoniaic acid) . **A. pruinata**

23* Thallus C-/KC-, K- or K+ yellow/red. Yet insufficiently clarified group **24**

24 Epihym. blue-black (dark olive-brown), K+ greenish. Sp. 9-18 x 2-3 µm, usually 4-5 celled, uppermost cell not enlarged. Ap. often spare, 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 **A. medusula**

24* Epihym. brownish, red-brown to dark brown, K+ olive to olive-brown. Sp. over 4 µm wide, with age brownish and finely warty, uppermost cell enlarged. Ap. numerous, ± sunken to depressed sessile . **25**

25 Ap. soon strongly convex, round, elliptical to lobed, not coalescing , blackish, thickly blue-gray pruinose, -0.8(1) mm. Sp. 3-4(5) celled, 12-18 x 4-7 µm. Thallus well developed, gray-white, P+ yellow-orange, K-/K± yellowish, with numerous black pycn., pycnosp. 4.5-6 x 0.7-1 µm. Psoromic acid . **A. cinereopruinosa**

25! Ap. flat to moderately convex, crowded, mostly angular and to star-like to coalescing into irregularly groups, red-brown to blackish, gray-white pruinose, -0.7 mm. Sp. 4-5 celled, 16-24 x 5-7 µm. Hym. 40-50 µm. Thallus well developed, gray-white, P- to P+ partially yellow, K- or K+ yellow to red (unknown substances, ± Norstictic acid). Without Pycn . **A. zwackhii**

25* Ap. flat to moderately convex, rounded, angular to elongate or lobed, coalescing into irregular to star-like groups, brown-black, whitish pruinose, thereby mostly ± cocoa colored, -1 mm. Sp. 4-5 celled, 15-22 x 6-8(9) µm, ± wedge-form. Hym. 50-65 µm. Thallus P-, K-/± yellowish, without pycn **A. fuliginosa**

26 Hyp. brown-black. Sp. 4-5 celled . **27**

26* Hyp. ± light **30**

27 Sp. 25-42 x 2.5-4 µm, often curved ↑ **Schismatomma pericleum**

27* Sp. clearly shorter **28**

28 Sp. (3-)4 celled, ± wedge-shaped (upper cell enlarged), 12-16 x 4-6 µm. ap. rounded, *Lecidea*-like, rarely elliptical, almost flat to convex, -1 mm. Thallus commonly indefinite. On bark crossing over to rock . **A. arthonioides (4)**

28* Sp. end cell not clearly enlarged, sp. 4-5 celled **29**

29 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 µm, 4(5) celled. Thallus thin, membranous, light yellowish to whitish . **A. mediella**

29* 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 **A. leucopellaea (22)**

30 Sp. 4-5(5) celled, 18-22(26) x 6-8(9) µm, uppermost cell usually clearly enlarged. Ap. dark red-brown to blackish, commonly branched (with side branches) to star-form, rarely elongate-

linear, sunken, ± flat, -2 mm. epihym. dark red-brown, K+ greenish, hyp. ± light. Thallus whitish to ochre-yellowish, coherent, often with brown prothallus. With center running lichen 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. Epihym. black to dark brown or greenish **31**

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, I+ blue. Sp. 4-(rarely -6) celled, 13-23(26) 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, often closely crowded and coalescing, fleck like, rounded to irregular, often unevenly wrinkled. Hym. I+ orange. Epihym. 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, I+ blue, epihym. brownish or greenish, K+ greenish. 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 **4**

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. clemens** (Tul.) Th.Fr

2* Ap. develops on the thallus of foliose lichens **3**

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. Epihym. 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.

3* On *Physcia, Phaeophyscia* and *Xanthoria*. Ap. 0.1-0.35 mm, often crowded, rounded, convex. Epihym. 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. Epihym. 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. intensa** 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-smed – 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., r.skioph., (r.-)v.hygroph., anombroph., anitroph., Char. Arthonietum pruinatae – r.rare (3); above all süRh, Ne, Do, in addition süHü-HRh, SJu, Bo, Ju, but otherwise rare or disappearing

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 (?, or

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 Leprarion 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 brook-side 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-subatl-smed(-med) – rare (2); above all Ne, süRh-HRh, Bo, Do, SFW, valleys of Ju and Sch (up to 650 m), Av, Al additionally *nöRh, O, Sp, Rh-Mn-T, Eif,* SJu

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, Ml, 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 Lobarion-fir or in the Parmelion perl. – mieur-subatl-med(subatl), oc – v.rare (0);*Ne(Trillfingen,* probably +) *Fr* +, Al, *Ml*

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.

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), Ml (Frauental in Zug)*

Arthonia insulata (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., euryöke, but competitively weak pioneer – bor-smed – r.rare; probably wide-spread, but often overlooked, above all Rh, Hü, 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, rather warm to warm, mild winter sites on old oak, rarely other deciduous trees, above all in river-pastures (Stellario-Carpinetum, Querco, Ulmetum), probably like *A. pruinata* (↑) – zentr-smed – v.rare +; *Mrh (Lorchhausen), SJu (Liestal)*

Arthonia muscigena Th.Fr. (A. leucodontis (Döbb. & Poelt) Coppins, Bryostigma l. Döbb & Poelt)
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, süHü-HRh, Ne, Ju, SJu, Sch, Al

Arthonia patellulata Nyl. (Allarthonia p. (Nyl.) Zahlbr.)
Up into the montane zone 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); süHü, *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 euryöke 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* (↑) – mieur-(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 basal 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.toxitol., in the Graphidion, also in contact with Calicion-community – s'bor-smed-mo – r.rare; e.g. süRh, Hü, 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 – mieur(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. Arthonietum vin., rare in the Opegraphetum verm. – s'bor-smed(-med) – rare; above all Sch, Vog, Sp, Al, additionally SFW, Ne, nöRh, 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 – mieur-atl-smed(atl) – v.rare (0); *nöRh (Karlsruhe)*

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Arthopyrenia Massal.

(Keys incl. Acrocordia, Anisomeridium, Strigula)

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.

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

fusiform or clavate, with mostly 1-3 cross-septa, often shrunken and asymmetrical ("slipper shaped"), often with perispore. Pycnosp. egg shaped to elongate or filamentous. Ch-.

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 . **Strigula sychnogonoides**

1! On limestone **2**

1* On bark or on mosses . **3**

2 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 scruffy-cracked, rose-gray, gray, greenish-gray, or brownish . **Acrocordia conoidea** (when per. 0.7-1.5, sp. 20-35 x 10-15 µm, invol. not finally protruding: **Acrocordia salweyi**)

2* Sp. 18-24 x 4-5 µm, 2- to indefinitely 4-celled, without perispore, ± 2-series in clavate asci. Paraph. slimy. Per. -0.2 mm. Thallus whitish, rose-gray, reddish-brown, thin. SJu, FrJu **Pyrenocollema saxicola** (Massal.) Coppins

3 Sp. with (3)5-7 cross-septa. On bark or mosses . **4**

3* Sp. with at best 3 cross-septa. On bark **6**

4 Paraph. mostly unbranched, definite. Asci ± cylindric. Sp. 1- or ± 2 series in the asci. With *Trentepohlia*-algae. Macroconidia 6-8 celled . **5**

4* 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) I+ red-brown. To *A. grisea* ? **A. personii**

5 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 .**Strigula glabra**

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 **Strigula stigmatella**

6 Sp. with ± thicker, finely warty perispore (only in the case definitely stronger enlarging) and thick septum, 2-celled, 15-27(30) x 8-13 µm, not shrunken at the septum, with rounded ends, 1 series ( ). Ascus cylindric, paraph. rigid erect. Per. mostly 0.5-1 mm, hemispherical projecting to almost sunken. Thallus whitish to indefinite (if sp. 11-16 x 5.5-9 µm, per. 0.3-0.6 mm: *Acrocordia cavata*) **Acrocordia gemmata**

6* Sp. without finely warty perispore, with thin septa, 1- to ± 2 series or irregular. Asci sub-cylindric to bulging. Per. -0.5 mm . **7**

7 Sp. at least 25 µm long **8**

7* Sp. shorter . **9**

8 Sp. 30-47 x 7-10 µm, 2-celled, with age because of two additional septa appearing 4-celled, often shrunken at the septa, slightly pointed, to (4, 6) 8 in slightly clavate asci, (1-)2 series. Paraph. rigid, branched. Per. -0.5 mm. Not lichenized. . **Anisomeridium macrocarpum** (Körber) V.Wirth

8* Sp. 25-40 x 8-13 µm, 2-celled, with age often 4-celled and browned, rounded on the ends, without perispore, ± 2 series to unordered in bulging-clavate asci. Per. -0.3(0.4) mm. Par. richly branched. Thallus indefinite, probably not lichenized . **A. antecellens**

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 **Anisomeridium nyssaegenum**

9* Thallus without conical pycn **10**

10 Thallus commonly with 0.1 mm black pycn. Macroconidia 13-20 x 3-6 µm, 4-celled, with rounded ends, ± cylindrical. Paraph. mostly unbranched. Per. 0.3-0.5 mm. Sp. 15-21 x 4-6.5 µm, 4-celled, not shrunken at the septa, fusiform. Thallus whitish to indefinite, under the bark . **Strigula affinis**

10* Thallus without 4-celled conidia. Paraph branched **11**

11 Sp. diagonally in one series to almost 2 series, with one septum, central or somewhat displaced to one end, often with additional apparent (Pseudo-) septa, often with somewhat pointed ends, 10-16 x 4-7 µm. Asci almost cylindric. Per. 0.2-0.4(0.5) mm. Thallus thin, gray-white. Pycn. punctiform, pycnosp. 1-1.5 µm, spherical or 2.5-4 x 1.8-2.7 µm **Anisomeridium biforme**

11* Sp. ± 2 series to irregularly in the asci, with true septa. Asci subcylindrical, clavate to bulging. **12**

12 On the thallus of *Graphis scripta*, producing flecks ca. -5 mm in size. Per. numerous, ca. 0.1 mm. Sp. 13-19 x 3-5 µm, 2-celled, a few old ones to 4-celled, cells usually unequal . **A. microspila** Körber (syn. *Stigmidium microspilum* (Körber) D. Hawksw.)

12* Not on *Graphis scripta* **13**

13 Sp. soon 4-celled. Hym. I-. Probably not lichenized **14**

13* Sp. 2 celled, only a few old sp. 4-celled (Caution: oil droplets may simulate 4-cell appearance, especially in *A. punctiformis*). Hym. I- . **16**

14 Per. usually elliptical, -0.4(0.5) x 0.2 mm. Wall brown, K+ greenish. Sp. 15-22 x 5-7 µm (with definite -2 µm thick perispore), clavate, ± shrunken at the septa. Ascus subcylindrical-clavate. Above all on *Prunus* **A. cerasi**

14* Per. rounded, -0.3 mm. Wall not K+ green. Scarcely on *Prunus* **15**

15 Thallus gray- to brown-black. Sp. 14-20 x 4.5-6 µm, with definite perispore. Per. usually dull. Ascus clavate **A. rhyponta**

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***

16* Sp. without perispore of envelop -1.5 µm thick (in K) . **17**

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. lapponina**

18 Thallus gray- to brown-black. Sp. 2-celled, (14)18-23 x 5-6 µm. Per. -0.25 mm, often somewhat shiny. Asci bulging-sack like. Hym. I- (dark layered *A. persoonii* I+ red-brown). "*A. laburni* Arnold" . **A. punctiformis**

18* Thallus ± lacking or implied by a light (rarely darker) fleck . **19**

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 the region, at this time, insufficiently known, ecology similar to *A. punctif.*, e.g. Sch **A. salicis** Massal.

19* Paraph. occurring . **20**

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. Asci clavate. Thallus light gray to yellowish-white **A. cinereopruinosa (17)**

20* Sp. "not waist-like" in the center of the cells, 2-celled, old ones even 4-celled. Perispore thin (1.5 µm). Per. wall brownish in K. Per. black. Thallus indefinite to implied by mostly light flecks . **21**

21 Per. 0.25-0.5 mm (often relatively crowded). Sp. 17-26 x 4.7 µm, ± shrunken at the septa. Cells often unequal. Asci 60-90 x 16-25 µm, clavate . **A. fraxini**

21* Per. -0.25 mm. Sp. 15-22 x 4-5 µm, 2-celled (with equal size cells), simulating 4-celled appearance by oil droplets, slightly shrunken at the septum. Perispore up to 1 µm thick. Asci 40-55 x 15-22 µm, bulging sack-like . **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. -subneutroph., m.photoph., r.-s.hygroph., anitroph., in initial stages of the Graphidion-community -- mieur-subatl-med -- r.rare (2); Sch, süRh, nöRh, Ne, Ju, SJu, Bo, O, Eif, Al

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*-twigs, 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

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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 multi-cellular 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.

1 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**

1* 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., anitroph., 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., anitroph., 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 greenish, 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. Epihym. 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 **2**

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. Epihym. 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 **3**

2* Thallus extensively sorediate **4**

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, epihym. 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.-e.acidoph., r.hygroph., substrate hygroph., r.skioph., s.photoph., anitroph., in the Lecideetum ulig., in moss community., *Leproloma membran.* stands – arct-mieur – r.rare (3); Sch, Vog, BayW, RhSch, ThW, Erz, Hz, besides rare: Pf, O, He (Rhön, Meissner), Bo, *Fr, Al*

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

LIT.: OBERMAYER 1994, POELT 1961B, POELT & VÈZDA 1977

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

Thallus thin crustose, with coccoid green algae. Ap. black, with proper margin. Exc. ± purple. Hyp. almost colorless to slightly red-brown. Epihym. 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, *Ml,* 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 disappearing thalloid margin, rarely soon sessile and with typical thalloid margin. Exc. as a rule reduced, colorless, sometimes pruinose. Hyp. colorless or pale. Epihym. greenish to brown. Hym. high (often over 100 µm), I+ greenish to blue. Paraphyses simple to sparsely branched, but richly reticulate, above short celled and shrunken at the septa, ends attached. Asci cylindric to clavate, with tholus, K/I-, with thin K/I+ blue gelatin envelop. Sp. 1-delled, ellipsoidal to spherical. Pycnosp. short to (v.)long bacillar. Ch- or with Aspicilin, sometimes with Stictic acid, Norstictic acid, et al. lichen substances.

1 On plant residue, mosses, bark, wood . **2**
1* On rock . **3**
2 Sp. 18-30 x 20-5 µm. Thallus clod-like areolate, gray-greenish, usually white pruinose; occasionally on dust impregnated wood, roots or the base of the trunk overflowing thallus of *A. contorta* (syn. *A. lundensis* (Fr.) Uloth), see 9
2* Sp. 30-60 x 16-42 µm. Thallus warty-uneven, whitish to light gray. Ap. sunken in warts, ± concave, blackish, occasionally pruinose, with entire thalloid margin, often with implied thin, blackish proper margin, -1(1.5) mm. Ch- **Megaspora verrucosa**
3 Thallus rounded, rosetted, clearly narrow-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. Epihym. 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**
3* Thallus not lobed at the margin, never K+ red . **4**
4 Thallus on lime-rich rock, mortar, concrete **5**
4* Thallus on lime-free or very weakly lime-containing silicate rock **10**
5 Thallus with dark brown to blackish soralia on the underside of scattered to thick standing curved squamules, gray, olive, brownish, white pruinose. Ap. rare, sunken, brown, pruinose. Ch- **A. moenium**
5* Thallus without soralia, with ap . **6**
6 Hym. blue(-green) colored above, Ch-. V.rare mountain species **7**
6* Hym. not blue above **8**
7 Thallus bluish to gray-blue, intensively colored when moist, uniform, ± endolithic, the upper surface often as if finely hammered. Hym. blue throughout. Sp. 6-15 x 5-11 µm, rarely completely developed. Ap. black to dark blue-gray, nonpruinose, soon marginless, often sunken in small thallus mounds, very small (0.2-0.4 mm). Ascus without amyloid tholus **Hymenelia coerulea** (if thallus light gray, ap. often irregularly curved: **H. homalomorpha** (Nyl.) Poelt, alpine)
7* Thallus pale ochre, gray-yellowish to dark, not bluish, very .thin, cracked. Epihym. blue(green). sp. ellipsoidal, 12-18 x 7-10 µm. Ap. black, rounded, -0.4 mm, concave, then flat. Ascus with amyloid tholus . **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. Epihym. 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. lacustris*, 16). Ch- . **Hymenelia prevostii**
8* Ap. black, but occasionally whitish pruinose. Epihym. 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 chalk white, upper surface often chalky-mealy, rarely gray-white or slightly ochre, cracked or cracked areolate (± radially cracked at the thallus margin), not warty- or clod-like areolate, often with gray to dark greenish prothallus. Ap. black, not or slightly pruinose, ± sunken, with slightly raised thalloid margin, often of a very irregular (almost lobed) form, coalescing, -1 mm. * . **A. calcarea**

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 thalloid 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, Hü)

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. süSch **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**

15* Ap. blackish, dark brown-red to dark brown, sometimes whitish to bluish pruinose . **17**

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 . . **18**

17* Medulla I-. Epihym. olive to verdigris green, rarely brownish **20**

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. myrinii** (Fr.) Stein

18* Ap. dark red-grown to black, brightened up moist, ± red-brown, sunken to later ± projecting. Sp. wall (epispore) I+ blue. Epihym. brown . **19**

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 or 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 .

Bellemerea cinereorufescens

20 Thallus (medulla) K+ blue-red. Norstictic acid .**21**

20* Thallus (medulla) K-, K+ yellow, rarely ± dirty red-brown **22**

21 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. * **A. cinerea**

21* 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. ***A. epiglypta**

22 Hym. carbonaceous 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, often (especially when sterile) erupting sorediate, usually -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. Gyrophoric acid **Rimularia gibbosa**

22* Hym. not carbonaceous black above. Hyp. light . **23**

23 Sp. approximately spherical 20-30 x 15-25 µm. Ap. often pruinose **A. contorta**

23* Sp. ellipsoidal to broadly ellipsoidal. Ap. nonpruinose . **24**

24 Sp. 7-10(14) x 3.5-5(6) µm. Epihym. green- blue to olive- (brown). Ap. -0.4 mm, black, sunken, flat without raised thalloid margin. Thallus thin, areolate, red-brown to brown, slightly shiny, medulla P+ red, K-, C-. Areoles flat to concave, on an often well- developed black prothallus, -0.4 (0.8) mm. Asci broadly clavate. Paraph. richly branched, anastomosing, not thickened above and the septa not shrunken. Tholus K/I+ blue. Argospin **Clauzadeana macula**

24* Sp. larger, at least 6 µm wide. Ap. over 0.4 mm wide. Paraph. thickened above, often shrunken at the septa. Without Argospin **25**

25 Paraph. loose in K. Asci not thickened above, cylindric. Sp. ellipsoidal, 11-17 x 6-7 µm. Epihym. emerald green. Ap. -0.8 mm. Medulla K+ yellow to brownish, P-, KC+ red, C± reddish . ↑ **Schaereria fuscocinerea**

25* Paraph. cemented, branched and anastomosing. Sp. commonly broadly ellipsoidal. Medulla not KC/C+ red . **26**

26 Medulla P+ orange, K+ usually yellow. Thallus usually dark olive-gray to dark gray, thin to very thin, indefinite to definite cracked, rarely cracked areolate, with smooth upper surface. Ap. numerous, close standing, flat to slightly concave, with ± definite proper margin, -0.4 mm. Sp. 13-17(23) x 9-13 µm. Stictic acid, ± Norstictic acid . **A. laevata**

26* Medulla P-, K- or after a long time dirty red-brown **27**

27 Sp. (9)11-14 x 7-9 µm often poorly developed. Epihym. (yellowish)olive. Ap. -1 mm, brown-black to black, ± flat, definitely margined, close standing. Thallus rather thick, cracked areolate, ash- to lead-gray, often with brown to brown-violet tint. Areoles ± uneven, the most fertile, 0.5-2 mm **A. recedens**

27* Sp. larger. Sometimes difficult to address, sometimes insufficiently defined, thick layered species, here only a part of the many described species considered. Ap. black, sunken **28**

28 Thallus section (microscope!) in K after treatment with Epson salts and washing with water with rust-red crystalline precipitate. Thallus light gray, yellowish-gray to bluish-gray, warty areolate (areole margin "deflected"), with dark prothallus. Medulla (section) opaque because of a ± thick layering of granules. Ap. one per areole, -0.8 mm, with thalloid margin (exc. indefinite, -25 µm). Sp. 20-26 x 12-14(18) µm. Hym. 120-150(185) µm **A. gibbosa** (**A. cupreogrisea** Th. Fr. distinguished by angular, uneven, very dark areoles)

28* Thallus section in K after HCl-treatment without rust-red crystals, medulla without granules, section transparent (or because of entrapped air ± opaque). Usually without dark prothallus. Areoles mostly ca. 0.4-1.2 mm **29**

29 Sp. 14-19 x 8-12 µm. Pycnosp. 7-8 µm long. Thallus dark gray, also with greenish or brownish color tint, irregularly cracked areolate, thin (areoles -1 mm wide). Ap. -0.7 (1.0) mm, with definite black proper margin (exc. 35-100 µm), often close standing and considerably varying in size. Hym. 85-100 (120) µm **A. obscurata**

29* Sp. broader and mostly longer. Ap. without black proper margin **30**

30 On from time to time flooded sites (brooks). Thallus light gray, gray, greenish-gray, cracked to cracked areolate, upper surface mostly smooth and rather even, K-. Ap. often sparse. Sp. to 8, 22-27(35) x 14-18 µm. Hym. (110)150-180(200) µm. Pycnosp. 12-15 µm long. Like *A. caesiocinerea*. Cortex cells regularly ordered in vertical rows **A. aquatica***

30* On dry, rarely on flooded sites. Thallus cracked- to warty-areolate, dark- to light gray, often slightly blue tinted, gray-white, also brown. areoles coalescing, very irregular in form and size, often uneven, K-, medulla K- or later often brownish. Ap. usually numerous. Exc. indefinite. Sp. often poorly developed, mostly to 6, (14)20- -30(35) x 12-16(22) µm. Hyp. (80)120-150(200) µm. Pycnosp. 6.5-9 (12) µm. Very form rich. Aspicilin **A. caesiocinerea** s.l..

(There have been numerous species described from relatives of *A. caesiocinerea*, which at this time are scarcely to be reliably distinguished)

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.) Arnold s.l. (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. Aspicilion calc. – s'bor-med – v.rare; SJu, JU and FrJu m.frequent additionally e.g. Th, Mn, Ne, süHü, 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. Aspicilion calc., above Aspicilietum 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 Umbilicarietum deustae, Parmelietum consp. – mieur-smed(-med) – rare (3); süSch, Ju, He, Alpine

LIT.: CLAUZADE & ROUX 1985, FRIES 1871, FRÖBERG 1989, MAGNUSSON 1939, OZENDA & CLAUZADE 1970

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 *Mycobilimbia* 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. trachona.*

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. Epihym. colorless, brown, red-brown, olive, green etc. Hym. colorless, I+ blue. Paraphyses simple, rarely branching, often thickened above. Asci clavate to narrowly clavate-cylindric, of the *Bacicia*-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

Bacidia PT 1: Rock Dwelling Species

1 Sp. spiral-like twisted to strongly curved. Ap. black-brown to black, convex without margin . ↑ **Scoliciosporum umbrinum**

1* Sp. straight or only weakly curved . **2**

2 Sp. needle-like, long pointed, mostly ± indefinitely septate **3**

2* Sp. fusiform to bacillar **6**

3 Hyp. red- to dark brown. Ap. ± flat . **4**

3* Hyp. colorless to yellow-brownish . **5**

4 Epihym. 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 pycnospores **Bacidina arnoldiana**

4* Epihym. 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 . **Bacidina egenula**

5 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 . **Bacidina inundata**

5* On other habitats. Thallus greenish, gray- green, granular. Ap. -0.2 mm, very numerous, rose, pale gray-brown, red-brown to dark-brown, with lighter margin, flat to moderately convex. Epihym. pale, to dark colored. Ap. brownish above (and then K+ purple). Hyp. weakly developed, colorless. Exc. colorless. Sp. 1-4 celled, 20-30(38) x 1.3-1.7 µm . **Bacidina chloroticula**

6 Hyp. red- to dark brown **7**

6* Hyp. colorless, yellow-brown **8**

7 Sp. 11-16(20) x 3-5 µm, 2-4 celled. Ap. black, flat and margined, then convex without margin, -0.8 mm. Epihym. green to olive. Esc. and hyp. dark red-brown. thallus cracked, granular to indefinite, gray to bluish-green or brownish, on limestone and mineral-rich silicate rock. Pycn. 0.1-0.3 mm, black, sessile, pycnosp. 3-5 x 1-1.5 µm **B. trachona**

7* Sp. 18-40 x (4)5-8 µm, 4-8 celled. Ap. red-brown, dark brown, brown-black to rarely black. Hyp. often yellow- to red-brown only in the upper part. Thallus granular, warty, or scruffy, whitish to pale greenish, usually only on mosses overgrowing rock **Mycobilimbia sabuletorum**

8 Ap. black, hemispherical, without margin. Exc. strongly reduced . ↑ **Micarea**

8* At least the young ap. not black. Exc. clearly developed . **9**

9 Ap., from the first, convex and without margin ↑ **Micarea peliocarpa**

9* At least the young ap. with margin **10**

10 Hyp., in the upper part relatively dark colored, light in the under part. Sp. 4-8(10) celled, 18-40 x 4-8 µm . **Mycobilimbia sabuletorum (7)**

10* Hyp. colorless to pale yellowish. Sp. 4(6) celled, up to 28 x 6 µm **11**

11 Ap. -0.4 mm, orange, rose, ochre-brown to dark red-brown, sometimes margin darker, flat to convex, with disappearing margin. Sp. bacillar/narrow fusiform, (2-)4(6) celled, (11)13-

25(28) x 2.5-3 µm. Thallus whitish, greenish to copper colored, finely granular to scruffy. Pycnosp. 10-19 x 0.8-1.2 µm, strongly curved . **Lecania cuprea**

11* Ap. -1mm, rose- to dark brown, flat, soon convex. Sp. fusiform, 4-celled, 12-19 x 4-5 µm. Thallus gray to bluish-green, intensive green when fresh, ± cracked areolate, erupting sorediate in places, usually sterile. Pycnosp. 16-22 x 6 µm **B. fuscoviridis**

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**

1* Thallus not shining yellow . **2**

2 Sp. needle- to long bacillar, -3.5(4) µm wide (Sp. a-I) . **3**

2* Sp. fusiform to finger-like, not long pointed, over 3.5 µm wide (Sp. j-n) **8**

3 On mosses over bark see *B. rubella, B. rosella* (PT 3)

3* On soil, soil-mosses, plant detritus, of mosses over rock **4**

4 Ap. black, flat, with margin, finally convex without margin, -1.4 mm. Epihym. bluish- to green-black, dirty emerald, rarely olive. Sp. 25-45 x 2-3.5 µm, (4)6-12 celled. Thallus gray-whitish to pale green-gray, warty to finely granular . **B. bagliettoana**

4* Ap. pale rose, orange, gray-brown, brown or brown-red, -0.7 mm, usually remaining flat **5**

5 Hyp. yellow-brown at least in the upper part. Thallus indefinite to granular-warty, light gray, without pycnidia. Ap. brown-red to dark brown, often various colored, usually remaining flat, -0.7 mm. Epihym. pale to brownish. Sp. 30-50(60) x 2-3 µm, (4)6-8 celled . **B. herbarum**

5* Hyp. colorless. Sp. shorter or narrower. Thallus often with sunken white pycn., pycnosp. curved . **6**

6 Sp. ca. 1.3-1.8 µm thick . **7**

6* Sp. 15-26 x 2.5-3.5 µm, 4(-8) celled. Ap. -0.7mm, yellow-red, red-brown, dark brown, flat, thin margin, with age even convex without margin. Epihym. colorless to (in the case of darker apothecia) brow-violet. Thallus whitish to green-white, warty to granular, granules 40-200 µm. Pycnosp. 30- 35 x 1-1.5 µm **B. subfuscula (11)**

7 Ap. -0.2 mm, often accumulated, rose, pale gray-brown, red-brown to dark brown, with lighter margin, sp. indefinite 1-4 celled, 20-30(38) µm long. Pycnosp. 30-43 x 0.5-1 µm. Thallus green, gray-green, scurfy- granular . **Bacidina chloroticula**

7* 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 **9**

8* Hym. colorless or brown, red-brown above. Ap. 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 . **11**

9 Hyp. colorless to slightly greenish or weakly brownish. A;. from the first convex marginless. Exc. reduced, or paraph.-like hyphae. Paraph. richly branched and anastomosing, strongly cemented. On acid substrates ↑ **Micarea**

9* Hyp. brown, red-brown, purple-brown, or black-brown **10**

10 Sp. 30-45 x (5)6-7(9) µm, (4)6-10 celled. Hym. over 60 µm high, epihym. 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 warty . **Mycobilimbia accedens**

10* 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. 13-26 x 2.5-3.5 µm, 4(-8) celled, narrow fusiform to bacillar. Ap. -0.7 mm, yellow- red, red-brown, or dark brown, flat, thin margined, in the older ones also convex marginless. Pycnosp. 30-35 x 1-15 µm **B. subfuscula** (Nyl.) Th. Fr.

11* Sp. at least 4 µm thick (*Mycobilimbia)* . **12**

12 Exc., hyp. and epihym. colorless or slightly yellowish. Exc. clearly developed, cartilaginous **13**

12* Ap. in section not colorless throughout . **14**

13 Thallus green, gray-green, finely granular to almost mealy-sorediate, granules 25-70 µm. Ap. rapidly hemispherical, then ± spherical, yellow- to flesh-reddish, beige, yellow- brown (old also brown), very rapidly marginless, -0.8 (1.1) mm. Sp. predominantly 2-, sparsely 4 celled, 10-17 x 3.5-5 µm, broadly fusiform to ellipsoidal. Zeorine **Mycobilimbia sphaeroides**

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*

.**Mycobilimbia carneoalbida**

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**

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**

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**

Bacidia PT 3: Bark-dwelling Species

1 Thallus with conspicuous white to brownish or hemispherical pycnidia **2**

1* Thallus in general without such conspicuous pycnidia . **6**

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**

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 . ↑ **Micarea peliocarpa/cinerea**

3* Thallus and hym. -. C-. Hyp. dark **4**

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 septate, 25-35 x 1.2-1.7 µm . **Bacidina arnoldiana**

4* Pycn. brown, violet-brown, black, projecting. Hyp. dark brown to red brown . **5**

5 Pycn. violet-brown to brown-black, lighter around the often 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**

6* Sp. straight to slightly bent . **9**

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**

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(8) celled, needle-form to at least partially worm-form. Thallus whitish to indefinite . **B. hegetschweileri**

8* Epihym. blue-green, olive, 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**

9* Sp. fusiform to thick finger-form, ends not long pointed (Sp. h, j-n, p), at the most 40 µm long . **30**

10 Hyp. brown, dark red-brown **11**

10* Hyp. colorless, yellowish or pale (red)brownish . **14**

11 Epihym. green, green-blackish to olive, rarely pale, K-. Hyp. at least above dark (red)brown, 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* Epihym. yellow-brown, brown, red-brown . **12**

12 Sp. 15-30 x 2-3 µm, bacillar, (often indefinite) 4-, rarely 6 celled. Epihym., 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**

12* Sp. longer, needle-form, long pointed on one end, or thread-like. Hyp. not K+ purple. Ap. not black . **13**

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)**

13* Thallus indefinite to thin scurfy-flat warty, without pycn. Ap. light brown to black- brown. Hyp. light brown, yellow-brown. Sp. 30-60 x 1.2-2(2.5) µm ↑ **B. arceutina (19)**

14 Ap. disk dark brown, dark red-brown, brown-black, black, gray-black, or lead-gray .**15**

14* Ap. not so colored, generally lighter **23**

15 Epihym. dark greenish to dark olive or blue-green to verdigris green **16**

15* Epihym. colorless, yellowish, brown, red- brown, or violet **19**

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. Epihym. 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**

17 Epihym. 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**

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 . **Micarea nitschkeana**

19 Sp. very narrow, 30-60 x 1.3-2(2.5) µm. Ap. -0.6(0l7) mm, center red- dark brown, brown-black, flat to mostly moderately convex and (often darker) margined, later often high convex-marginless. Epihym. 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 warty **B. arceutina**

19* Sp. broader, (2)2.5-3.5(4) µm. Ap. becoming larger **20**

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)brown to black, shiny, margin often definitely lighter. Epihym. 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**

21 Epihym 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- to greenish-gray, flat warty to almost crustose squamulose . **B. polychroa**

21* Epihym. mostly strongly colored. Paraph. little thickened (2 µm) above. Uncertain separation **22**

22 Ap. black, purple-black, rarely dark brown, flat, margined, later convex-marginless, crowded sessile. Epihym. gray-brown, brown-red, black-brown, blue-black, dark olive-violet, 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 convex, when young narrowed and therefore somewhat raised sessile. Epihym. blue- violet, 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 **24**

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 . **28**

24 Ap. light brown to dark brown, -0.6(0.8) 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. Epihym. 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, scruffy to flat warty . **B. arceutina**

24* Ap. whitish, yellowish, orange, light red- brown, brick-red, -0.6 mm. 8 celled . **25**

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. Epihym. 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, scruffy-granular, often relatively thick, with sunken whitish pycn. Pycnosp. 34-45 x 1 µm, with indefinite septa, the sp. very similar **Bacidina chloroticula**

25* Ap. 0.2-0.6 mm wide . **26**

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 epihym. colorless. Sp. indefinitely 4-8 celled, (20)25-48 x 1-1.5(2) µm. Pycnosp. 21-40 x 1 µm **Bacidina delicata**

26* Thallus whitish, gray to gray-green, thin to unevenly warty, not of discrete granules. Sp. 4(8) celled . **27**

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 **Bacidina 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. ± 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 **B. rosella**

28* Hym. without granular outer layer. Ap. not rose, -1.5 mm **29**

29 Thallus flat warty to almost crustose-squamulose, whitish to greenish-gray. 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. Epihym. 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., epihym. and hyp. colorless to yellowish (pale orange). No region K+ violet. Sp. 45-75(84) x 2.5-3.5 µm . **Bacidia rubella**

30 Hyp. dark red-brown to black-brown . **31**

30* Hyp. definitely lighter **34**

31 S. elongate to fusiform, at best 4 µm thick. Lichens only basally on trees and on decaying wood . **32**

31* Sp. bacillar, 2-3.5 µm wide. Ap. at least at first flat and margined, -0.9 mm, black, rarely dark purple-brown. Hyp. at least above dark red-brown **33**

32 Sp. 12-22 x 4-5.5 µm, (2-)4(6) celled. Epihym. mostly blue-green. Ap. convex marginless, black, -0.4 mm . ↑ **Micarea melaena**

32* Sp. 18-40 x 5-8 µm, 4-8(10) celled. Epihym. brown to olive. Young ap. margined, brown, red-brown to (almost) black. Hyp. red-brown above. ↑ **Mycobilimbia sabuletorum (PT 2/16)**

33 Epihym. 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* Epihym, 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. Epihym. 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**

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. Epihym. brown to red-brown, but even olive to green. Paraph. ranched, 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**

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**

39 Ap. brown to black or lead-gray. Red-brown part of the exc. and epihym. usually K+ (strongly) purple **40**

39* Ap. light colored, whitish, yellowish, rose, rose-brown, or light brown. Exc., hyp. and epihym. colorless or slightly yellowish **41**

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 . Epihym. 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. Epihym. 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 epihym.

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**

42 Thallus green, gray-green, 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 Acrocordietum gemm., with *B. rubella* – mieur-subatl-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 Toninion 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)

Bacicia 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) Vaino
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-subatl – 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* (↑), bur 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-subatl-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) Vaino
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, *Ml*

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. Hü, 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 Lobarion, in the Acrocordietum gemm., Lecanoretum sambuci – mieur-subatl-smed(-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, *nöHü*, *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*, *Aleurodiscus*, 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

LIT.: FRIES 1874, MIGULA 1929-31, PURVIS ET AL. 1992, VAINIO 1922.

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, oak-hornbeam, 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 chloroticula (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,

subneutroph.-r.acidoph., m.photoph., anitroph. – s'bor-mieur(subatl)-med – rare (3); süSch, Ju, *SFW*, O, Sp. Eif, *Al*

LIT.: DIEDERICH 1989, PURVIS et al. 1992, VAINIO 1922, VÉZDA

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, margined to marginless. *B. dryina* is found almost exclusively on the trunks of oak in old oak-hornbeam forests. They are, like many dwellers on old oak, strongly colored. They are distributed from southern Europe (Black Sea) over central Europe to south Sweden and are largely absent in the high atlantic west. There it is replaced by the closely related *B. corticola*, which is established into north Germany.

Genus Characteristics

Thallus crustose, thin scurfy or endophloeic, ± undifferentiated, with *Trentepohlia*. Ap. black to brown-black, with or without definite proper margin. Exc. definite, exterior dark red-brown, interior often lighter. Hyp. colorless. Epihym. 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 cylindric, fissitunicate, 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, bacillar or elongate ellipsoidal. Ch-.

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 (2); süRh, süHü-HRh(-süSch), Bo, Ju, Ne, O, Sp. *Rh-Mn-T+, MRh-Ts, Eif*

LIT.: LETTAU 1932-1937, EGEA & TORRENTE 1993.

Baeomyes 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

Thallus granular, squamulose to appearing foliose, upper side with cortex, sometimes sorediate, with disk-like schizidia, with *Coccomyxa* or *Elliptochloris*. Ap. stalked, at times almost sessile, brown, marginless, stalk light or greenish, without cortex or basally to largely with cortex, interior ± colorless, of strongly gelatinized hyphae. Exc. and hyp. ± colorless. Hym. I-. Paraphyses simple or sparsely branched above. Asci cylindric, thin walled, thickened above, I- and K/I-. Sp. 1-celled, fusiform. Pycnosp. short cylindric. Ch: often Stictic acid, Norstictic acid.

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, Baeomycic acid, ± Squamatic acid, Barbatic acid . **Dibaeis baeomyces** (= *B. roseus*)

1* Ap. light brown, rose-brown, red-brown, moderately convex, stalk often covered with thallus granules/-squamules, thallus gray, gray-green, brownish gray, light green when moist, P+ orange, K+ yellow, C- **2**

2 Thallus rosetted, with definite enlarged, crenate, -5 mm wide lobes at the margin, interior ± squamulose. Ca. 0.2 mm flat to convex schizidia are cut off at the upper surface (splitting off parts of the upper cortex), leaving behind concave scars. Ap. rare, red-brown, -4 mm high, 5 mm wide. Stictic acid . **B. placophyllus**

2* Thallus without such marginal lobes, purely crustose to small squamulose, squamules -1 mm, not sorediate or with diffuse greenish to whitish soralia, commonly with small, up to 0.2 mm wide schizidia. Ap. brown-rose to red-brown, sessile to clearly stalked, -5 mm high, 2 mm wide. Stictic acid, ± Norstictic acid, ± Gyrophoric acid **B. rufus**

(When ap. ± rose-red, K+ yellow, then red: var. **callianthus** (Lettau) Lettau)

Ecology and Distribution of the Species

Baeomyces placophyllus Ach.
Up into the high montane (but other places also alpine) sites, especially in high precipitation or mild winter regions, on sandy-loam, peat or stony soils, above all on compacted road borders, in heath moors, in soil filled fissures on fissured silicate cliffs and over mosses, also on trickle moistened sites, mostly on rather to very light rich, nutrient poor to moderately nutrient rich habitats, m.-v.acidoph., ± substrate hygroph. – arct-mieur(subatl) – v.rare (3); nöSch, O, Vog, Pf, Hu, Ts, *Sp*, Eif, Th, Erz

Baeomyces 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.skioph.-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

LIT.: FREY 1932, POELT 1969.

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

Thallus crustose, clearly developed, cracked- to warty areolate, on a black prothallus, medulla I+ blue. Photobiont coccoid green algae. Ap. sunken, with concave to flat disk, with thalloid margin, but outwardly usually not recognizable as a separate margin (cryptolecanorine). Exc. reduced to lacking. Hyp. colorless. Epihym. brown to olive. Paraphyses branched and reticulate, often with a thin pigmented layer on the ends. Asci of the *Porpidia* type. Sp. 1-celled, rarely appearing 2-celled, ellipsoidal to almost spherical, with perispore, wall (epispore) I+ blue. Pycnosp. short bacillar. Ch: sometimes with Norstictic acid.

Ecology and Distribution of the Species

Bellemerea alpina (Sommerf.) Clauz. & Roux (Aspicilia 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.

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

LIT.: CLAUZADE & ROUX 1984*, 1985, FRIES 1871.

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 lectissima*, *Opegrapha gyrocarpa* or *Lecanactis dill.* (e.g. in the Porpidietum glaucophaeae, in contact with Enterographetum 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 ellipsoidal to narrowly ellipsoidal , 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. Hym. shiny colorless or yellowish above, without granular layer above, I+ blue. Hyp. cartilaginous, colorless to yellowish. Paraphyses simple to scarcely branched, thickened above. Asci 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 . **B. fallax**

1* Thallus not of such squamules **2**

2 Thallus sorediate, often sterile **3**

2* Thallus not sorediate, at best completely finely granular, R- . **6**

3 Sorediate region yellowish-green to yellowish, C+ red or P+ red, K- . **4**

3* Sorediate region yellowish, yellowish-green, gray-green, R- . **5**

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, epihym. colorless to brownish. Sp. 10-16 x 4-6 µm, 1-2celled. 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. 2celled, rarely 4celled, 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 . **7**

6* Sp. 2-4 celled (*Mycobilimbia)* . **Bacidia PT2**

7 Ap. very small, -0.3 mm, whitish-rose, rose-yellow, moderately to finally high convex, at first delicately margined, then marginless. Sp. 7-13 x (2)2.5-3 µm. Hyp., epihym., 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) . **8**

8 On mosses, plant detritus, decaying wood, rarely on bark. Ap. C-, -1 mm, often narrowly sessile, usually light brown to brown, moderately to very convex. Sp. (10.5)12.5-20 x 4-6 µm. Thallus warty to granular, gray- to greenish-white. Hym. ca. 80 µm. Ch-. – arct-bor-mieur-h'mo/alp – Vog . **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 2celled. Thallus flat warty areolate, light gray to gray-greenish. 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. Epihym. pale to orange-yellow. Hym. pale (brown-reddish). Paraphyses simple, slender, scarcely reticulate, richly branched in the epihymenial 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-

1 On soil, over mosses, dying plants, rarely on decayed wood. Thallus thin, often little developed, whitish-gray to greenish. Sp. elongate, 5-8 x 2-3.5 µm **2**
1* On tree bark, wood or resin. Sp. spherical **3**
2 Ap. -0.3(0.5) mm, light flesh-reddish to rose-brown, flat to concave, with whitish, at first clearly projecting margin, sessile, when moist very light and translucent, exc. strongly developed . **Sarcosagium campestre**
2* Ap. =1(2) mm, brown-yellow, yellow-reddish, red lead-red, even brown, from the first convex marginless, sunken to depressed, without exc . **B. hemisphaerica**
3 On older resin of conifer trees. Ap. flat to concave, margined. Sp. 2-3 µm. Not lichenized . **4**
3* On wood and bark. Sp. 1.7-4 µm, ap. -0.5 mm **5**
4 Ap. red-brown to yellow-red, -1.5 mm. Hym. 85-100 µm high **Sarea resinae**
4* Ap. black to black-brown, -0.8 mm. Hym. 50-60 µm **Sarea difformis**
5 Ap. dark red-brown to black . **6**
5* Ap. lighter, yellow-brown, rose-brown, yellowish, or whitish **8**
6 Exc. strongly developed, 35-45 µm thick, ± brown, K+ brownish. Ap. flat and indefinitely

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 . **7**

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 pinicola**

7* Hym. olive green, emerald to violet above. Ap. black to brown-black. Thallus indefinite to granular. Hym. -110 µm. Pycnosp. 2.5-3.5 x 1-1.7 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. 3.3.5 µm **Biatoridium monasteriense**

8* Thallus indefinite, often in the substrate. Sp. 3-4.5 µm **9**

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*

LIT.: HAFELLNER & CASARES-PORCEL 1992*, MAGNUSSON 1935, POELT & VÉZDA 1977.

Biatoridium Lahm

(Determination ↑ Biatorella)

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. Asci 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

Brodoa Goward

(Determination ↑ Hypogymnia)

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

Thallus foliose, lobes narrow, mostly elongated, white-gray, brownish, compact and relatively rigid, underside black, without rhizines. Soralia lacking. Photobionts coccoid green algae. Upper cortex paraplectenchymatous, under cortex a palisade plecthechyma. Ap. brown, with permanent thalloid margin, with concave to flat disk. Sp. 1-celled, ellipsoidal. Pycnosp. narrowed in the center and at the ends. Deviating from *Hypogymnia* by the compact medulla and the lack of soralia, by the larger spores and an otherwise constructed lower cortex. Ch: Atranorin in the cortex. Fumarprotocetraric acid or (in the non indigenous alpine species) Physodic acid, Protocetraric acid.

Ecology and Distribution of the Species

Brodoa 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* (↑), 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 ↑ 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 psuedocyphellia. 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, Fumarprotocetraric 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 . **2**

1* Thallus KC-, C-. Without Alectorialic acid, Barbatolic acid, or Gyrophoric acid . **4**

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, ± Fumarprotocetraric acid, ± Atranorin (B. vrangiana") . **B. implexa**

2* Thallus P+ intensively yellow, K+ remaining intensively yellow, soralia P+ orange-red. Pseudocyph. usually sparse and indefinite. Alectorialic acid. Fumarprotocetraric acid in the soralia . **3**

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 isotomic-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-creeping, 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-. Lichesterinic 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 (Furmarprotocetraric 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. fuscescens**

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-isidiate 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**

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**

15* Commonly without, rarely with inconspicuous pseudocyph. Ap. rare. With or without Fumarprotocetraric acid **16**

16 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-. Medulla of the main filament looser. Vulpinic acid (only in soralia and ap.). Without Fumar-protocetraric acid. Very rare boreal species **B. fremontii**

16* Soralia and ap. not yellowish. Without Vulpinic acid, with Fumarprotocetraric acid. Main filament commonly -0.6 (0.8) mm thick. Pseudocyph. lacking (Caution: young split-form soralia appear pseudocyph.-like) . **17**

17 Thallus light gray, 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.

17* 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 Lobarion 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, Vgb,* Ts, *Eif,* ThW, Al

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 Usneetum filip., Evernietum div., also Psuedevernietum, M.-r.acidoph., m.-r.photoph., v.hygroph., 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 (Hohneck)

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

LIT.: BRODO & HAWKSWORTH 1977, HAWKSWORTH 1972, HOLIEN 1989, MOTYKA 1962

Buellia De Not

(Key includes Catolechia, Epilichen et al.)

Introduction

The *Buellia* species are crustose lichens with scarcely visible, endolithic to strongly developed, areolate to isolated squamules, commonly white, gray , brown or yellowish colored thallus, black apothecia with ± clearly developed proper margin as well as brown, two celled, rarely four celled to muriform divided spores. The genus is world-wide distributed with several hundred species, with the high point in warm and temperate zones. In Germany there about 35 known species. A few species groups are yet insufficiently known.

Among the indigenous species *B. schaereri, B. disciformis, B. poeltii, B. griseovirens* and *B. alboatra* live on tree bark, while *B. erubesces is limited to wood. B. thiopoliza*, which in central Europe is still known only from the Vogesen, and *B. insignis, B. geophila* and *B. papillata* which occur in the arctic-alpine adjacent Allgäu overgrowing moss and lichens in the high mountain region. *B. asterella* is found in openings in thin calcareous turfs and on soil covered rock surfaces. *B. epipolia*, a species with broader ecological amplitude, resides on limestone, *B. venusta* nearly pure lime and *B. porphyrica* calcareous or basic silicate rock. *B. venusta* occurs on nutrient rich, sunny sites, e.g. bird roosting sites and occurs also as a young parasite on *Lecanora muralis*.

Silicate lichens are *B. aethalea*, which is often also found on anthropogenic habitats, *B. ocellata*, which grows sometimes on lichens and mosses *B. badia* as well as *B. leptocline, B. spuria, B. uberior* and *B. miriquidica*: the two latter parasitising the thallus of *Schaereria fuscocinerea.*

Numerous Buellias are very rare in the region; their occurrences often represent outposts or isolated discovery points in the area, thus in the case of the mediterranean *B. spuria*, which here reaches the northern boundary of the distribution, *B. thiopoliza*, which till now is known only from the Auvergne, the Vogesen and in the Black Forest, in the case of *B. asterella*, a central European (= temperate) species, *B. poeltii*, a lichen of the mountain forests of the higher mountains of central Europe, or *B. uberior* very scattered in west Europe from Scandinavia and Great Britain up into the west Mediterranean). All these species are strongly colored, likewise *B. leptocline* and *B. miriquidica*, which occur in north Europe and rarely in central European mountains. The area of *B. alboatra, B. ocellata* and *B. venusta* stretches over south and central Europe and ends

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, *Lecanora* type, with commonly 8, exceptionally also more or less sp. Sp. 2- up to cross-septate 4-celled or (weakly) muriform, gray-green to brown, wall uniformly thick or somewhat thicker around the septum. Pycnosp. rather polymorphic, ellipsoidal to filamentous. Ch: mainly Atranorin, Stictic acid, Norstictic acid, rarely e.g. Xanthone.

Key hint: Spore ornamentation only recognizable with oil immersion

1 Living on other lichens . **2**

1* Not living on other lichens **12**

2 Own thallus well developed, brown, gray or ± yellowish. Apical apparatus I+ intensive blue **3**

2* Without own thallus. Parasymbiotic on crustose lichens, foreign thallus not brown. Ap. permanently margined, ± flat. Apical apparatus I- . **8**

3 Sp. predominantly bent sickle-like, 2-4 celled. Young thallus living on crustose-, rarely foliose lichens on silicate rock, granular to thick warty, light yellow, yellow, yellow-white, C+ orange, P-, K-/+ yellowish, UV+ orange. Arthothelin, arctic-alpine . **B. concinna** Th.Fr.

3* Sp. ± straight, 2-celled . **4**

4 Thallus greenish-yellow to yellow, on *Baeomyces* over soil, warty to almost squamulose-areolate. Ap. usually soon high convex and marginless, often coalescing. Epihym. olive brown to brown, K-. Sp. 11-18 x 6-10 µm, without perispore. Paraph. strongly reticulate branched. Thallus P+ yellow-orange, K-, C-. Pulvinic acid. -derivatives **Epilichen scabrosus**

4* Thallus brown to gray, not on *Baeomyces*, on silicate rock . **5**

5 Island-like on yellowish *Pertusaria* species. Sp. 18-23 x 9-11 µm. Thallus warty areolate, brown . ↑ **Rhizocarpon epispilum**

5* Not island-like on yellowish crustose lichens. Sp. smaller . **6**

6 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- **Buellia badia**

6* Thallus purely crustose, areolate, whit-gray to brown-gray, often island-lake, growing on or at least near the brown-gray thallus of *Schaereria fuscocin*. Ap. sunken (cryptolecanorine) to sessile, -0.8(1) mm. Sp. up to 12 x 6.5 µm, elongate, shrunken at the septum **7**

7 Sp. upper surface streaked. Sp. wall usually under 1.5 µm. Sp. 8.1-9.3-11.7 x 4.7-4.6-6.4 µm. Ap. commonly remaining sunken. Hyp colorless to middle brown, epihym. olive to black green, rarely brown-olive. Thallus light to dark gray or gray-brown, shiny. Gyrophoric acid, ± Stictic acid . **B. uberior**

7* 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. Miriquidic acid . **B. miriquidica**

8 On the rock dwelling crustose lichens *Porpidia glaucophaea* or *Diploschistes scruposus*. Sp. 2-4 celled. Asci not I+ blue (*Karschia*) . **9**

8* On *Pertusaria*, *Ochrolechia* or *Baeomyces*. Sp. 2 celled, 9-15 µm long. Asci covered above with gelatin caps, which are colored intensive blue with I (*Dactylospora*) . **10**

9 On *Porphidia glaucophaea* (↑). Ap. -0.5 mm. Sp. 15-20 x 7-9.5 µm, rather long time colorless. Epihym. and hyp. light brown to brown . **Karschia santessonii** Haf.

9* On *Diploschistes scruposus* (↑). Ap. -0.6 mm. Sp. 11-17(19) x 6-8(9) µm. Epihym. and hyp. brown **Karschia talcophila** (Ach. ex Flotow) Körber

10 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

10* Sp. 2 celled, 4.5-7 µm wide. Hyp. light to yellow brown. Ap. -0.8 mm **11**

11 On rock dwelling yellow-whitish to yellowish crustose (*Pertusaria*, above all *amarescens, flavicans*, mostly C+ orange, UV+ yellowish to orange). Epihym. brown, K- .
Dactylospora saxatilis (Schaerer) Haf.

11* On soil- and rock dwelling *Baeomyces rufus.* Epihym. red-brown, K+ giving a purple solution .**Dactylospora athallina** (Müll.Arg.) Haf.

12 Lichens on soil, mosses, or plant detritus .**13**

12* Lichens on bark, wood, or rock **21**

13 Thallus ± citron yellow, ochre yellow. Sp. 2 celled **14**

13* Thallus whitish to gray. Sp. 2- or 4 celled **16**

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 µm. Arthothelin, Granulosin, (Dichlornorliche-xanthone), (Thiophanic acid) **Buellia thiopoliza**

14* Thallus citron yellow, C-, with Pulvinic acid derivatives, UV+ orange **15**

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. Epihym. 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 *Baeomyces*. Epihym. brown to olive brown .**Epilichen scabrosus (4)**

16 Sp. 4 celled, 23-24 x 9-13 µm. Thallus white, UV+ orange, KC+ orange. Ap. mostly non pruinose. Capistraton. On mosses over calcareous rock; arctic-alpine .**B. geophila**
(Flörke ex Sommerf.) Lynge

16* Sp. 2 celled **17**

17 Thallus brown, occasionally on rock mosses
B. badia (6)

17* Thallus white to gray . **18**

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**

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 . **20**

20 Sp. 18-24 x 8/10 µm. Thallus thickish, strongly unevenly papillose. Capistraton, (Atranorin) – Arct-alp . **B. papillate**
(Sommerf.) Tuck.

20* Sp. 22-32 x 9-13 µm. Thallus granular-warty. C+ yellow, P-/P+ yellowish. Atranorin, unknown substance **B. insignis**

21 Thallus sorediate **22**

21* Thallus not sorediate . **25**

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**

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. Alectorialic acid
B. pulverea
Coppins & P. James

23* Thallus KC- to + yellow(ish), C-, with fleck soralia, thin, often in the substrate and then only the soralia conspicuous **24**

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 thalloid collar, flat to concave, round to (on wood) elliptical or elongate, -0.4 mm, K-/+ yellowish, P-. Ap. very rare. Thallus whitish, of thin areoles or usually indefinite. Atranorin, Placodiolic acid **B. arborea**
Coppins & Tonsberg

25 Sp. 2-celled **26**

25* Sp. 4-celled to muriform **43**

26 Thallus on bark or wood. Epihym. brown **27**

26* Thallus on rock **31**

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 **28**

27* Sp. predominantly longer and wider. Ap. usually larger. Thallus K-, K+ yellow or red. Hym. without or with oil droplets **29**

28 Sp. 7-10(11) x 2.5-4(4.5) 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. Exc. 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**

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 **38**

31* On silicate rock **32**

32 Thallus greenish-yellow, gray-yellow, or pale yellow . **33**

32* Thallus without yellow tint . **36**

33 Thallus areolate, with elongated marginal areoles, yellowish to yellowish-white, in the region C-, P+ yellow 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**

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**

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), exc. 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 . **37**

36* Ap. sessile . **41**

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**

38 Thallus K+ yellow, then (yellow)red (crystals in the medulla) . **39**

38* Thallus K- or K+ yellow **40**

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 . **B. aethalea (39)**

40* Thallus K= light yellow, cracked to flat areolate, white, gray-white, with Atranorin, 2'-O-Methyl-pertalotic 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-. mieur-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**

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

B. leptocline

42* Sp. narrower, 9-15 x 4.5-6.5 µm. Thallus granular to cracked, K+ intensive yellow to orange (red). Ap. permanent narrow margin, flat to convex, -0.6(1) mm. Atranorin, Stictic acid, ± Norstictic acid. Lichens often parasitic on *Lecidella carpathica* . **B. spuria (39)**

43 On bark **44**

43* On rock. Completely insufficiently known species group . **45**

44 Sp. 2-, very rarely 4-celled. Hym. with oil droplets. Ap. nonpruinose, sessile ↑ **B. disciformis (30)**

44* Sp. 4-celled to commonly weakly muriform when ripe, 13-23 x 6.5-11 µm. Ap. usually whitish pruinose, thereby appearing whitish to bluish, without or above all when young with (sometimes crenate) thalloid margin, -1.2 mm. Thallus gray-white, gray, coherent to cracked or warty areolate, with smooth or rough upper surface, Ch- **B. alboatra**

45 Thallus when young parasitic on *Caloplaca* sp. and *Xanthoria elegans* and related thalli, indefinite to white, areolate to warty areolate. Ap. ± pruinose, thick margined, eventually convex marginless. Sp. 16-26 x 6-11 µm . **B. nivalis** (Bagl. & Car.) Hertel (*B. margaritacea* ("Sommerf.") Lynge)

45* Thallus not parasitic **46**

46 Sp. 4-celled, very rarely with a single elongate wall (or parallel -6celled), 14-22(25) x 6-10 µm, straight to often curved. Thallus on limestone, white. Ap. pruinose, -1.5 mm **B. epipolia s.l.**

46* Sp. 4-celled to commonly sometimes (ripe) with single elongate wall **47**

47 Thallus commonly on basic or slightly calcareous silicate rock, roof tiles, usually thin, cracked, "often thinning out" at the margin, white to white gray. Medulla usually K+ yellow to partly red, I+ blue or I-. Ap. disk nonpruinose to weakly pruinose, flat, sunken to depressed, often with "thalloid margin". Sp. 4-celled to muriform, 15-20(25) x 7-11 µm **! B. porphyrica**

47* Thallus commonly on limestone and mortar, gray-white, gray, coherent to cracked or warty areolate, with smooth to rough upper surface. Medulla K-, I-. Ap. without or above all when young with (sometimes crenulate) thalloid margin, -1.2 mm, almost always whitish pruinose. Sp. 13-23 x 6.5-11 µm . **B. alboatra**

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 Umbilicarion cyl., Acarosporetalia 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, süHü-HRh, *nöHü, 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., 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 fuscocin.* (↑) 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-smed-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

LIT.: HAFELLNER 1979, MIGULA 1929-31, POELT 1969, SCHAUER 1965, SCHEIDEGGER 1987, 1988, 1993.

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. Asci 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

on young trees, on very humid cool in part also late occurring frost occurring habitats, oceanic in reference to the moisture conditions, r.acidoph., m.photoph., anitroph., usually only with *Hypogymnia phys.* – mieur-subatl-med, oc – v.rare (0); *süSch (Schramberg), Ju (Schörzingen, Ehingen), Ne (Trillfingen), Do-Av* (repeatedly)

LIT.: PURVIS ET AL. 1992, SANTESSON 1952

Calicium Pers.

Introduction

The genus *Calicium* numbers only the group of coniocarpic or dust fruited lichens (goblet lichens). As fir 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 yellow-green 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 over-hanging 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. glaucellum* 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-, Rhizocarpic acid . **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 yellow (-greenish) pruinose (contains Vulpinic acid when ripe). Ap. -1 mm high . **5**

4* Ap. capitulum not yellow (-greenish) pruinose . **6**

5 Thallus usually clearly developed, warty to almost squamulose-scurfy, gray to yellowish-gray, K+ red, P+ 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. Mazaedium 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**

6* Capitulum underside whitish pruinose or black **8**

7 Thallus usually clearly developed, warty to granular, yellow-green to green. Ap. -3(4) mm high. Sp. 11-13.5 x 6-7 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, bluish-green, even yellow- green to whitish, Ch- **C. lenticulare**

8* Stalk and exc. I- . **9**

9 Ap. capitulum underside or/and margin whitish pruinose **10**

9* Ap. capitulum not pruinose . **12**

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 (13)**

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**

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**

12* Ripe asci cylindric, sp. single series. Thallus lacking or indefinite. Ap. stalk and capitulum margin indefinite . **14**

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** Tibell

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 (7)**

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), Hü, 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 *Haematomma 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. – bor-med-mo – r.rare (3); above all in the mountains, in the hilly zone v.rare to lacking and regressing because of eutrophication of the habitats

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.
Rather like *C. adspersum* (↑), *Chaenotheca phaeoc.* (↑) – *(s'bor-)mieur(-med-mo) – v.rare (0);* nöRh, Ts, Ju

Calicium salicinum Pers. (C. sphaerocephalum auct.)
Up into the montane, rarely high montane zone, like *C. glaucellum* (↑), in higher sites above all on hard, tough decayed wood of deciduous and conifer trees, char. Calicion hyp. – bor-med-mo – r.rare (-m.frequent) (3); most frequent species of the genus, throughout the entire region, above all Sch. Vog, PfW, RhSch, Sp, Ne (northeast), v.rare in dry-warm hilly sites

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 forests as well as on free-standing, rather windy trunks, on moderately rainy to rain protected, cool to cold habitats, r.-v.acidoph., r.phtotindiff., 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)

LIT.: TIBELL 1975, 1977, 1984*, TIBELL IN POELT & VÉZDA 1981, VAINIO 1927

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 calciphytic rock lichens *C. citrina, C. decipiens, C. coronata,* and *C. ruderum.* In addition *C. alociza, C. arnoldii, c. aurantica, C. chalybaea, C. cirrochroa, c. dolomitica, C. flavescens, C. granulosa, C. holocarpa, C. lactea, C. ochracea, C. polycarpa, C. saxicola, C. variabilis* and identified from the Allgäu *C. nubigena* and *C. percrocata* 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. xantholyta*.

Silicate rock "favoring" *C. arenaria, C. atroflava, C. crenularia,* the *C. grimmiae* living as a parasite on *Candelariella vitellina* as well as *C. irrubescens, C. obliterans, C. scotoplaca,* 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. tiroliensis (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. tetraspora,* 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 south 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. dolomiticola, 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. grimmiae* 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,

sometimes with soralia or isidia. Upper side in the case of the species with strongly developed thallus ± paraplectenchymatous cortex. Photobiont *Trebouxia* like. Ap. yellow to orange-red, orange-brown or rarely black, either with thalloid margin or with proper margin, rarely with proper- and thalloid-margin. Exc. proprium, when thallinum developed next to a definite exc. it is usually thin and developed toward the top, of parallel hyphae, but also very strongly developed , colorless, colored exterior. Hyp. colorless. Epihym. generally thick covered with yellow-brown to orange-brown crystals, K+ violet-red. Paraphyses simple to branching, septate, usually thickened above. Asci clavate, of the *Teloschistes* type. Sp. ellipsoidal, with 2, rarely 4 bored-through septa bound cells (in one nonindigenous species 1-celled). Pycnosp. ellipsoidal. Ch: Species with yellow to orange-red thalli/ap. with anthraquinones (above all Parietin = Physcione) and K+ violet-red.
The greater part of the *Caloplaca* species are by reason of their want of diagnostically easily comprehensible characters still insufficiently known. This affects, for the most part, the species with pure crustose thallus on rock. Many species occurring in the region are at this time not definable and are not presented here.

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-isidiate. Ap. very rare, gold-yellow to orange, narrowly sessile. Above all in rock fissures of calcareous rock. Alpine – Al **C. epiphyta** Lynge (*C. bryochrysion* Poelt)
1* Thallus not sorediate **2**
2 Sp. with very thin (1-2 µm) septum, narrowly ellipsoidal to fusiform. Thallus ± yellow, K+ red . **3**
2* Sp. with thicker septum. Thallus K- **4**
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**
4* Ap. margin not whit-gray to blackish, disk color relatively little different, K+ red . **7**
5 Ap. rust red, the young with thick, often partially thallus colored margin see **C. ammiospila**
5* Ap. light yellow, orange, orange-red, red-brown, even dirty olive, remaining flat with raised margin, -1.5 mm. sp. 10-16 x 6-8.5 µm (*C. cerina*) . **6**
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 . **8**
7* Ap. light yellow, yellow- to red-orange, with age also olive-black, flat, with thin margin . **9**
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. 13-17.5 x 6.5-8 µm. Thallus white-gray, thin, uneven to granular **C. ammiospila**
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 **2**
1* Thallus without soredia or isidia **9**
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, scruffy-granular to finely isidiate, Alps)

2* thallus sorediate . **3**

3 Thallus and soralia gray-white, gray, greenish-gray, greenish to blackish-gray, K- . **4**

3* Thallus or soralia yellow, ochre-yellow, orange, at least the soralia K+ red . **6**

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.) Coppins: 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 ± eutrophic base of deciduous trees, above all ash and hornbeam, e.g. Sch, Ju

4* 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**

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* . **C. ulcerosa** Coppins & P. James

5* Thallus light to dark gray, green 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 . **C. obscurella**

6 Thallus becoming sorediate, soredia ca. 30-50 µm thick. ap. yellow-orange, with thin thalloid margin . **C. citrina**

6* Thallus with bordered soralia **7**

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 . **C. lucifuga**

7* Thallus ± clearly developed, light yellow, yellow-gray, yellow-green, orange. Ap. often lacking . **8**

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. **C. chrysophthalma***

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 . **C. citrina**

9 Ap. with clearly developed, long remaining whitish, gray to almost black thalloid margin . **10**

9* Ap. margin yellow, orange, orange-red, K+ red **14**

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 . **C. assigena**

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**

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* Dish not pruinose, not olive tinged . **12**

12 Disk brown-red, concave to flat. Thallus dark gray to blue-gray, ± warty areolate to almost granular. Ap. -1 mm, crowded. Sp. 11-14 x 5-8 µm. Very rare mediterranean species . **C. haematites**

12* Disk yellow, orange, red-orange, red-brown. Thallus light to dark gray, gray-black, green- gray **13**

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 . **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** Vèzda: 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 thalloid margin. Hym. below and the hyp. conspicuous turbid because of numerous oil droplets. Sp. 15-18 x 6-10 µm, septa 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: **C. lobulata)**

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**

15 Ap. margin yellow **16**

15* Ap. margin orange, brown-orange, orange-brown, rust red . **18**

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**

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 thick standing, long time flat, rounded to usually wavy in outline, clearly and often irregularly margined. 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**

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 thalloid margin), flat to convex and finally marginless, numerous, close standing. Sp. elongate. Paraph. ends thickened, 4-5 µm. Hym. 60-75µm. 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. Epihym. K+ violet or K- **2**

1* Ap. yellow, orange, rust red, brown (or lacking), K+ intensively (violet) red . **5**

2 Thallus ± in the rock (endolithic), indefinite. Ap. flat to moderately convex, without thalloid margin, with or without thin proper margin, sunken in the rock or more rarely ± sitting up, pruinose or nonpruinose. Epihym. K+ violet. Sp. 11-21 x 6-11 µm, septum thin, -3 µm . **C. aloziza**

2* Thallus not endolithic, usually clearly developed. Ap. not sunken into the rock **3**

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, epihym. commonly K+ reddish, then violet. Ap. whitish to blue-gray pruinose on nonpruinose . **4**

4 Ap. sunken into the thallus to half sunken, with often rather indefinite thalloid 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 thalloid 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 **6**

5* Not living on other lichens **11**

6 On silicate lichens. Without its own definite thallus . **7**

6* On calcareous lichens. (*C. dolomiticola* group) **9**

7 On yellow crustose lichens (*Candelariella vitellina/coralliza*) on sunny habitats. Ap. disk

cinnabar- to dark red or brownish-red, usually flat, ap. margin lecanorine, light to blackish-brown, ap. -1(1.3) mm, single or in groups. Sp. 10-12(13) x 6-6.5 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**

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. epithallina** Lynge

9 On endolithic *Verrucaria* species. Thallus thin or lacking. Ap. -0.6 mm, orange, with border **10**

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***

10 Thallus indefinitely (endolithic), "on" *Baglietoa parmigera* 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-rosetted, elongated areoles or indefinite lobules, on *Verrucaria calciseda*. Ap. orange to orange-red. Sp. 9-15 x 5-8 µm . **C. polycarpa**

11 Thallus yellow, orange, red, brown-yellow, K+ violet-red . **25**

11* Thallus not so colored, clearly developed or lacking, K- or K+ slightly violet colored, rarely fleck-like K+ weakly violet-red (!: the K-reaction yellow to red often depends upon the color of bordering thallus part!) . **12**

12 On calcareous rock and calcareous anthropogenic substrates (concrete, mortar etc.) . **13**

12* On silicate rock **16**

13 Thallus very clearly developed . **14**

13* Thallus indefinite or very thin **15**

14 Thallus rosetted-roundish, sometimes appearing lobed, with exception of the region of the margin scruffy-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 **C. teicholyta**

14* Thallus thick, cracked (-areolate), clearly bordered, but not appearing lobed, not scruffy-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. erythrocarpa**

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 ¼ 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-scruffy ± 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 scruffy-granular . **17**

17 Margin of the ap. clearly colored other than the disk, not yellow, orange, or red . **18**

17* Margin of the ap. usually rather similar colored to the disk, yellow, orange, rust red, or olive . **21**

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**

19 Thallus throughout with granular upper surface, gray, dark gray, scruffy to cracked areolate. Disk rust red, with definite, often lighter proper margin, often with exterior deposited light gray to gray thalloid margin. Ap. -1.5 mm. Ecology like *C. teicholyta* **! C. albolutescens**

19* With other characteristics. Ap. with thalloid margin . **20**

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. 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 . **22**

21* Thallus definitely developed. Paraph. ends only slightly thickened (2-3(3.5) µm) . **23**

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 thalloid margin), flat to soon moderately convex and finally marginless, numerous, close-standing. Sp. 10-16 x 5-8 µm, septum 2.5-5 µm, ¼ -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 syanthropic 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. caesiorufella** (Nyl.) Zahlbr. (*C. letpocheila* 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**

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. crenularia**

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. atroflava***

25 Thallus lobed (placoid) at the margin . **26**

25* Thallus not lobed at the margin **38**

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**

27 With soralia or ± spherical isidia. Ap. rare **28**

27* Without soralia or isidia, usually with ap.; ap. above all in the center part of the thallus **32**

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**

29 Thallus disintegrating sorediate in the center and citron- to light yellow, at the margin with narrow (up to 0.5 mm wide) radiating lobules ↑ (**C. cirrochroa 31**)

29* Thallus with small bordered soralia, usually -2 cm wide **30**

30 Thallus with lip- to capitate 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 . **31**

31 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**

31* 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**

32 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. aurantia* s.l.) **33**

32* Sp. not bulging outward in the region of the dividing wall, ellipsoidal. Thallus scarcely over 2.5 cm . **34**

33 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. aurantia s.str.**

33* 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**

34 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**

34* Thallus surface attached to the substrate, only the upper side corticate **35**

35 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)**

35* Thallus lobes more robust, wider. Not parasitic . **36**

36 Ripe spores broadly ellipsoidal, 9-16 x 5-9 µm (Sp.) Sp. septa at most ¼ 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. Difficultly addressed, rare species . **C. biatorina**

36* Sp. elongate to (narrowly) ellipsoidal . **37**

37 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 ¼ to 1/3 the length of the sp. Difficult to separate from *C. saxicola*-forms **C. arnoldii**

37* 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)

38 Thallus with bordered soralia or uniformly leprose, i.e. consisting of fine granules . **39**

38* Thallus not sorediate, not granular or "mealy" **46**

39 Thallus with bordered fleck soralia **40**

39* Thallus continuously with mealy, granular or finely isidiate upper surface **41**

40 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**

40* 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**

41 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 . **42**

41* 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 **44**

42 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**

42* Without corticate thallus part . **43**

43 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**

43* 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**

44 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 thalloid margin, -1 mm. Sp. 10-15 x 5-6 µm **C. citrina**

44* Thallus not typically sorediate **45**

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 . **C. ruderum**

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. coronata**

46 On silicate rock **47**

46* On lime-rich rock, mortar, concrete **51**

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. rubelliana**

47* Thallus not gray-rose to cinnabar red . **48**

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 . **! C. crenulatella**

48* Septum thicker . **49**

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**

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 . **C. irrubescens**

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 **C. flavovirescens**

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 **C. ochracea**

51* Sp. 2-celled **52**

52 Septum very thin. Lichens usually on mortar . **C. crenulatella (48)**

52* Septum thicker, ¼-1/2 the sp. length . **53**

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 **C. flavovirescens**

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. -1mm, 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. dolomiticola s.l.*) . **54**

54 Living on endolithic *Verrucaria* species, small, -1.5 cm . **10**

54* Not on endolithic *Verrucaria* species . **55**

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 . **C. inconnexa (9)**

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. dolomiticola**

Ecology and Distribution of the Species

Caloplaca albolutescens (Nyl.) Oliv.
Like *C. teicholyta* (↑), 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. & Sarnth. (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 Räsänen) 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 NH_4^+-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-

smed-mo/alp – v.rare (R); süSch (Utzenfeld), *Lahn (Runkel)*, FrJu, Al

Caloplaca coronata (Krempelh. 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 synathrop, 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 rousting places, on overhangs of limestone) rare, optimal on well lighted warm habitats, basiph., xeroph., (m)r.-v.photoph., toxitol., Char. Caloplacion dec. – (s'bor-)mieur-med(mo), (subko) – frequent, relatively rare in silicate regions

Caloplaca dolomiticola (Hue) Zahlbr. (C. velana auct.)
On carbonate rocks on well lighted habitats, rather like *C. variabilis* (↑), *Lecidella stigm.* (↑), above all Aspicilion calc., rarer Caloplacion dec. –mieur-med – moderately frequent in limestone regions, but apophytic

Caloplaca erythrocarpa (Pers.) Zwackh (non auct., C. lallavei (Clem. ex Ach.) Flagey)
In warm, winter-mild, (r.) low precipitation, hilly sites on calcareous rock, above all on dolomitic limestone, limestone, calcareous sandstone, e.g. on boulders in dry turf, like *Aspicilia calc.* (↑), but in need of warmth, Char. Aspicilietum calc. – s'mieur-subatl-med – v.rare; Saar (1)

Caloplaca ferruginea (Hudson) Th.Fr.
Up into the montane zone, above all in mild climate sites on mostly smooth to flat-cracked subneutral, often mineral-rich bark of open to free standing deciduous trees (field trees, or roadways), subneutroph., r.photoph., a-/m.nitroph., e.g. in the Parmelietum ac. – bor-subatl-med – v.rare (0); süSch. SJu, Al, *süRh*, nöPf, *nöHü, O, Ne, Ju, Fr*

Caloplaca flavescens (Hudson) Laundon (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 rousting 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. aurantia*, 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 flavorubescens (Hudson) Laundon (C. aurantiaca (Leightf.) Th.Fr. auct. p.p.)
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.)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 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. coralliza* (↑) 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 Parmelietum 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-/r.nitroph., in the Xanthorion par., Caloplacion dec., in *Xanthoria elegans* stands – arct-med – frequent (epiphytically rare)

Caloplaca hungarica H.Magn. (C.subathallina 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 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 (Schaerer) Flagey
(Xanthocarpia o. (Schaerer) 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-subatl-med0mo – (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.)
Up into alpine sites on lime rich to weakly calcareous rock above all on vertical surfaces and overhangs, mostly on dry ± sunny, but also shaded, humid habitats, rarely also on dust impregnated wood, r. euryök, like *C. decipiens* (↑), yet its high point on less to strongly eutrophic sites and even going over to nutrient poor substrates, also on cool sites, less frequent than *C. decipiens* on anthropogenic substrates, here more (as well as less strongly competitive) on compact, relatively hard rocks than on mortar, basiph., m.-v.photoph., m.ombroph.-anombroph., m.-r.(s.) nitroph., Char. Calopacetum sax., Caloplacion dec. – bor-med – r.frequent (synathrop in regions without calcareous rocks)

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.-m.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., Lecidelletum 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 (1); 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, Ju, FrJu, Al, MRh, süHü

LIT.: CLAUZADE & ROUX 1985, FRIES 1871-74, KÄRNEFELT 1989*, LAUNDON 1974, MAGNUSSON 1944, MIGULA 1929-31, NORDIN 1972, OZENDA & CLAUZADE 1970, POELT 1954, POELT & HINTEREGGER 1993, PURVIS et al. 1992 WUNDER 1974

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.* (↑), Char. Xanthorion par. – s'bor-med(mo) – r.rare (3); above all Ju, süHü, süRh-HRh, süSch, SJu, Ne, Bo, Av, but rare, in intensively agricultural regions and regressing in industrial regions

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 . **C. medians**
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 . . **4**
3 On silicate rock. Thallus of thickly crowded, at first hemispherical, then elongated, cylindric to coralloid segments (side view of broken of areoles). Ap. rare. Sp. 10-14 x 4.5-6 µm. On dunged silicate rock . **C. coralliza**
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 **C. kuusamoensis**
4 Ap. lacking. Thallus erupting sorediate or throughout fine granular to mealy **5**

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. xanthostigma**

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. viae-lacteae**

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. xanthostigma**

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 Caloplacion 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 caesiocinerea* (↑), 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.nitroph., e.g. often with *Normandina* – 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 – mieur-med – v.rare (0); süSch (+?), SJu, Al

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 Physcietalia 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

Thallus crustose to endolithic, sometimes parasitic; many species lichenicolus fungi. Photobionts coccoid green algae. Ap. black to brown-black, rarely red-brown. Exc. carbonaceous-black to light colored and exterior strongly pigmented. Hyp. colorless to brown-black, orange, blue-green, etc. Epiphytic mostly blue-green to green. Paraphyses simple to branching and bound, thickened above. Asci clavate, *Lecanora* type. Sp. 1- to 2-celled. Pycnosp. long thread-like. Ch- or Atranorin, depside, Depsidone and others.

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 Aspicilietalia gibb. – bor-atl-mieur-subatl-smed – 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 – Al

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, oceanic sites on open and ± wind open metamorphic and magmatic silicate rocks, probably parasitic on crustose lichens, like e.g. *Schaereria cinereorufa* (↑), m.-r.acidoph., v.ombroph., 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., Nesolechia v. (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

Carbonea vorticosa (Flörke) Hertel (Lecidea v. (Flörke) Körber)
In high montane and alpine, high precipitation sites on mineral rich silicate rocks (e.g. basalt, slate), rarely on lime leached limestone, on mostly lower, m.-r. exposed rocks and boulders on well lighted, cool to cold, m.-r long snow covered habitats, subneutroph.-m.acidoph., v.ombroph., anitroph. – arct-h'mo/alp – rare (3); süSch, Vog, BayW, Erz, Al, v.rare Rhön

LIT.: FRIES 1874, HERTEL 1983, TRIEBEL 1989.

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 involucrellum. Hym. I+ yellow-orange to reddish, rarely bluish-green, K/I+ blue. Paraphyses lacking in ripe per. Periphyses predominantly simple. Asci thin walled, clavate to elongate cylindric, without tholus, wall I-, exterior with thin amyloid gelatin layer. Pycnosp. short cylindric to cylindric or elongate ellipsoidal. Sp. 1-celled, ellipsoidal. Ch-.

1 Per. sitting between the thallus squamules, not sunken, with carbonaceous invol. Squamules ± crustose coalescing, very small, -1(1.5) mm, thin (mostly 100-200 µm thick) **2**

1* Per. sunken into the thallus squamules, without invol . **3**

2 Thallus squamules with blackish paraplec-tenchymatous lower cortex. Exc. brown to black-brown, surrounded by a ring-like carbonaceous involucre. 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 carbonaceous involucre 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 **C. cinereum**

3* Squamules possibly pruinose in places . **4**

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 cylindric, sp. single series **7**

5 Squamules finely crenate to deeply crenate lobed, usually whitish pruinose, often dark bordered, usually coalescing, ± compressed. Lower cortex blackish, paraplectenchy-matous. Sp. 17-23 x 6.5-8.5 µm **C. cinereum**

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**

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 gray greenish. Lobe ends often flecked gray to violet gray pruinose **C. psoromoides**

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) **C. daedalum**

7 Per. wall dark, 20 µm thick below. Sp. 11-15 x 5-6 µm. Squamules 1-4 mm large, thin, -250 µm, closely attached, light to dark brown, dull, undersides blackish . **C. michelii**

7* Per. wall colorless, over 20 µm thick **8**

8 Squamules covered with very fine colorless hairs at the margin . **C. pilosellum (12)**

8* Squamules not hairy at the margin . **9**

9 Thallus attached directly to the rock, robust, leathery, brown to dark brown or red-brown, dull or mostly shiny, usually wavy curved. Squamules 6-10 x 3-5 mm in size, 350-600 µm thick, margins commonly somewhat raised. Sp. 15-20 x 7.5-9 µm, often empty and deformed. Pycn. sessile on the margin . **C. rufescens**

9* Thallus on soil or on soil encrusted rock **10**

10 Squamules very robust, (300) 350-600 µm thick. Medulla hyphae almost exclusively with long cylindric lumina . **11**

10* Squamules thin, 200-400 µm thick, 2-6 mm broad. Medulla hyphae with numerous spherical lumina. Sp. 12-17 x 5.5-7.5 µm **12**

11 Sp. 14-17 x 6-8 µm. Squamules 2-7 mm, middle to mostly dark (red) brown, dull, often with bulging margin **C. lachneum**

11* Sp. 15-20 x 7.5-9 µm. Squamules mostly 6-10 mm, middle to dark brown to red-brown * **C. rufescens (9)**

12 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**

12* 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.-(m.)basiph., photoph., xeroph., e.g. in Toninion sed. – arct-med-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 SiO_2 poor silicate rocks); neutroph.-basiph., photoph. -- arct-mieur-alp(-med-alp) – v.rare; *Al,* Vog

Catapyrenium michelii (Massal.) R.Sant.
(Dermatocarpon m. (Massal.) Zwackh)
On fine soil and loess, like *C. squamulosum* – mieur-smed – 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. & Sarnth.)
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 Toninion 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 cylindric 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-.

1 On garden soil, humus, plant detritus, moss . **2**
1* On rock, bark, wood, living on conifer needles . **6**
2 On naked mineralized, sandy-loam to loamy soils. Ap. convex to hemispherical, marginless, black, -0.6 mm. Epihym. and hyp. dark purple-brown, hym. purple. Exc. dark purple, soon reduced. Sp. 1-2 celled, 9-15 x 3-4(4.5) µm. Paraph. branched in the upper part. Thallus very thin flowing, scattered or warty areolate, blue greenish. Saxony .
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**
3* Hyp. red-brown to black-brown **5**
4 Sp. 10-17 x 4-5 µm, with definite epispore, 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. Epihym., hym., hyp. 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 . .
Mycobilimbia sphaeroides
4* Sp. smaller. Ap. convex. Paraph. branched and reticulate. Exc. mostly strongly reduced, paraph. hyphae like ↑ **Micarea**

5 Ap. marginless from the first. Exc. reduced, of paraph. like hyphae . ↑ **Micarea**

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. Epihym. 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- . **Mycobilimbia hypnorum**

6 On rock **7**

6* Not on rock **17**

7 On silicate rock. Paraph. simple to strongly branched . . **8**

7* On limestone. Paraph. simple, only occasionally short branched above. Thallus R-, Ch- **10**

8 Paraph. only little thickened above, frequently branched and reticulate (KOH), cemented. Exc. of paraphyses like hyphae. Ap. marginless (*M. subnigrata, M. prasina, Carbonea intr.*) ↑ **Micarea**

8* Paraph. strongly capitate thickened above (6 µm) and dark colored (with sharply bordered dark brown cap), occasionally short branching only above. Ap. with margin. Epihym. dark brown to (olive)black. Exc. clearly developed. R-, Ch- . **9**

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 . **C. atomarioides**

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. chalybeia**

10 Paraph. only little thickened above (-3 µm), weakly colored. Thallus indefinite R- **11**

10* Paraph. strongly capitate thickened above, -6(8) µm . **12**

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 shrunken 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 . **13**

12* Hyp. red-brown to brown-violet, (usually also the epihym. and exc.) K± purple-violet. Ap. black (even when moist) . **15**

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. Epihym. 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**

14 Paraph. cemented, without sharply delimited brown pigment cap. Pigment in the epihymenium 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 brown-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, epihym. black-green, often abraded. Sp. 9-13.5 x 3.5-5.5 µm. Ap. 0.3-0.5(1.5) mm, ± 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. Epihym. olive-brown to greenish-black . **16**

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. light colored, whitish, yellowish, rose-brown, brown . **18**

17* Ap. dark brown to black **26**

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, epihym. very pale. Sp. 10-15 x 3-

5 µm, often shrunken at the septum. Thallus scurfy- granular to mealy, pale greenish, Ch-
Fellhanera bouteillei

18* On other substrates **19**

19 Ap. with raised margin for a rather long time, flat for a long time . **20**

19* Ap. completely marginless or not a raised margin or margin very rapidly disappearing **22**

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 µm. Algae *Trentepohlia* . see **Dimerella pineti**

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 µm. Atranorin . **21**

21 Ap. lead gray, rose-gray, brownish to blackish, -0.8 mm. Epihym. rather light or dark, then K+ violet. Pycn. -0.2 mm. Roccellic acid .
Cliostomum griffithii (30)

21* Ap. pale yellow to (rose)yellowish (in the herbarium even darker yellow), 0.5-1.0 mm, at first thick margined, concave to weakly convex, often lacking. Thallus warty to almost lumpy areolate, whitish, yellowish gray, old herbarium specimens often ± ochre, pycn. 0.25-0.5 mm, projecting. Usnic acid in the ap
. **Cliostomum corrugatum**

22 Ap. often with pale margin, disk rose-brown to yellow-brown, weakly convex. Paraph. branched, reticulate. Sp. 9-16 x 3-5 µm. Thallus pale greenish to green-gray, with apothecia like structures having pycnosp. Pycnosp. 6-10 x 2-3 µm . **Micarea adnata**

22* Ap. without lighter margin. Without apothecia like containing whitish pycnosp **23**

23 Ap. brown-rose, orange, rose-yellowish, yellowish, beige, 0.5-1 mm. Sp. 11-17 x 4-5 µm. Epihym., hym, hyp. and exc. colorless to slightly yellowish
Mycobilimbia sphaeroides (4)

23* Ap. smaller, -0.4 mm . **24**

24 Ap. whitish, yellowish, yellow-brown, reddish-yellow, ochre. Thallus R- **25**

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 µm . ↑ **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 µm. Ap. whitish to (old) pale ochre, ± pruinose, hemi-spherical to almost spherical. Epihym. pale yellowish, with the finest crystals throughout (in K solution). Asci (1-)2 celled (6.5)8-10(11.5) x 2.3-3 µm **C. alba**

25* No white, pruinose pycn. occurring. Ap. pale yellowish, yellow-brown to reddish-yellow. Thallus indefinite. Exc. clearly developed. Epihym. pale. Sp. 8-15 x 3-5 µm **C. erysiboides**

26 Ap. marginless from the first . **27**

26* Ap. at least at first clearly margined and ± flat, later even convex marginless . **28**

27 Exc. clearly developed, swollen, as though paraplectenchymatous. Paraph. simple (generally only slightly branched above), often strongly capitate. Ap. brown-black to black, 0.2-0.6 mm. Epihym. gray, brown, olive, green-black, K± greenish. Hyp. light. Sp. 8-15 x 2-3 µm. 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 capitate. Epihym. often violet. Commonly on wood, see *Micarea (denigrata, misella, elachista)*

28 Sp. 20-30 x 10-15 µm, 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. Epihym. dark green. Hym. 120-140 µm. Thallus very thin, with (often incorrectly identified) *Trentepohlia* algae. Ch-
. **Megalaria grossa**

28* Sp. clearly smaller . **29**

29 Sp. 2-3.5 µm wide, elongate **30**

29* Sp. at least 3.5 µm wide, ellipsoidal, rarely fusiform **32**

30 Paraph. not capitate 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 epihym. K± violet, at first concave, later flat to moderately convex, 0.4-0.8(1) mm. Pycnosp. 3.5-4 x 1.5-2 µm. Atranorin, Roccellic acid
Cliostomum griffithii

30* Paraph. strongly capitate thickened. Thallus generally thin, Ch- . **31**

31 Paraph. cemented, not easily freed by pressure, without sharply delimited pigment cap. Sp. 8-15 x 2-3 µm, 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) µm. 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**

32* Hyp. colorless to pale brownish **35**

33 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, dark 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-celled, rarely 2-celled, (8)10-15 x 3.5-6 µm. Ch- . **Mycobilimbia sanguineoatra**

33* 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 . **34**

34 Thallus thin, not sorediate, pale yellowish, P-, C- . Epihym. dark purple-brown to blackish blue-green(-violet), K+ red-violet. Hym. colorless or ± red-violet. Sp. 12-17 x 6-8 µm. Ap. flat to slightly convex **Megalaria laureri**

34* Thallus with granular, often coalescing soralia, usually for the most part erupting sorediate granular, finally producing a cracked areolate sorediate crust, gray with (blue)greenish tint, yellowish-green to whitish, K+ yellow, P+ rust-red, C-, KC± yellow. Epihym. dirty bluish to dark green, K+ green. Hyp. colorless to light brown, K- (ap. rare). Sp. 10-19 x 4.5-6.5. Atranorin, ± Zeorin, Fumarprotocetraric acid .**Megalaria pulverea**

35 Sp. 8-16 x 2.5-4 µm. Ap. rose-gray, gray-brown, brown to blackish, often slightly pruinose, if dark, then epihym. K± 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 .**Cliostomum griffithii (30)**

35* 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. Ch- **36**

36 Asci predominantly 12-16 spored. Sp. 9-13 x 5-6 µm . **Catinaria neuschildii**

36* Asci 8-spored . **Catinaria atropurpurea**

Ecology and Distribution of the Species

Catillaria s.str.

Catillaria atomarioides (Müll.Arg.) Kilias
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-shaded 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, *HRh*, *Ml*, 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- field- and garden trees, toxic tolerant, also endures eutrophication by dung emitted dust, e.g. even on green algae sites with *Scoliciosp. 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.l.

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-smed – v.rare (1); süSch (Säckingen)

Catillaria detractula (Nyl.) Oliv.

Usually on lime-rich rocks up into montane sites on sunny, warm habitats, basiph., photoph. – s'mieur-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')mieur-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 – mieur-med – rare; SJu-Ju-FrJu, süHü, Al

LIT.: KILIAS 1981, PURVIS ET AL. 1992, VAINIO 1934

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. Epihym. 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 (Schaerer) Vèzda & Poelt (Catillaria a. (Schaerer) 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

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, Pyrenese) 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

LIT.: HAFELLNER 1978.

Cecidonia Triebel & Rambold

(Determination ↑ Lecidea Pt 6)

Introduction

The genus includes lichen dwelling, gall producing fungi (at this time 2 species). *C. umbonella* produces small rounded white galls on the thallus of the *Lecidea lapicida* group. The arctic-alpine species is known in central Europe in addition to the Alps only from one site in the high Black Forest.

Genus Characteristics

Lichen dwelling, fungi producing galls in the thallus of the host. Galls white to light beige, -6 mm wide. Ap. black, with proper margin, disk often with navel. Exc. exterior carbonaceous black, interior lighter. Hyp. ± brown. Hym. with brown pigmented hyphal strands, I+ blue (to red). Epihym. (olive)-brown. Paraphyses reticulate, frequently branched. Asci clavate to subcylindric, tholus *Lecidea* like. Sp. 1-celled, ellipsoidal. Pycnosp. bacillar.

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

LIT.: TRIEBEL & RAMBOLD 1988

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.

LIT.: HERTEL 1967, KÄRNEFELT 1989*, KILIAS 1985

Cetraria Ach.

(Key includes Cetrelia, Cornicularia, Platismatia, Vulpicida)

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 (*Vulpicida*) 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. cuccullata/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. sepicola.*. *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. sepincola*. 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. sepincola* 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 turn. 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. sepincola* 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

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 paraplecten-chymatous or prosoplectenchymatous), coccoid green algae. Ap. ± marginal, brown to brown-black with thalloid margin. Hyp. colorless. Epihym. red-brown, brown, dark brown. Paraphyses branched, rarely reticulate bound, often thickened above. Asci ± clavate, *Lecanora*-type. Sp. 1-celled, ellipsoidal 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 . **2**

1* Thallus on bark or rock, foliose, decumbent or erect or small shrubby-cushion like . **8**

2 Thallus pale yellow-greenish to yellowish- white or strongly yellow, 2-4(5) cm high, medulla R- **3**

2* Thallus light to dark brown . . **5**

3 Thallus deep yellow, with yellow medulla, erect, not channeled. On wind exposed alpine calcareous turfs. Usnic acid, Vulpinic acid, Pinastrinic acid. – n'mieur-mieur-alp – Alpine **Vulpicida tubulosus** Schaerer) 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**

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 **6**

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 . **7**

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 **9**

8* On bark, wood, only exceptionally on rock (above all 13) . **11**

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**

10 Underside usually dark brown. Medulla K-, P-, C-, KC+ rose/KC-. Pycnosp. ellipsoidal to fusiform. Ch- or ± α-Collatolic acid, ± Alectoronic acid **C. commixta**

10* Underside usually dark brown to brown- black. Medulla K+ yellow to yellow-red, P+ yellow, C-, KC+ yellow-orange. Pycnosp. dumb-bell shaped. Stictic acid, ± Norstictic acid . **C. hepatizon**

11 Thallus upper side brown to dull olive, ascending. Medulla R-. Protolichesterinic acid .**12**

11* Thallus otherwise colored. Ap. very rare . **13**

12 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**

12* 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**

13 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, Vulpinic acid, Pinastrinic acid **Vulpicida pinastri**

13* Thallus pale yellow-greenish or gray, bluish-gray, brown-gray. Medulla white . **14**

14 Thallus yellow-greenish to pale gray-greenish, undersides whitish to light brown, K-, P-. Medulla R-. Usnic acid, Protolichesterinic acid. Rare montane/high montane species. Lobes -5 mm wide . **15**

14* Thallus gray, bluish-gray, on exposed sites even browned, undersides brown to black, with age also white, usually large, lobes 0.5-2 cm wide. Cortex K+ yellow. Atranorin **16**

15 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. oakesiana**

15* 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. * **C. laureri**

16 Thallus upper side without 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 *Pseudevernia* and *Hypogymnia physodes* . **Platismatia glauca**

16* Thallus upper side with fine white, scattered 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.*) . **17**

17 Medulla C-, KC- or KC+ rose, K-, P-. ± Perlatolic acid, ± Imbricaric acid. * **Cetrelia cetrarioides**

17! Medulla C+/KC+ rose-red, K-, P-. Olivetoric acid * . **Cetrelia olivetorum**

17* 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. (Cornicularia 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 Cladonietum 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

montane sites, e.g. in sunny calcareous turfs, here like *C. aculeata* (↑) – bor-mieur-mo/alp(-smed-alp) – v.rare (1); *Ju*, Sju, süSch, Vog, ThW, Erz, Rothaargeb., Hz, Al

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., Peltigeretalia (Char.) and others – arct-mieur(-med-mo) -r.rare (3); Al, Sch & Vog moderately frequent, Erz, BayW, Fr, r.rare Ju, FrJu, but rare to v.rare (e.g. Ts, Eif)

Cetraria muricata (Ach.) Eckfeldt (Cornicularia m. (Ach.) Ach., Coelocaulon 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 sepincola (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 – bor-mieur-mo(-smed-subalp) – rare (2); Sch, Vog, Rhön, BayW, Av; v.rare O, Sp, Ju, Hu, Eif, Sauerl, Erz.

LIT.: ANDERS 1928, HILLMANN 1936, KÄRNEFELT 1979, 1986 KÄRNEFELT & THELL 1993*, KÄRNEFELT ET AL. 1992, POELT & VÈZDA 1981

Cetrelia W.Culb. & C.Culb.

(Determination ↑ Cetraria)

Introduction

The *Cetrelia* 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

Thallus foliose, gray, blue-gray, even browned in places. Lobes broadly rounded, upper side with punctiform to elliptical pseudocyphellae, in the case of the indigenous species with border soralia, underside black, brown at the margin, with simple rhizines. Cortex ± paraplectenchymatous. Photobiont *Trebouxia*. Ap. central- to marginally located, disk brown to brown-red, usually perforated, with thalloid margin. Asci of the *Lecanora* type. Sp. 1-celled, ellipsoidal. Pycnosp. short bacillar, with slight swelling toward the ends. Ch: Cortex with Atranorin, medulla with depsides and depsidones.

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, soil 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. xyloxena* 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. Asci disintegrating early. Sp. 1-celled, spherical, brown to pale brown, rarely ellipsoidal to cylindric 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.

1 Ap. underside of the capitulum and the margin (greenish-)yellow pruinose . **2**
1* Ap. capitulum not (greenish-)yellow pruinose. Sp. spherical . **12**
2 Thallus bright yellow to green-yellow, R- . **3**
2* Thallus not bright yellow to greenish, Ch- . **5**
3 Thallus mealy, green-yellow to citron yellow. Ap. capitulum ± without margin, spherical, stalk extensively yellow pruinose. Ap. -2.7 mm high. Sp. spherical, 2-3 µm. Algae *Stichococcus*. On bark, moss, soil, rock. Vulpinic acid, Pulvinic acid. Pulvinic acid-Lactone **Ch. furfuracea**
3* Thallus not mealy, algae coccoid **4**
4 Thallus olive-yellow to green-gray, granular. Sp. cylindric. Ch- (Ap.: Vulpinic acid) . **Ch. laevigata (6)**
4* Thallus mostly bright yellow, coarse granular to warty areolate. Ap. capitulum clearly margined, not spherical, stalk only yellow pruinose above, otherwise black to brown. Ap. -1.3(1.5) mm high. Sp. ellipsoidal to almost spherical, 6-9 x 4-5 µm. Algae chlorococcoid. On bark. Vulpinic acid . **Ch. chrysocephala**
5 Sp. predominantly ellipsoidal to cylindric . **6**
5* Sp. predominantly spherical . **7**
6 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. Ap. stalk green-yellow pruinose. Thallus olive-yellow to gray-green, granular to warty, with chlorococcoid algae **Ch. laevigata**
6* 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 **Ch. chlorella**
7 Thallus indefinite, in the substrate . **8**
7* Thallus ± definite. Sp. 5.6-7.2 µm. Exc. and margin well developed. Ap. -1.3 mm high. Algae chlorococcoid **11**
8 Sp. 2.3-4 µm. ap. capitulum ± spherical to ± hemispherical or top-shaped. Algae *Trentepohlia* or *Stichococcus* **9**
8* Sp. larger. Algae *Trentepohlia* **10**
9 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 µm . **Ch. brachypoda**

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 µm. 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 µm. Exc. or margin well developed **Ch. hispidula**

10* Young ap. capitulum spherical and ± sessile, 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 µm. Exc. well developed **Sclerophora nivea**

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, coherent, brown-olive to olive-gray. Ap. capitulum conic to lens-form. Stalk 0.06-0.1 mm thick, usually only green-yellow pruinose above, even nonpruinose. Ap. usually somewhat more crude than the former **Ch. phaeocephala**

12 Thallus indefinite, in the substrate, possibly recognized by light gray flecks, usually wood dwelling. Ap. slender, -1.6 mm high . **13**

12* Thallus definite **17**

13 Sp. 3-4.5 µm thick, stalk black to light . **14**

13* Sp. 6-9 µm thick. Stalk pale yellowish, whitish, middle- to dark brown. *Trentepohlia* algae. Ap. -1.2 mm. Sp. very light, with colorless wall **16**

14 Stalk light brown. *Trentepohlia* algae. Ap. -0.8 mm, young capitulum pale yellowish, with age underside red-brown to slightly violet. Sp. 3-3.6 µm, very light, with colorless wall . **Sclerophora peronella (9)**

14* At least the basal part of the stalk black. Algae coccoid green algae or *Stichococcus*. Ap. -1.6 mm . **15**

15 Ap. capitulum and stalk nonpruinose. Stalk shiny black. Algae chlorococcoid. Capitulum spherical. Ap. -1.6 mm, sometimes with branched stalk and several capitula. Sp. 3.5-4.5 µm, brownish . **Ch. brunneola**

15* Ap. capitula underside and stalk strongly white pruinose in the upper part, base of the stalk black. Capitula conic. Ap. -1.5 mm. Sp. 3-3.8 µm. Algae *Stichococcus*. Ch- . **Ch. xyloxena**

(When ap. capitula and stalk nonpruinose, capitula conic, mostly relatively coarse, see *Ch. ferruginea* (17) with weakly developed thallus)

16 Ap. 0.7-1.2 mm high. Stalk light to dark brown. Young ap. often red-violet pruinose, old ap. underside strongly gray-white pruinose. Mazaedium later ± brown .**Sclerophora farinacea**

16* Ap. 0.4-0.8 mm high. Stalk whitish to light yellowish. Underside of the ap. pale yellowish to white. Mazaedium light brown, often white pruinose . **Sclerophora nivea (10)**

17 Thallus white-gray to gray-green, often partially or entirely yellowish-ochre 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 µm, 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**

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. brunneola* (15) with developed thallus.

18* Algae not spherical, but elongate to approaching rectangular, often in short chains (*Stichococcus*) . **19**

19 Sp. 2.5-3 µm, 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**

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 µm. Unknown substances . **Ch. stemonea**

20* Ap. capitula lens-form to conic to narrowly conic. Thallus Ch- **21**

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 µm **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, Al

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), Ml*

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, Ml

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 Calicion vir., e.g. in Chrysotrichetum cand. – mieur-med(mo) – v.rare (2); süH-HRh, süRh, Ju, Ne (above all Sb), Sp, O, *PfW, 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 Calicion 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 Calicion 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 nisches 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 Calicietum 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 xyloxena 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*

LIT.: TIBELL 1975, 1978A, 1980B, 1984*.

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 ± 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 *Mycocalicium* 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 µm, 1-celled **Ch. exserta**

1* On bark, wood, bark-dwelling crustose lichens or *Cladonia* . **2**

2 On crustose lichens or *Cladonia* . **3**

2* On growing on other lichens (or not recognizable **8**

3 On thallus squamules of red fruited *Cladonia* species. Sp. 2-celled, 6-10 x 2.3-3 µm. Ap. -0.7 mm high **Ch. parasitaster**

3* On crustose lichens (*Arthonia, Chaenotheca, Calicium*) **4**

4 Sp. 1-celled, 5-9 x 2.5-3.5 µm, 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-celed. On cup lichens (*Chaenotheca, Calicium*) with algae of the genera *Trebouxia* or *Stichococcus*. Ap. -1 mm high **5**

5 Stalk in squash preparations with greenish yellow tint, K+ purple (reaction rapidly disappearing). On wood-dwelling *Chaenotheca brunneola*. Ap. black throughout (rarely stalk brown at the base), capitula -0.4 mm wide. Sp. 5.5-9 x 2.2-3 µm, smooth – bor-med **Ch. pusiola**

5* Stalk in squash preparations K- or K+ greenish or brownish . **6**

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) µm, smooth . **Ch. pusilla (9)**

6* Sp. septum not lighter colored than sp. wall . **7**

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 µm. Epihym., 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 µm, 1-celled, finely ornamented. On bark of conifer trees **Ch. viridialba**

8* Stalk black to brown **9**

9 Sp. 1-celled, brown. Ap. black **10**

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 *Mycocalicium 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) µm, smooth . **Ch. pusilla**

10 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 oak **Ch. rubescens**

10* Not growing on *Arthonia*. Thallus not with *Trentepohlia*. capitula and stalk K-. Ap. black or stalk somewhat lighter . **11**

11 Sp. 5.5-8 x 2-3.5 µm, ± smooth. Capitula top shaped, 0.3-0.7 mm wide. Stalk 0.04-0.10 mm thick. Ap. -1.2 mm, sometimes even higher and in the older parts more robust, size very variable. Asci 45-65 µm. Without algae **Mycocalicium subtile**

11* 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. On bark (above all conifer trees) in moist shaded sites – bor-mieur **Ch. nana** Tibell

Ecology and Distribution of Species

Chaenothecopsis consociata (Nádv.) A.Schmidt (Calicium consociatum Nádv.)
In the high montane zone parasitic on *Chaenotheca chrysoc.*, of narrower ecological amplitude than these and limited to cold habitats, rather similar to *Calicium vir.* (↑), above all in spruce forests on high snowfall sites – bor-mieur-mo – v.rare (3); Sch, BayW, Alps

Chaenothecopsis exserta (Nyl.) Tibell (Strongyleuma paroica auct.)
In mild climatic, hilly and submontane sites on shaded steep surfaces of silicate rocks on the thallus of sorediate anombrophytic crusts, above all on *Haematomma ochrol.* (↑), like *Calicium coryn.* (↑) – mieur-subatl-med – v.rare (0); O, ThW

Chaenothecopsis parasitaster (Bagl. & Car.) D.Hawksw.
In montane and high montane sites on thallus squamules of red-fruited *Cladonia* species, usually on decayed wood, above all on relatively little rained upon sites (flanks, nisches of stumps), even on peat walls – s'bor-mieur – rare (2); Sch

Chaenothecopsis pusilla (Ach.) A.Schmidt (Ch. subpusilla (Vainio) Tibell, Calicium subpusillum Vainio, C. floerkei Zahlbr., Chaenothecopsis alboatra (Flörke) Nádv., Calicium alboatrum Flörke)
In sub- to high montane sites, e.g. on trunk of old conifer trees in near natural and natural conifer forests, rather like *Ch. viridialba* (↑), on wood (stumps, debarked trunks, also boards), in the Calicion vir. or on old oaks in oak forests – bor-mieur-h'mo – v.rare (1); süSch (Feldberg), *Ju, Vgb*

Chaenothecopsis pusiola (Ach.) Vainio (Calicium pusiolum Ach.)
In cool sites on the thallus of *Chaenotheca brunneola* (↑) or associated with algae – bor-med-mo – possible in the region

Chaenothecopsis rubescens Vainio
Like *Arthonia byss.* (↑), mostly parasymbiotic, above all in deep bark cracks – mieur – v.rare (2); süRh, süHü-HRh-süSch, Sb, *Bo, Ml*
Chaenothecopsis viridialba (Krempelh.) A.Schmidt (Mycocalicium cinerascens (Nyl.) Vainio)
In high montane, very high precipitation sites in near natural and natural, old conifer forests (above all spruce forests) on cracked bark on trunks (often near the base) of old conifer trees, almost only on spruce on cold (cold air basins), very to extremely humid, r.-v. poorly lighted habitats, v.acidoph., anombroph., anitroph., in the Calicietum vir. – bor-mieur-h'mo – v.rare (1); süSch (Feldberg, Notschrei)

LIT.: SCHMIDT 1970, TIBELL 1973, 1975, 1984*, TITOV & TIBELL 1993.

Chromatochlamys Trevisan

(Determination ↑ Protothelenella)

Introduction

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. Asci very thick walled, indented above, fissitunicate, I-. 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*) – bor-smed-mo(-med-mo) – rare-v.rare (2); süSch, Vog, Ju, Ries, *FrJu, SJu, 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

Thallus powdery leprose, yellow, yellow-green, of spherical granules throughout, with coccoid green algae. Ap. unknown in the region, unbordered of very thin border, green-yellow, yellow or brownish. Exc. reduced. Paraphyses reticulate above. Sp. 2- to 4-celled, narrow ellipsoidal to narrow egg shaped, colorless. Ch: Pulvinic acid derivatives.

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.,

anitroph., Char. Chrysotrichetalia chlor. – bor-smed(-med-mo) – r.rare; Sch, Vog, Pf, RhSch, ThW, v.rare O, Rhön

LIT.: LAUNDON 1981, TONSBERG 1992.

Cladonia Hill ex Browne

(Determination incl. Pycnothelia)

Introduction

The species of the genus C*ladonia* 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 are – 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. pysidata, 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. pysicata* 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. pysicata* ssp. *pysicata* 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. pysidata, 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. zopfii.* 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. Photobiont *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 Fumarprotocetraric 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 foliose thallus often occurring . **2**

1* Podetia entirely without squamules, cylindric, but often open in the axils. Primary thallus lacking **4**

2 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. Furmarprotocetraric acid . . **C. furcata** ssp. **furcata**

2* K+ yellow, P- or P+ red, with Atranorin . **3**

3 P-. Podetia usually erect and occurring in ± thick turfs, therefore similar to reindeer lichens, with or without squamules, whitish- gray, pale greenish-gray, the ends strongly browned, the end branch often ± regularly forked, cortex variegated, dark fields (transparent algae groups) separated by light lines. Rangiformic acid, ± Fumarproto-cetraric acid * **C. rangiformis**

3* P+ yellow-orange to red, podetia relatively robust and loosely branched, commonly decumbent to ascending,, sparsely squamulose, usually brown to olive, frequently cracked a the base and with erupting white bulges. Fumarprotocetraric acid * .**C. furcata** ssp. **subrangiformis**

4 Podetia densely shrubby branched (virtually reindeer lichens), usually 3-8 (12) cm . **5**

4* Podetia weakly branching, often forked, smooth cortex, usually 1.5-10 cm. Always containing Usnic acid **12**

5 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, Perlatolic acid. Lichens of cold sites (watch for confusion with densely branched *C. portentosa*) . **C. stellaris**

5* 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 **6**

6 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**

6* (when K+ yellow, with Atranorin, Rangi-ormic acid, ± Fumarprotocetraric acid, end branches splayed, but not curved back, podetia gray flecked: *C. rangiformis* 3) Branches usually going out 3 or 4 **7**

7 Thallus gray-white to gray, K+ yellow, without Usnic acid, commonly with Atranorin, Fumarprotocetraric acid, (Protocetraric acid). Branch ends browned **8**

7* Thallus with (sometimes only weakly) yellowish tint (whitish, pale gray-yellow, yellow-green), K-, with Usnic acid, without Atranorin . **9**

8 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. * **C. stygia**

8* 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. rangiferina**

9 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 sparsely branched. Usnic acid, Perlatolic acid . **C. portentosa**

9* 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 Perlatolic acid . **10**

10 P- (very rarely P+ red), with Rangiformic acid, Usnic acid. Podetia bushy branched, ends little curved **C. arbuscula** ssp. **mitis**

10* P+ yellow or P+ red, Usnic acid, without Rangiformic acid . **11**

11 P+ yellow. Psoromic acid, ± Fumarproto-cetraric acid, ± Protocetraric acid. * Podetia often appearing cup-form. Very rare . **C. arbuscula** ssp. **arbuscula**

11* 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**

12 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**

12* Podetia yellowish, gray-yellowish, pale green-yellowish, points often browned **13**