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KEY TO GENERA AND GENERIC GROUPS OF LICHEN-FORMING FUNGI IN HUNGARY

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Abstract: A key to treat 269 genera of lichen-forming fungi including 940 species from Hungary is compiled. The key sorts lichens according to traditionally distinguished morphological groups based on vegetative and reproductive structures, fruticose, foliose and crustose thalli with apothecia and perithecia. Elongated and stalked reproductive structures are also distinguished, as well as the type of photobiont (cyanobacterium, green alga) is considered. Due to recent phylogenetical-taxonomic studies several taxa with recent nomenclature grouped under larger, morphologically related genera following the practice of published national identification keys from Germany and Great Britain.

Keywords: genera, identification, lichens, morphology, taxonomy

INTRODUCTION

The last identification key to lichen-forming fungi in Hungary was published by Klára Verseghy (1994) 30 years ago. Nomenclatural and taxonomic changes took place over the decades in the majority of taxa. An online checklist was compiled in 2009 (Lőkös and Farkas 2009) and updated from time to time, resulting the most recent version (Farkas *et al.* 2023). According to our recent knowledge the number of Hungarian lichen-forming fungi reached 940 belonging to 269 genera.

A key to treat these 269 genera of lichen-forming fungi is compiled here to support the identification of recent collections and the revision of herbarium material. The key sorts lichens according to traditionally distinguished morphological groups based on vegetative and reproductive structures, fruticose, foliose and crustose thalli with apothecia and perithecia (*Figure 1–2*). Elongated and stalked reproductive structures are also distinguished, as well as the type of photobiont (cyanobacterium,

green alga) is considered. In several cases, the key is leading to species because of their specific morphological characters or for presenting their relation to similar species. Due to recent phylogenetical-taxonomic studies (*e.g.,* Crespo *et al.* 2010; Divakar et al. 2017; Kistenich *et al.* 2018; Zhao *et al.* 2016) several taxa with recent nomenclature are grouped under larger, morphologically related genera following the practice of published national identification keys from Germany (Wirth *et al.* 2013) and Great Britain (Smith *et al.* 2009). In a key to species (currently under preparation) starting from the known genera or generic groups, the identification will result in species named according to the recent nomenclature. For certain species molecular genetic sequencing might be necessary, otherwise the result may lead to the identification of species groups only.

For nomenclatural issues indexfungorum.org and mycobank.org and further recent literature sources were consulted. Stereo and research microscopes are necessary for studying microsocopic characters. Spot tests (C, K, Pd) and chromatographic analysis of lichen secondary metabolites must be carried out where it is necessary following the usual methods (Arup *et al*. 1993; Orange *et al*. 2010).

GLOSSARY

acicular – needle-shaped

amyloid – stained blue by Lugol's iodine solution

apothecium (plural: *apothecia*) – a round, nearly flat or often cup-like ascus producing fruiting body, where the → *hymenium* is exposed at maturity (*Figure 1g, i, 2e*)

ascoma (plural: *ascomata*) – ascus producing fruiting body

areolate – consists of islands (areoles) of thallus developing on the hypothallus, resulting a cracked apperarance of the thallus

ascospore – reproductive propagule, the product of meiosis, most often 8, formed and arranged in a line within an → *ascus*

ascus (plural: *asci*) – a sac-like fungal cell containing the ascospores (produced by meiotic cell division)

basidioma (plural: *basidiomata*) – basidium producing fruiting body

basidiospore – reproductive propagule, the product of meiosis, formed within a basidium (→ *basidioma*), most often 4 are released independently at the apex of a basidium

biatorine (of apothecia) – lacking a true exciple when mature, pale or coloured (not black), soft in consistency, often becoming convex

cephalodium (plural: *cephalodia*) – delimited region of a lichen thallus containing a photobiont (usually a cyanobacterium) different from that characteristic of the rest of the thallus (mostly a green alga); inside the thallus or a warty, squamulose, or shrubby structure on the surface

cilia (singular: *cilium*) – hair-like out-growths of the thallus usually at or near the margin

clavate – club-like

corticolous – on bark of a tree

crustose (of lichen thalli) – crust-like with modified layered or more simple structure (*Figure 1f–i, 2a–d*)

epiphytic – on plant / tree bark

exciple – tissue forming the margins or walls of an ascoma

farinose – flour-like, powdery

filamentose (*filamentous*) – thread-like

foliose (of lichen thalli) – leaf-like; with layered structure of an upper cortex, photosynthetic layer, medulla and lower cortex separable from the substratum (*Figure 1d*, *e*)

fruticose (of lichen thalli) – shrub-, beard- or worm-like appearance with modified layered structure (*Figure 1b*, *c*)

furcate – forked

fusiform – spindle-like; narrowing at both ends

gyrose – brain-like, circularly folded

habitat – living place

halo – → *perispore*

hymenium (of ascomata and basidiomata) – the spore-bearing layer of a fruit-body

hypha (plural: *hyphae*) – a fungal filament

hypothecium – the tissue below the hymenium and generative layer

isidium (plural: *isidia*) – a photobiont-containing outgrowth of the cortex (*Figure 2g*)

lecanorine (of apothecia) – with a thalline exciple (containing both photobiont cell and fungal hyphae) (*Figure 1f, g*)

lecideine (of apothecia) – without a thalline exciple (margin consists of fungal hyphae only → *true exciple*) (*Figure 1h, i*)

leprose – thallus surface a granular mass of algal and hyphal cells without any cortex (*Figure 2a, b*)

lirella (plural: *lirellae*; adjective: *lirellate*) – long, narrow apothecium (*Figure 2c*)

mazaedium – a dry powdery mass of free ascospores and occasionally sterile elements lying on the surface of the ascoma (*Figure 2d*)

medulla – the loose layer of hyphae below the cortex and photobiont layer

muriform (of spores) – divided by transverse and vertical or oblique cross walls

mycobiont – fungal symbiont partner (→ *thallus*) consisting of → *hyphae*

paraphysis (plural: *paraphyses*) – a slender, branched or unbranched hypha growing upward and basally in a fruitbody (→*ascoma*) *(cf. → pseudoparaphysis*)

paraphysoid – interascal or pre-ascal tissue stretching and coming to resemble → *periphysoid*

paraplectenchyma – tissue consisting of cell-like hyphae with ± isodiametric lumina

periphysoid – short, interascal filaments growing down from the top of a perithecium, perithecium-like apothecium or pycnidium (e.g. in *Cryptothele*)

perispore – a colourless, often gelatinous layer (halo) enveloping a spore outside the main spore wall (epispore).

perithecium (plural: *perithecia)* – a subglobose or flask-like ascoma in which the hymenium is not exposed

photobiont – a photosynthetic symbiont which may be either a green alga or a cyanobacterium (→ *thallus*)

podetium (plural: *podetia*) – the lichenized stem-like part of an apothecium; typically in *Cladonia*, apothecial discs may be missing (→ *secondary thallus*) (*Figure 1a*)

polarilocular (of ascospores) – bicellular with the two cells separated by an often thick, centrally perforated septum (*e.g.,* at *Caloplaca*)

primary thallus – basal thallus part of fine or coarse granules or squamules (*Figure 1a*)

prothallus – initial structure of hyphae without algae from which a lichenized thallus develops; often visible along the edge of the thallus or areoles (by characteristic colour)

pruina – a frost-like or flour-like surface layer composed of crystals

pruinose – covered with pruina

pseudocyphella – dot-like to fusiform or irregular pale areas of the thallus where the medulla is spreading to the surface (and not surrounded by specialized cells) (*Figure 2h*)

pseudoparaphyses – very often remotely septate, anastomosing and very narrow *paraplectenchyma* – tissue consisting of cell-like hyphae with ± isodiametric lumina

pyrenocarpous – with perithecioid ascoma

rhizine – a root-like hair or thread for attaching mostly the foliose thallus to the substrate (*Figure 2i*)

saxicolous – on rock

secondary thallus – upright, fruticose part of the thallus (→ *podetium*) (*Figure 1a*)

septum (plural: *septa*) – cell wall or partition

simple (of spores) – without septa

soralium (plural: *soralia*) – a structure or region of a thallus producing soredia, resulting an appearance of flour-like, castor sugar-like or granular (*Figure 2f*)

soredium (plural: *soredia*) – a non-corticate, loose, tiny ball-like structure of photobiont cells and fungal hyphae deliberating from cracks or pores on the thallus surface (*Figure 2b, f*)

squamule – a tiny scale, without a cortex on its lower surface

substrate – underlying material of the thallus, surface of the habitat

terricolous – on soil

thalline exciple – margin of apothecium consists of both photobiont cells and fungal hyphae

thallus (plural: *thalli*) – the vegetative body of a lichen consisting of fungal hyphae (→ *mycobiont*) and algal (or cynobacterial) cells (→ *photobiont*)

tholus – the thickened inner part of the ascus wall in the ascus apex; apical dome

tomentum (adjective *tomentose*) – felt-like mat of hyphae
true exciple – an exciple derived from the ascocarp lacking photobiont cells, usually of a different colour from the thallus (→ *lecideine*)
umbilicus – the central holdfast occurring in certain foliose lichens (*e.g., Lasallia, Umbilicaria*) (*Figure 1e*)
verrucose – covered with warts (verrucae)

ABBREVIATIONS

C – natrium- or calcium-hypochlorite (+ / – spot reaction resulting a characteristic colour or not reacting)
K – potassium-hydroxide (+ / – spot reaction resulting a characteristic colour or not reacting)
Pd – p-phenylene-diamine (+ / – spot reaction resulting a characteristic colour or not reacting)

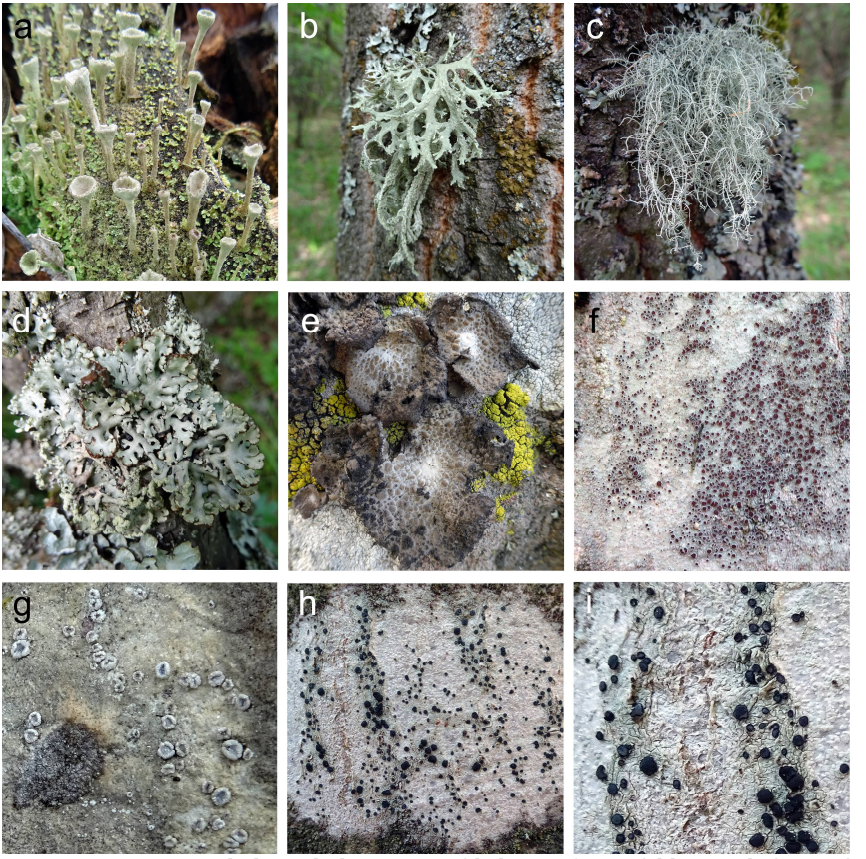

Figure 1. Main morphological characters of lichens: **a**), twofold growth form of foliose primary thallus and fruticose podetium (*Cladonia fimbriata*), **b**), fruticose growth form with flattened strapshaped lobes (*Evernia prunastri*), **c**), fruticose growth form with cylindrical branches (*Usnea* cf. *dasopoga*), **d**), foliose growth form (*Hypogymnia physodes*), **e**), foliose growth form with a central holdfast / umbilicus (*Lasallia pustulata*), **f**), crustose growth form with lecanorine apothecia (*Lecanora chlarotera*), **g**), crustose growth form with lecanorine apothecia (*Lecanora crenulata*), **h**)–**i**), crustose growth form with lecideine apothecia (*Lecidella elaeochroma*).

Figure 2. Main morphological characters of lichens: **a**)-**b**), entirely sorediate sterile thallus (*Lepraria lobificans*), **c**), crustose growth form with elongated apothecia (*Graphis scripta*), **d**), crustose growth form with stalked ascomata (*Calicium glaucellum*), **e**), sexual reproductive structures: apothecia (*Xanthoparmelia conspersa*), **f**), asexual reproductive structures: laminal soralia (*Flavoparmelia caperata*), **g**), asexual reproductive structures: isidia (*Parmelia saxatilis*), **h**), pseudocyphellae on the upper surface (*Cetrelia chicitae*), **i**), rhizines on the lower surface (*Peltigera canina*).

GENERIC KEY TO LICHEN-FORMING FUNGI

1 Thallus consists of a basal primary thallus of fine or coarse granules or squamules and an erect secondary thallus part (*Figure 1a*) **2**

– Thallus uniformly crustose, foliose or fruticose **7**

2(1) The erect part represents basidiomycete fruitbodies resembling other types of omphalinoid mushrooms or basidiomata club-shaped ..... ***Lichenomphalia*, *Multiclavula***

– Fruitbody if present, represents ascomycetes **3**

3(2) Primary thallus of granules **4**

– Primary thallus of squamules **6**

4(3) Basal thallus fine powdery leprose, erect thallus of short, delicate slender, white, cartilaginous, terete, branching pseudopodetia covered by an almost continuous, sorediate crust; apothecia unknown ..... ***Leprocaulon quisquiliare*** (syn. *L. microscopicum*)

– Basal thallus granulose or small squamulose, erect thallus not sorediate **5**

5(4) Basal thallus granulose or small squamulose, erect thallus solid white podetium (2–10 mm); apothecia (2–3 mm) brown reddish brown or rose, developing on the top of podetia; ascospores simple ..... ***Baeomyces*, *Dibaeis***

– Basal thallus of 0.2–1 mm non-corticate granules, erect thallus without soredia; podetia hollow (5–15 mm); apothecia rare (1–2 mm), arising on the tips of the podetia, ascospores simple or 1–3-septate ..... ***Pycnothelia papillaria***

6(3) Erect thallus hollow, often with squamules (at least at the base) and cups; phyllocladia and cephalodia absent; ascospores simple ..... ***Cladonia***

– Erect thallus solid, without cups and squamules; granular, peltate or finger-like phyllocladia and often sessile, wrinkled to convoluted, pale brown to blackish cephalodia present; ascospores septate ..... ***Stereocaulon***

7(1) Photobiont cyanobacterium (or filamentous green alga *Trentepohlia*), thallus grey, black or brown, often gelatinously swelling when wet **8**

– Photobiont green alga **25**

Lichens with cynobacterium photobiont
[and a filamentous species with *Trentepohlia* photobiont]

8(7) Thallus of fine branching filaments.....***Polychidium***, ***Synalissa*** [***Racodium rupestre***, if photobiont green alga – a central *Trentepohlia* chain surrounded by elongate, straight, ± parallel-orientated septate hyphae; filaments smooth]

– Thallus foliose or consists of small granules or squamules or dwarf fruticose.....**9**

9(8) Thallus foliose.....**10**

– Thallus consists of small granules or squamules or dwarf fruticose.....**18**

10(9) Thallus swelling strongly when wet, stiff and fragile when dry, black, grey, brown, can be white pruinose, hairy at the edge, lower side black, green, bluish grey, sometimes, yellowish, usually without rhizines, but occasionally with fine white hairs; apothecia with characteristic margin, ascospores colourless.....**11**

– Thallus not swelling strongly when wet, brown, grey, lower side white, beige, or brownish, naked or densely tomentose, or with rhizines arranged on veins, photobiont *Nostoc* or other filamentous cyano-bacterium.....**14**

11(10) Photobiont is not filamentous like a string of pearls, however a single celled cyanobacterium; apothecium lecanorine, but initally or even longer tiny spotlike, reminiscent of a perithecium....***Phylliscum*** group (***Anema***, ***Gonohymenia***, ***Phylliscum***, ***Thallinocarpon***, ***Thyrea***)

– Photobiont is filamentous like a string of pearls, cyanobacterium *Nostoc*; apothecium with thalline or / and proper margin, brown, reddish brown, widely opened.....**12**

12(11) Thallus with paraplectenchymatic cortex, consists of a single row of isodiametric to shortly rectangular cells well recognizable in section.....***Leptogium*** group (***Leptogium***, ***Pseudoleptogium***, ***Scytinium***)

– Thallus without a cortex, however the margin of the apothecium is often surrounded with a paraplectenchymatic cortex (pseudocortex) **13**

13(12) Ascospores simple ..... ***Lempholemma***

– Ascospores with parallel septa or submuriform ..... ***Collema*** group (***Blennothallia***, ***Callome***, ***Collema***, ***Enchylium***, ***Lathagrium***, ***Scytinium***, ***Porocyphus***)

14(10) Apothecia immersed in the upper surface of the thallus ..... ***Solorina saccata*** **8**

– Apothecia not immersed, sessile or saddle-shaped **15**

15(14) Apothecia are at lobe-ends **16**

– Apothecia sessile on the thallus lobes or absent **17**

16(15) Apothecia on the often uprising lobe surfaces or in saddle positon; the lower surface ecorticate with anastomosing veins where bunches of rhizines arise ..... ***Peltigera***

– Apothecia on the lower surface, but convoluting to the upper surface, not in saddle position; lower surface corticate, without veins, but pubescent or with dense velvety beige, pale brown tomentum ..... ***Nephroma***

17(15) Lobes are usually wide, thallus large, stout, lower surface ecorticate, with rhizine carrying anasotomosing veins or entirely tomentose ..... ***Peltigera***

– Thallus divided into small lobes, bluish grey or brownish, often forming rosettes; without veins on the lower surface ..... ***Pannaria*** group (***Fuscopannaria nebulosa***, ***Protopannaria pezizoides***, ***Vahliella leucophaea***)

18(9) Terricolous, also on bryophytes and plant debris **19**

– Saxicolous **20**

19(18) Thallus black, brownish black, crustose, small granulose or thicker, areolate or coralloid; apothecia, brown, reddish brown, perithecioid at first; photobiont single cells or cells in clusters with common gelatinous sheath *Chroococcidiopsis* ..... ***Psorotichia*** group

– Thallus of thicker black, greenish, bluish grey, brownish, olive granules or squamules; apothecia reddish brown, immersed in thallus; photobiont filamentous *Scytonema* ..... ***Heppia***

20(18) Thallus of minute, grey, olive, umbilicate squamules of sorediate margin; lower surface pale; photobiont unicellular, *Chroococcidiopsis*.....***Peltula euploca***
– Thallus without sorediate margin.....**21**
21(20) Thallus of tiny, hollow squamules, often rosette-shaped forming small cushions attached by a minute umbilicus; photobiont not filamentous, *Gloeocapsa*-type single celled or cells in clusters.....***Phylliscum***
– Thallus is not like that.....**22**
22(21) Apothecia usually present.....**23**
– Apothecia can be absent.....**24**
23(22) Thallus endolithic in calcarous rocks; apothecia at first closed perithecia-like with white starlike margin, later while opening, the rose, organge disc appear; ascospores acicular, 4-celled, surrounded by halo; photobiont filamentous *Scytonema*.....***Petractis clausa***
– Thallus not endolithic; either closely attached, lobes flat or swollen, grey, brown, olive or black; apothecia black, lecideine, extended, not tiny spotlike; ascospores acicular or elliptic, parallel-septate, 2–4(–8)-celled (*Placynthium*) or ascospores simple, broad ellipsoid or globose, thallus dwarf furticose, photobiont chroococcoid (*Peccania*) .....***Placynthium, Peccania***
24(22) Lobes are often radiating at thalline edges or surrounded with greenish-, bluish-black hypothallus; photobiont filamentous *Scytonema*.....***Placynthium***
– Thallus without radiating lobes and hypothallus; photobiont single celled or cells in clusters, not clearly filamentous, gelationus sheath is yellow-brown.....
.....***Psorotichia***

Lichens with green alga photobiont

25(7) Thallus fruticose.....**26** (*FRUTICOSE LICHENS*)
– Thallus crustose, squamulose, placodioid or foliose.....**41**

FRUTICOSE LICHENS

26(25) Thallus consists of an erect foliose or fruticose part (secondary thallus) and a basal granulose or squamulose part (primary thallus)..... **2**
– Thallus clearly fruticose (consiting of cylindrical or flattened branches, hanging or shrubby)..... **27**
27(26) On soil and terricolous bryophyes..... **28**
– On trees, shrubs, wood, rocks..... **34**
28(27) Thallus of ± erect, slightly branching flattened, guttered or convoluted lobes..... **29**
– Thallus of terete, cylindrical branches, sometimes angulate or ridged, hanging or erect..... **31**
29(28) Thallus olive, brown, dark brown, reddish or blackish brown, sometimes pale..... ***Cetraria*** (incl. ***Flavocetraria***)
– Thallus pale to bright or greenish yellow..... **30**
30(29) Thallus bright yellow, medulla yellow, uprising to vertical..... ***Cetraria*** (syn. *Vulpicida*)
– Thallus pale yellow or pale greenish yellow, pale green, greyish green, flat or convolute to almost tubular..... ***Flavocetraria*** (key with ***Cetraria***)
31(28) Thallus section presents a solid structure of lobes..... **32**
– Thallus section presents a hollow, tubular structure of lobes..... **33**
32(31) Thallus of slightly branching white solid terete lobes covered richly with white squamules..... ***Stereocaulon***
– Thallus brown, lobes fine, thin, hairlike, slightly branching, mostly pendulous, with or without soralia..... ***Bryoria***
33(31) Thallus richly branching, 2-4 terminal branches may turn in the same or different directions..... ***Cladonia***
– Thallus slightly branching, with pointed or scyphose apex, basal part can be squamulose, soredia may occur on podetia..... ***Cladonia***
34(27) Thallus of flattened lobes of upper and lower surface different in colour (dorsiventral)..... **35**
– Thallus of flattened lobes or terete, cylindrical branches of ± uniform in colour (lower parts might be somewhat paler)..... **38**

35(34) Thallus yellowish green, pale green above, lobes 2–4 mm wide, 2–6(–10) cm long, without isidia, marginal soralia can occur, lower side white ..... ***Evernia prunastri***

– Thallus of flattened lobes, greyish above, pale or blackish below, with or without cilia **36**

36(35) Thallus without cilia, lobes 1–5 mm wide, up to 10 cm long with laminal, cylindrical to coralloid isidia, lower surface white to rose at younger parts, older parts near to the attachment bluish black, black ..... ***Pseudevernia furfuracea***

– Thallus with cilia **37**

37(36) Thallus grey, lobes firmly attached, 1–2 mm wide, forming rosettes (3–8 cm diam.) or more rarely widely spreading, sometimes ascending, with labriform soralia, lower surface white or tan; apothecia, very rare, disc brown-black; ascospores very thick walled, 1-septate, often with 1–3 additional small locules beyond the main locules, brown, ellipsoid-oblong, surface smooth, *Pachysporaria*-type ..... ***Heterodermia speciosa***

– Thallus pale grey ± finely tomentose, lobes >2 mm wide, 3–5 cm long, without isidia and soralia, lower surface pale brownish white; apothecia occasional, 2–5 mm diam.; disc brown-black, often blue-grey pruinose; ascospores uniformly thin-walled except at the septum, *Physconia*-type, 34–41 × 17–21 µm, dark brown, wide ellipsoid, with rounded apices, with minute spines or ridges ..... ***Anaptychia ciliaris***

38(34) Thallus of ± erect, slightly branching flattened, guttered, channelled or convoluted lobes **39**

– Thallus of terete, cylindrical branches, sometimes angulate or ridged, hanging, pendulous or erect **40**

39(38) Thallus yellowish green, greenish grey, lobes flattened, strap-shaped, single to numerous, often with soralia, mostly erect, shrubby ..... ***Ramalina***

– Thallus grey, bluish grey, lobes are tubular and ascending with capitate rounded soralia at lobe ends ..... ***Hypogymnia tubulosa***

40(38) Thallus of terete, cylindrical branches, sometimes angulate or ridged, branching irregular, with or without fibrils, tubercles, papillae, pseudocyphellae, isidia, isidiomorphs and soredia, yellowish green, greenish grey, hanging or erect ..... ***Usnea***

– Thallus of fine, thin, cylindrical, hair-like branches, brown, reddish brown, pale greyish brown, often with inconspicuous pseudocyphellae and tuberculate or fissure-like soralia, mostly hanging ..... ***Bryoria***

Yellow, yellow-green, orange-red lichens of various morphology

41(25) Thallus (when dry) bright yellow, bright yellow-green to orange-red (pigments anthraquinones or pulvinic acid derivatives) **42**

– Thallus not as above; sometimes dull yellow-green owing to usnic acid **49**

42(41) Thallus K+ purple-red (pigments anthraquinones) **43**

– Thallus K± yellow, not purple-red (pigments pulvinic acid derivatives) **45**

43(42) On bark, wood or stone; schizidia absent; ascospores polarilocular **44**

– On calcareous soil, often spreading to mosses; schizidia often present; ascospores simple or 1-septate, not polarilocular ..... ***Gyalolechia*** (syn. *Calogaya*, *Fulgensia*) (with ***Caloplaca***)

44(43) Thallus closely attached to substratum by entire lower surface, often placodioid, rhizines and other attachment organs absent ..... ***Caloplaca*** (incl. ***Klauderuiella***)

– Thallus ± loosely attached to substratum by a basal sheath, attachment discs or rhizines ..... ***Xanthoria*** (incl. ***Galowayella***, ***Massjukiella***, ***Oxneria***, ***Rusavskia***, ***Zeroviella***)

45(42) Thallus foliose, markedly incised with ± granular or marginal soralia **46**

– Thallus placodioid to squamulose **47**

46(45) Thallus lobes to c. 1 cm wide; soralia marginal..... ***Cetraria pinastri*** (syn. *Vulpicida pinastri*)

– Thallus lobes very small, 0.3–0.5(–1.5) mm wide; soralia granular..... ***Candelaria concolor***

47(45) Marginal lobes elongated, convex. Thallus irregularly granular-isidiate towards centre with white-pruinose marginal lobes..... ***Candelariella medians***

– Marginal lobes not much different from internal squamules, flattened..... **48**

48(47) Thallus bright greenish yellow to whitish grey, sorediate, on soil; lobes pruinose; apothecia black; ascospores septate..... ***Arthrorhaphis citrinella***

– Thallus usually on rock, wood or bark; lobes not pruinose; apothecia yellow; ascospores simple..... ***Candelariella vitellina***

Lichens of various morphology

49(41) Thallus foliose, squamulose or placodioid (with marginal lobes differing from the centre), often attached to substratum by rhizines, hapters or by a central disc (umbilicus), often with stratified structure..... **50**

– Thallus crustose, continuous or rimose-cracked, areolate, powdery, or evanescent, immersed, at least partially embedded in the substratum..... **114** (*CRUSTOSE LICHENS*)

50(49) Thallus distinctly foliose, small to large, often rosette-forming or strap-shaped, attached to substratum by rhizines, hapters, tomentum, folds or by an umbilicus..... **51** (*FOLIOSE LICHENS*)

– Thallus squamulose, sometimes minutely so, squamules mostly closely attached to substratum or elevated towards margins, scattered, contiguous or overlapping, or thallus placodioid and ± crustose at the centre with contiguous lobed margins..... **86** (*SQUAMULOSE OR PLACODIOID LICHENS*)

FOLIOSE LICHENS

51(50) Thallus attached to substratum at a central point by an umbilicus..... **52**
– Thallus not attached to substratum by an umbilicus, attachments various..... **54**
52(51) Thallus dotted with abundant black perithecia on upper surface..... ***Dermatocarpon*** (incl. ***Heteroplacidium***)
– Thallus with apothecia or sterile..... **53**
53(52) Thallus surface with distinctive, coarse, oval pustules; isidia black, coralloid, very rarely fertile..... ***Lasallia pustulata***
– Thallus surface without coarse pustules, surface smooth, wrinkled or ridged, sometimes cracked; soredia, phyllidia or thalloconidia sometimes present, or often fertile..... ***Umbilicaria***
54(51) Thallus lobes rounded..... **55**
– Thallus lobes spreading, apothecia if present not immersed in thallus..... **56**
55(54) Apothecia single urceolate, ± immersed in the thallus, lower surface white or pale brown, tomentose, with rhizines, without lichen secondary metabolites..... ***Solorina saccata***
– Apothecia at the edge of podetia (very rare), or the thallus sterile, lower surface white or pale yellow, rhizines and lower cortex are missing, usnic acid, fumarprotocetraric acid (Pd+)..... ***Cladonia foliacea***
56(54) Thallus lobes inflated, hollow in section, lower surface without rhizines..... **57**
– Thallus lobes solid in section, flat or convex, with distinct lower cortex..... **58**
57(56) Thallus without perforations on the upper or lower surface..... ***Hypogymnia***
– Thallus with scattered round perforations <1 mm diameter on the upper surface..... ***Menegazzia terebrata***
58(56) Lobes with tomentum on lower surface, wide-spreading. Cyphellae and pseudocyphellae absent. Thallus green-brown when dry, bright green when wet, with distinct depressions with a network of ridges on upper surface.....

.....***Lobaria pulmonaria***

– Lobes without tomentum on lower surface.....**59**

59(58) Thallus white, grey or brownish grey, lobes up to 5 mm wide, usually matt, often pruinose: spores brown, 1-septate (Physciaceae).....**60**

– Thallus yellow-green, grey or brown, lobes from 1 mm to several centimetres wide, usually ± shiny in younger parts, rarely pruinose; spores colourless, simple (Parmeliaceae).....**66**

60(59) Lobes strap-like, erect, elongated and narrowly linear, lower cortex absent.....**61**

– Lobes rounded or if linear, branching regularly, adnate, forming rosette-like thalli.....**62**

61(60) Lobes grey-green to white; thallus K+ yellow (atranorin)... .....***Heterodermia***

– Lobes pale to dark brown; thallus K–.....***Anaptychia***

62(60) Thallus whitish to bluish grey, maculate and sorediate or with isidia or lobules.....**63**

– Thallus grey brown to brown, emaculate.....**64**

63(62) Upper cortex and hyphae running parallel to the upper surface (microscope).....***Heterodermia***

– Upper cortex and hyphae with a cellular (pseudo-parenchymatous) structure (microscope).....***Physcia*** (with ***Physciella*** – differing in prosoplectenchymatous lower cortex)

64(62) Thallus ± loosely appressed to substratum, lobes pruinose at tips.....***Physconia*, *Poeltonia***

– Thallus closely appressed to substratum, lobes not pruinose at tips.....**65**

65(64) Rhizines absent or sparse.....***Hyperphyscia adglutinata***

– Rhizines numerous.....***Phaeophyscia***

66(59) Thallus lobes brown throughout.....**67**

– Thallus lobes yellow-green, green to grey-green or whitish.....**71**

67(66) Thallus erect, ± tufted. Lobes with distinct upper (darker brown) and lower (paler, sparseley rhizinate) surfaces..... .....***Nephromopsis chlorophylla*** (syn.: *Tuckermanopsis c.*)

– Thallus adnate to loosely overlapping, sometimes with irregular clusters of isidia or pale-coloured soralia. Rhizines present at least in the centre of the thallus, lobes loosely to closely attached to the substratum; substrata various **68**

68(67) Medulla UV+ white, saxicolous ..... ***Xanthoparmelia***

– Medulla UV–, corticolous or saxicolous **69**

69(68) Medulla C+ red (lecanoric acid) ..... ***Melanelixia***

– Medulla C– **70**

70(69) Medulla Pd– (usually without lichen secondary metabolites); lobes flat to concave ..... ***Melanohalea***

– Medulla usually Pd+ yellow or red; if Pd– then with convex lobes and whitish punctiform pseudocyphellae ..... ***Melanelia*, *Montanelia***

71(66) Pseudocyphellae present on upper surface, punctiform or effigurate **72**

– Pseudocyphellae absent **74**

72(71) Pseudocyphellae effigurate ..... ***Parmelia***

– Pseudocyphellae punctiform **73**

73(72) Lobes overlapping with wavy crisped margins and marginal soralia ..... ***Cetrelia***

– Lobes with soredia developing from laminal and marginal pseudocyphellae ..... ***Punctelia*** (greyish, with atranorin); ..... ***Flavopunctelia*** (yellowish green, with usnic acid)

74(71) Rhizines branched dichotomous or squarrose (simple rhizines may also be present) ..... ***Hypotrachyna***

– Rhizines simple (or at most forked) **75**

75(74) Thallus closely appressed to substratum **76**

– Thallus not appressed to substratum with loosely overlapping lobes **80**

76(75) Lower surface pale tan to white. Thallus grey-white, K+ bright yellow, densely isidiate ..... ***Imshaugia aleurites***

– Lower surface dark brown to black **77**

77(76) Thallus yellow-green or yellow-grey (usnic acid in cortex) **78**

– Thallus grey or blue-grey (without usnic acid in cortex). Cilia present in axils and/or on the apices of lobes; soralia absent; medulla UV– **79**

78(77) Medulla Pd–, UV+ white (divaricatic acid)..... ***Parmeliopsis ambigua***
– Medulla Pd+ orange UV- (stictic acid)..... ***Xanthoparmelia mougeotii***
79(77) Cilia abundant also on apices of lobes..... ***Parmelinopsis***
– Cilia mainly restricted to lobe axils..... ***Parmelina***
80(75) Thallus grey-green (usnic acid absent)..... **81**
– Thallus yellow-green (usnic acid present)..... **85**
81(80) Thallus lobes very small, 0.3–0.5(–1.5) mm wide..... ***Candelaria concolor***
– Thallus lobes more than 2 mm wide..... **82**
82(81) Lower surface strongly veined and wrinkled..... ***Platismatia glauca***
– Lower surface not strongly wrinkled..... **83**
83(82) Lower surface pale tan to white..... ***Pleurosticta acetabulum***
– Lower surface dark brown to black..... **84**
84(83) Medulla C+ red..... ***Hypotrachyna***
– Medulla C–..... ***Parmotrema***
85(80) Thallus with discrete or pustular soralia..... ***Flavoparmelia***
– Thallus without soralia; isidia sometimes present..... ***Xanthoparmelia***

SQUAMULOSE OR PLACODIOID LICHENS

86(50) Squamules shell- or ear-like with raised, sorediate margins, glaucous to green-grey..... ***Normandina pulchella***
– Squamules variously shaped and coloured, but not as above..... **87**
87(86) Perithecia present, mostly ± immersed; photobiont green..... **88**
– Apothecia present, emergent or sessile, or fruits absent; photobiont green or blue-green..... **91**
88(87) Hymenial photobiont cells present..... ***Endocarpon***
– Hymenial photobiont cells absent..... **89**
89(88) Squamules minute, 0.05–0.3(–0.5) mm wide; ascospores muriform; asci 2- or 8-spored..... ***Agonimia***
– Squamules small to medium, 0.5–4(–7) mm wide; ascospores simple or septate; asci 8-spored..... **90**

90(89) Ascospores simple ..... ***Catapyrenium***
– Ascospores 1-septate ..... ***Placidiopsis***
91(87) Thallus of appressed or ascending, individual squamules, overlapping or ± dispersed, not forming radiating and elongated marginal lobes **92**
– Thallus ± forming rosettes or placodioid when ± crustose in centre with distinctly elongated radiating marginal lobes **106**
92(91) Asci 50- to 300-spored; ascospores minute, 3–6(–13) × l–3(–6) µm ..... ***Acarospora*** (incl. ***Caeruleum***, ***Glypholecia***, ***Myriospora***, ***Polysporina***, ***Sporastatia***)
– Asci to 8-spored; ascospore size various; or thallus sterile **93**
93(92) Thallus sorediate or with clusters of coarse, irregular, isidia-like protuberances, squamules wider, than 0.3 mm, generally not green **94**
– Thallus without soredia and isidia **97**
94(93) Squamules ± ascending, at least at edges, often ± elongate, margins frequently incised; small podetia frequently present ..... ***Cladonia***
– Squamules ± closely appressed to substratum, mostly rounded, with ± entire margin; podetia absent ..... **95** (see also ***Baeomyces rufus***)
95(94) Squamules C+ red, squamules orientated in one direction, overlapping, the margin and lower surface sorediate; thallus brownish, Pd– ..... ***Hypocenomyce scalaris***
– Squamules C– **96**
96(95) Squamules peltate, with a conspicuously darker central area; ascospores (1–)3–5-septate ..... ***Stereocaulon***
– Squamules not peltate, without a darker central area; ascospores simple or 1-septate; soredia lip-shaped, ± restricted to marginal soralia; ascospores simple; on peat or wood; cortex Pd–; on peat or rotting wood ..... ***Trapeliopsis***
97(93) Squamules ± ascending, at least at edges, often ± elongate, margins frequently incised; often green; small podetia frequently present ..... ***Cladonia***
– Squamules ± closely appressed to substratum, mostly rounded, with ± entire margin; podetia absent **98**

98(97) Thallus on wood or bark; squamules mostly >0.5 mm, bullate or flattened, matt or shiny; apothecia black; ascospores simple to 1(–3)-septate ..... ***Hypocenomyce scalaris***

– Thallus on rocks or soil **99**

99(98) Thallus with schizidia; squamules minute, forming a ± continuous crust ..... ***Baeomyces***

– Thallus without schizidia; squamules varied **100**

100(99) Thallus C+ red ..... ***Trapelia glebulosa***

– Thallus C– **101**

101(100) Thallus with lip-shaped soralia on lobe ends; on peaty turf or wood ..... ***Trapeliopsis***

– Soralia absent **102**

102(101) Apothecia without a thalline margin **103**

– Apothecia with a thalline margin; thalline margin smooth; thallus with appressed, ± overlapping squamules; squamules yellow-grey or grey-green; ascospores simple ..... ***Squamarina***

103(102) Ascospores simple **104**

– Ascospores colourless, 1- to 5-septate **105**

104(103) Ascospores nearly globose; on siliceous rock ..... ***Schaereria***

– Ascospores ellipsoid; on soil or limestone; Apothecia brown-black; on soil amongst limestone rocks ..... ***Psora*, *Romjularia***

105(103) Paraphyses free, each with a distinct swollen apical cell, covered by a pigmented cap ..... ***Thalloidima*, *Toninia*, *Toniniopsis*, *Xylopsora***

– Paraphyses conglutinated, without cap ..... ***Bilimbia lobulata***

106(91) Thallus sorediate, leprose or with irregular, isidia-like protuberances **107**

– Thallus not sorediate, without irregular, isidia-like protuberances **111**

107(106) Thallus surface leprose ..... ***Lepraria*, *Botryolepraria*, *Chrysothrix*, *Leproplaca***

– Thallus sorediate or isidiate **108**

108(107) Thallus C+ red; soralia developing from the sides of areoles or cracks in the thallus ..... ***Trapelia placodioides***

– Thallus C– **109**

109(108) Thallus K+ yellow, thallus pruinose, with distinct lobes closely contiguous for mostof their length; apothecia without a thalline exciple ..... ***Diploicia canescens***

– Thallus K–; thallus non-pruinose; apothecia with a thalline exciple **110**

110(109) Thallus lobes corticate; soralia discrete; thallus greenish to brown ..... ***Hyperphyscia adglutinata***

– Thallus not corticate; soredia irregular and confluent; thallus whitish ..... ***Kuettlingeria teicholyta***

111(106) On soil; thallus ± white, or white-pruinose; without papillae; apothecia frequent, sessile; on calcareous soil; apothecia with a thalline exciple; ascospores colourless, simple ..... ***Squamarina lentigera***

– On rocks **112**

112(111) Thallus ± crustose with elongated marginal lobes; apothecia immersed; asci >200-spored; thallus C+ red ..... ***Sporastatia***

– Thallus squamulose, apothecia sessile; asci <8-spored, thallus C– **113**

113(112) Ascospores 1-septate; on limestone and coastal serpentine ..... ***Solenopsora***

– Ascospores simple; on a range of substrata, especially nutrient enriched rocks and building materials ..... ***Lecanora*** (placodioid species)

CRUSTOSE LICHENS

114(49) Thallus fertile (fruits globose, volcano-like, disc-like, elongate, stalked, shelf, or mushroom-like) ..... **Fertile thalli**

– Crustose thalli with perithecioid ascomata ..... Fertile thalli **KEY 1**

– Crustose thalli with stalked apothecia ..... Fertile thalli **KEY 2**

– Crustose thalli with lirellate (elongated) apothecia..... Fertile thalli **KEY 3**
– Crustose thalli with rounded apothecia..... Fertile thalli **KEY 4**
– Thallus sterile (often with isidia or ± delimited soredia, or entirely leprose)..... **Sterile thalli** (not treated)

Fertile thalli KEY 1 – Crustose thalli with perithecioid ascomata

1 Thallus squamulose of squamules < 1cm or placodioid (central crustose part surrounded by elongated lobes)... **2**
– Thallus crustose, granulose or inconscpicuous..... **6**
2(1) Ascospores muriform, colourless or brown..... **3**
– Ascospores simple or septate, colourless..... **4**
3(2) Thallus greenish brown (turning yellowish, greyish brown in herbarium) squamules of 0.3–1 cm, perithecia conical or barrel shaped with verrucose surface, among squamules or slightly immersed in the thallus. Without hymenial algae..... ***Agonimia tristicula***
– Thallus brown, greyish or olive brown, squamulose with squamules of 0.5–2.5(–4) mm. With hymenial algae..... ***Endocarpon***
4(2) Ascospores 1–3-septate..... ***Placidiopsis*, *Placopyrenium*, *Thelidium***
– Ascospores simple..... **5**
5(4) Thallus of single or confluent squamules..... ***Placidium*, *Placocarpus*, *Catapyrenium***
– Thallus of areolae, with larger marginal areolae or rarely of squamules..... ***Verrucaria, Verruculopsis***
6(1) Ascospores slightly or clearly muriform, at least with one longitudinal septum..... **7**
– Ascospores simple or transverse septate..... **9**
7(6) With small sphaerical or cylindrical algae in the hymenium; saxicolous..... ***Staurothele***
– Without hymenial algae..... **8**
8(7) Perithecia conical or barrel shaped with verrucose surface, paraphyses missing. Thallus granulose or squamulose. On soil, mosses, plant remnants..... ***Agonimia tristicula***

– Perithecia different, not conical or barrel shaped, not with verrucose surface, hemisphaerical to entirely immersed paraphyses dissolved while ripening. Thallus obvious to inscopious. On calcareous and siliceous rock, also on soil, mosses, plant remnants ..... ***Polyblastia*, *Verrucula***

9(6) Ascospores various, simple, 1- to multiseptate or muriform **10**

– Ascospores septate **21**
(with submuriform/muriform at ***Gyalecta***)

10(9) On bark ..... ***Strigula*, *Thelenella*, *Chromatochlamys***

– On rock, soil, mosses, plant remnants **11**

11(10) Ascospores small, in a large number in the asci ..... ***Thelopsis*, *Thelocarpon***

– Ascospores 1–8 in the asci **12**

12(11) On bark, wood **13**

– On soil, mosses, rocks **15**

13(12) Ascospores needle-shaped, thin acicular- fusiform, slightly curved, under 3.5 µm wide ..... ***Leptorhaphis***

– Ascospores ellipsoid **14**

14(13) Ascospores thin-walled, 3–11 µm, perithecia black, up to 0.7 mm, ± immersed ..... ***Bagliettoa*, *Verrucaria***

– Ascospores thick-walled, mostly at least 30 µm wide ..... ***Pertusaria***

15(12) Ascospores at leasts partly wider than 40 µm ..... ***Pertusaria*** (incl. ***Lepra***)

– Ascospores up to 40 µm wide **16**

16(15) On soil, mosses **17**

– On rocks **19**

17(16) Parahyses obvious, not branching. Thallus inconspicous when dry, mucous when wet ..... ***Thrombium***

– Paraphyses missing in developed perithecia. Thallus well developed **18**

18(17) Thallus of areoles or squamules, grey to brown ..... ***Catapyrenium***

– Thallus of tiny greyish green goniocytangia-like granules of 0.015–0.04 mm or thin ..... ***Verrucaria***

19(16) Ascospores very thin, threadlike to cylindrical or clavate ..... ***Sarcopyrenia***

– Ascospores ellipsoid to sphaerica..... **20**

20(19) Photobiont cynobacterium (*Gloeocapsa* photobiont with a red-brown K+ purple gelatinous sheaths); hamathecium of periphysoids near to the ostiole; interascal filaments either absent or inconspicuous and much shorter than the asci; asci thin-walled, with pointed tips..... ***Cryptothele rhodosticta***

– Photobiont green alga; hamathecium of periphyses and periphysoids, interascal filaments absent; asci clavate, wall thickened above..... ***Parabagliettoa*, *Psoroglaena*, *Verrucaria***

21(9) Ascospores brown, thallus with *Trentepohlia* photobiont..... ***Pyrenula*** (incl. ***Eopyrenula***)

– Ascospores colourless or slightly coloured..... **22**

22(22) Ascospores septate or muriform. Ascomata flat to urceolate apothecia. Thallus thin, smooth, photobiont *Trentepohlia*..... ***Gyalecta***

– Ascospores transversely septate..... **23**

23(22) Ascospores 1(–3)-septate with thick walls, clavate, oblong or fusiform, in single line in asci (uniseriate), paraphyses sparsely branched or anastomosing..... ***Acrocordia*, *Anisomeridium*, *Arthopyrenia*, *Naetrocymbe*, *Naevia***

– Ascospores with several septa..... **24**

24(23) Ascomata perithecioid, exciple pseudoparenchymatous. Ascospores threadlike, acicular-fusiform, 1–3-septate mostly without photobiont or loosely associated with *Trentepohlia*..... ***Leptorhaphis***

– Ascospores acicular-fusiform, 4–8-celled; paraphyses are unbranched or branched, thallus without soredia..... ***Porina*, *Pseudosagedia*, *Swinscowia***

Fertile thalli KEY 2 – Crustose thalli with stalked apothecia

1 Apothecium with a dry spore mass (mazaedium)..... **2**

– Apothecium without a dry spore mass (mazaedium), stalk white..... **7**

2(1) Apothecium with short stalk or without stalk, ascospores with brown wall..... **3**

– Apothecium obviously stalked **4**
3(2) Ascopore simple, on bark ..... ***Sphinctrina***
– Ascopore 2-celled to submuriform, on wood ..... ***Calicium notarisii***
4(2) On siliceous rock **5**
– On bark or wood **6**
5(4) Thallus, stalk and lower part of apothecia is yellow, yellow-green. Ascospore simple, pale ..... ***Chaenotheca furfuracea***
– Mazaedium brown, ascospore light brown, not clearly 1-3 septate ..... ***Chaenotheca*, *Sclerophora***
6(4) Mazaedium brown, ascospore light brown, not clearly 1-3 septate ..... ***Chaenotheca*, *Sclerophora***
– Mazaedium black, ascospore dark brown, 2-celled ..... ***Calicium***
7(1) Hymenium jelly I+ blue; apothecium pink ..... ***Dibaeis baeomyces***
– Hymenium jelly I-; apothecium reddish brown ..... ***Baeomyces rufus***

Fertile thalli KEY 3 – Crustose thalli with lirellate (elongated) apothecia

1 Apothecia lacking true exciple or rarely rudimentary and developed only laterally **2**
– True exciple present; photobiont various **3**
2(1) Ascospores 1- to 7-septate, ovoid to oblong-ovoid ..... ***Arthonia*, *Bryostigma*, *Diarthonis***
– Ascospores submuriform to strongly muriform, ovoid-ellipsoid ..... ***Arthothelium***
3(1) Ascospores simple, outer surface of apothecium pale brown; paraphyses simple or sparingly branched ..... ***Xylographa***
– Ascospores multiseptate or muriform **4**
4(3) Ascospores I+ violet, thick-walled, their cells with lens-shaped, round or oval lumina; hamathecium of simple paraphyses. Ascospores not coloured when mature, occasionally becoming brown when old; apothecia with surfaces becoming longitudinally grooved or ridged and

narrow discs ..... ***Graphis***

– Ascospores I–, with cylindrical or cuboid lumina, colourless or not; hamathecium variable **5**

5(4) Ascospores brown. True exciple not friable; ascospores often becoming rough ..... ***Opegrapha***

– Ascospores colourless. Lateral exciple in section well-developed, brown to black **6**

6(5) Thallus Pd+ yellow; on rock; ascospores 3(–5)-septate ..... ***Psoronactis*** (*Lecanactis*) ***dilleniana***

– Thallus not Pd+ yellow ..... ***Opegrapha*** (incl. ***Alyxoria***, ***Zwackhia***, ***Gyrographa***)

Fertile thalli KEY 4 – Crustose thalli with rounded apothecia

1 Thallus yellow, orange, orange-red, K+ deep red immediately. Ascospores 1(–3)-septate, mostly thick walled ..... ***Caloplaca*** (incl. ***Athallia***, ***Blastenia***, ***Calogaya***, ***Cerothallia***, ***Flavoplaca***, ***Seawardiella***, ***Solitaria***, ***Squamulea***)

– Characters different from the above ones. If thallus is yellow, reaction is not as above **2**

2(1) Ascospores multicelled **3**

– Ascospores simple **42**

3(2) Ascospores muriform (both with longitudingal and transverse septa) **4**

– Ascospores only with transverse septa **9**

4(3) Apothecia grey to white, similar to soralia, immersed in the whitish grey thallus. Thallus K+ red, on bark. Ascospores ellipsoid, 1–2 in ascus ..... ***Phlyctis***

– Apothecia not similar to soralia, not, covered with whitish granules **5**

5(4) Apothecia pink, brown, yellowish, orange to almost colourless. Thallus with *Trentepohlia*, or usual green algae ..... ***Gyalecta***, ***Gyalidea***

– Apothecia black, but also grey pruinose ones **6**

6(5) Ascospores soon brown to green coloured **7**

– Ascospores remain long colourless or with a pale hue / tone. Apothecia black, pruinose. Paraphyses richly branched and forming a net. Thallus well developed, with

areoles. On rocks ..... ***Rhizocarpon***

7(6) Apothecium disc deeply sitting from the beginning, true and thalline exciple turning inwards with narrow opening, at first black, later becoming pruinose. Thallus thick, grey to ochraceous, C+ red. On rock, soil, mosses ..... ***Diploschistes***

– Apothecium disc not immersed, no thalline margin or white thalline margin. Thallus C– **8**

8(7) Ascospore with halo at least when young, Paraphyses richly branched and forming a net. Thallus well developed, with areoles. On rocks ..... ***Rhizocarpon***

– Ascospore without halo. Parphyses simple of forkening. On various substrates ..... ***Diplotomma***

9(3) Ascospores colour, greenish, olivaceous, dark brown **10**

– Ascospores colourless (slightly coloured when old) **13**

10(9) Photobiont *Trentepohlia*. Apothecia without a margin, brown to black, occasionally pruinose. Excipulum reduced, thin. Paraphyses netlike and anastomosing. Ascospores 2- or multicelled, brown only with ripening ..... ***Arthonia*, *Coniocarpon***

– Photobiont coccoid green alga **11**

11(10) Paraphyses richly branched and anastomosing. Ascospores halonate at least when young. Thallus usually well developed, areolate. On rocks ..... ***Rhizocarpon***

– Paraphyses simple or forked. Ascospore not halonate. On bark and rock **12**

12(11) Apothecia with thalline margin. Hypothecium mostly colourless or pale brownish. Septa of apothecia unevenly thickened ..... ***Rinodina*** (incl. ***Helmutiopsis***)

– Apothecia without thalline margin (no algae in the margin) or immersed in thallus. Hypothecium dark. Septa evenly thickened ..... ***Buellia*** (incl. ***Amandinea*, *Dimelaena, Epilichen*, *Monerolechia*, *Tetramelas***)

13(9) Ascospore bipolar 2-celled, with small opening in the middle of the wall. The wall can be thin or thick. Apothecium yelow, orange, red or orange-brown, K+ dark red ..... ***Caloplaca*** (incl. ***Athallia, Kuettlingeria, Laundonia*, *Olegblumia*, *Opeltia*, *Pisutiella, Pyrenodesmia*, *Rufoplaca*, *Variospora*, *Xanthocarpia***)

– Ascospore not bipolar, septae thin..... **14**

14(13) Photobionta *Trentepohlia*..... **15**

– Photobionta coccoid green alga..... **26**

15(14) Ascospores 2-celled..... **16**

– Ascopores with more cells..... **18**

16(15) Paraphyses netlike, anastomosing. Exciple reduced. Apothecia without margin..... ***Arthonia***

– Paraphyses simple..... **17**

17(16) Apothecium whitish to orange, with concave to flat disc. Hypothecium and excipulum colourless. Ascospores fusiform or ellipsoid. Thallus thin, grey to green. On bark and mosses..... ***Coenogonium***

– Apothecium dark, black or brown, round. Hypothecium and excipulum dark or pale. Ascospore remaining colourless, cells with the same size..... ***Catillaria***

18(15) Apothecium not black..... **19**

– Apothecium black, sometimes with pruina..... **21**

19(18) Ascospores 16 or more in the asci..... ***Gyalecta***

– Ascospores up to 8 in the asci..... **20**

20(19) Apothecia with margin..... ***Gyalecta***

– Apothecium without margin..... ***Arthonia***

21(18) Ascospores multicelled, needle-shaped, threadlike, 50–80(–100) × 1.5–3 µm, fragmented into short parts. Apothecia black, thallus whitish, on *Quercus* bark..... ***Bactrospora*** (*Lecanactis*) ***corticola***

– Ascospores shorter, mostly fusiform, not fragmented into smaller parts..... **22**

22(21) Hamathecium of paraphysoids. Asci clavate, apex thickened. Acospores without a halo. Apothecia grey, with pruina..... ***Dirina massiliensis***

– Hamathecium of paraphyses. Acospores with or without a halo..... **23**

23(22) Paraphyses simple or forked, anastomosing in lower part. Ascospore 4-celled, with halo. Asci thinwalled Apothecia black. On calcareous rock..... ***Sagiolechia***

– Paraphyses branched and anastomosing. Asci thickwalled..... **24**

24(23) Apothecium peritheciumlike, disc tiny dotlike. Dark exciple develops only sidewards. Thallus dark brown with pale soralia, prothallus represented as a black line.....***Enterographa zonata***

– The disc not dotlike. Dark exciple develops also below, a conelike sheath develops.....**25**

25(24) Apothecium not round, disc often with rim and umbilicus. Sheath is black, often strongly developed below. On rock.....***Opegrapha***

– Apothecium round, often pruinose, disc shiny, with proper margin, sheath blackish brown. On rock and bark.....***Dendrographa*** (*Lecanactis*) ***latebrarum***

26(14) Apothecium with a starlike opening, a thalline cover splits radially from a central pore as the structure expands, partly sinked in calcareous rock. Photobiont *Scytonema*.....***Petractis clausa***

– Apothecium edge not starlike. Not with *Scytonema*, but green algae.....**27**

27(26) Apothecium disc yellow, orange, brown orange, K+ deep red, ascospores 2-celled.....***Caloplaca*** (incl. ***Athallia***)

– If apothecium disc yellow to orange, not immediately K+ deep red.....**28**

28(27) Ascospores large of several hundred µm, 2-celled, with wall of several layers. Apothecia immersed by 1–3 in a thalline wart. Thallus thick, white to grey, C+ red. On plant remnants, mosses.....***Varicellaria***

– Ascospore smaller, thinwalled.....**29**

29(28) Apothecium margin with algae (colour similar to that of thallus – lecanorine) or apothecia immersed in thalline warts. On plant remnants, mosses and wood.....**30**

– Apothecium margin without algae (colour similar to that of disc – lecideine, biatorine) or without a margin.....**32**

30(29) Ascospores at least 30 µm long, fusiform or needleshaped with (1–)3–7 transverse septa. Apothecium red, K+ dark red or blue, or apothecium rarely brown, not pruinose, concave or swollen.....***Haematomma***

– Ascospore shorter, ellipsoid, simple to 2–4-celled, up to 8 in asci. Apothecium not red.....**31**

31(30) Apothecium disc yellow, dirty yellow, brownish yellow, K– or slightly reddish. Thallus yellow or grey, ascospores simple to 2-celled ..... ***Candelariella***

– Apothecia brown, reddish brown to black, white pruinose, c. 1mm, thalline margin soon disappearing, ascospore 2- or 4-celled ..... ***Lecania***

32(29) Thallus of thick, more seldom thinner squsamules. Apothecia black, occasionally pruinose. Ascospore fusiform or needleshaped, 2–8-celled, on soil, moss, calcareous, more seldom siliceous rock ..... ***Toninia, Toniniopsis, Thalloidima, Porpidinia***

– Thallus not squamulose, crustose, even, not differentiated or areolate **33**

33(32) On thin branches and conifer needles and evergreen deciduous trees **34**

– On other habitat **35**

34(33) Apothecia pale, whitish, beige, or pink, brown, orange. Excipulum of spherical to ellipsoid or angulate cells. Ascospores 2-celled or 2–4(–6)-celled, very thin (up to 1.5–2 μm) ..... ***Bacidina***

– Apothecia dark brown, dark reddish brown to black, soon without margin, excipulum of radiating, branched and anastomosing hyphae ..... ***Scoliciosporum***

35(33) Hypothecium and excipulum missing, hymenial gelatine missing, I– . Apothecia flat or swollen, thallus fine granulose of goniocystangia, ephemeral ..... ***Vezdaea***

– Hypothecium well developed, hymenial gelatine present, I+ blue **36**

36(35) Ascospores 2-celled, not needleshaped or threadlike **37**

– Ascospores mulitiseptate, if needleshaped or threadlike or wider up to 4 um. Apothecia pale to brown, with obvious margin at least when young, exciple well developed, proso- or paraplectenchymatic (consisting of radial or cellular hyphae) ..... ***Bacidia*** (incl. ***Aquacidia***, ***Bellicidia***, ***Bibbya***, ***Coppinsidea***, ***Mycobilimbia***)

37(36) Apothecia frequent, zeorine, immersed, 0.5–2(–4) mm across, with a brownish black, concave to flat, smooth disc, triangular lobes radiating all around the apothecia. Asci many-spored, narrowly clavate, thin-walled, apically

thickened, the wall I-. Ascospores 1-septate, colourless, narrowly ellipsoid (7–)11–17 × (2–)3–4 µm. On loess ..... ***Gyalidea asteriscus***

– Apothecia not with startlike appendages, asci not with many ascospores, substrate different **38**

38(37) Apothecium concave, small, up to 0.4 mm, yellowish to pale brownish, asci thickened in upper part, I+ reddish brown. Paraphyses simple. On wood ..... ***Absconditella***

– Apothecia flat or swollen **39**

39(38) Apothecia black **40**

– Apothecia pale to black **41**

40(39) Apothecium margin persistent. Thallus effuse, thin, ± evanescent; soralia large, grey-white to glaucous, granular, hypothecium colourless or pale brown, K–. Ascospores broadly to fusiform-ellipsoid, the walls rather thick; not with halo (perispore absent). On bark ..... ***Megalaria pulverea***

– Apothecium margin disappearing. Hypothecium black to brown. Ascospores with halo at lease when young. On rock ..... ***Rhizocarpon***

41(39) Paraphyses simple or forked. Apothecium pale to black, margin obvious at least when young ..... ***Catillaria*** (key with ***Biatora*, *Catinaria*, *Cliostomum***)

– Paraphyses branching. Apothecium not brownish black or black, without or with inconspicuous margin ..... ***Micarea*, *Leimonis***

42(2) Asci with many (above 50) tiny ascopores **43**

– Asci with 1–16 (sometimes 32) ascospores, mostly 8 ..... **47**

43(42) Apothecia / thallus warts with apothecia with small, dotlike opening, peritheciumlike, pale or greenish yellow. Thallus inconspicuous ..... ***Thelocarpon***

– Apothecium with widely opening disc, if less wide, then thallus well developed **44**

44(43) On rock **45**

– On bark, wood, plant remnants **46**

45(44) Apothecia mostly with brown, reddish brown disc (sometimes black, dotlike), with thalline margin or immersed in thallus ..... ***Acaropsora***

– Apothecia black to reddish brown, white pruinose, with proper margin, no thalline margin. Thallus obvious or inconspicuous ..... ***Sarcogyne***

46(44) Apothecium blackish, ±flat, with obvious thalline margin. Hypothecium pale, epihymenium dark brown. Ascospores 5–6.5 × 2.5–3.5 µm. Thallus pale greyish, olive-green to olive-brown, warty, granulose ..... ***Maronea constans***

– Apothecium without thalline margin, with or without proper margin, whitish, yellowish, ochraceous, brown, reddish brown or blackish, soon swollen. Hypothecium pale to brownish ..... ***Biatorella, Biatoridium, Piccolia, Sarcosagium***

47(42) Apothecia yellow, orange or rust coloured, immediatly strongly swollen, without margin and fast K+ deep red ..... ***Protoblastenia***

– With other characters, if thallus or apothecium yellow, then not K+ deep red **48**

48(47) Ascospores very large, mostly above 30 µm, widely ellipsoid or spherical **49**

– Ascospores less large, mostly up to 30 µm **51**

49(48) Apothecia mostly flat, with thick thalline margin, disc wide, rose-brownish, white pruinose. Asospores ± thickwalled ..... ***Ochrolechia*** (key with ***Pertusaria***)

– Apothecium different **50**

50(49) Ascospores ±thickwalled, mostly ovoid, 1–8 in ascus. Apothecium peritheciumlike, disc narrow, dotlike, immersed in thallus warts, rarely black, widely opened, not immersed in thallus warts, often rich in lichen secondary metabolites ..... ***Pertusaria***

– Ascospores ± thinwalled (up to 2.5 µm), 4–8 in ascus, widely ellipsoid 30–60 × 20–40 µm. Apothecia deeply immersed in the 1.5 mm wide thallus warts, disc black, dotlike at first, then opens more widely (to 0.5 mm). Thalline margin somewhat black inside. Thallus uneven, whitish, pale grey. On mosses, plant rests, bark ..... ***Megaspora verrucosa***

51(48) Apothecium yellow, lemon yellow, ochraceous, brownish or olive yellow, often also thallus is yellow **52**

– Apothecium not yellow **54**

52(51) Ascospore 4–7 × 1–2 µm, up to 8 in ascus. Thallus fine farinose, lemon yellow, greenish yellow. Apothecium swollen, without margin. Paraphyses ±simple, thin. Usually on vertical position on siliceous rock..... ***Psilolechia lucida***

– Ascopores larger..... **53**

53(52) Ascospores to 8 or 12–32, mostly cylindric. Apothecia flat to swollen, mostly with margin, lecanorin, seldom biatorince, yellow. Thallus fince granulose or sometimes areolate, sometimes finely sorediate. Tholus amyloid only at lower part – usually with pulvinic acid derivatives..... ***Candelariella***

– Ascospores up to 8. elliptic. Apothecium lecanorine, pale yellow, pale greenish yellow, brown yellow. Thallus areolate or sorediate, the entire tholus is amyloid, rich in lichen secondary metabolites, mostly without pulvinic acid derivatives..... ***Lecanora*, *Bryonora***

54(51) Photobiont *Trentepohlia*..... ***Hymenelia epulotica***

– Photobiont not *Trentepohlia*, usually coccoid green alga..... **55**

55(54) Apothecium lecanorine, with thaline margin..... **56**

– Apothecium biatorine or lecideine, with thaline margin..... **57**

56(55) Apothecium disc concave, deeply immersed in thallus. On rock..... ***Aspicilia*, *Circinaria*, *Ionaspis*, *Lecaimmeria*, *Lobothallia***

– Apothecium disc flat to swollen. Apothecium normally sessile, only rarely immersed..... ***Lecanora*** (incl. ***Eiglera***, ***Glaucomaria***, ***Myriolecis***, ***Olegblumia***, ***Placynthiella***, ***Polyozosia***, ***Rhizoplaca***, ***Rimularia***, ***Straminella***, ***Tephromela***)

57(55) Hypothecium and excipulum missing, hymenial gelatine missing, I–. Apothecia flat or swollen, thallus fine granulose of goniocystangia, ephemeral..... ***Vezdaea***

– Apothecia flat to swollen, immersed or sessile. Paraphyses simple or branched and anastomosing. Ascospores elongated, narrow or wide elliptic or spherical. Hypothecium colourless or brown black. Asci obvious, K+I reaction is strong + blue, hymenium I+ blue...

.....***Lecidea***
(incl. ***Ainoa, Bryobilimbia, Carbonea, Clauzadea, Farnoldia, Fuscidea, Lambiella, Porpidia, Ropalospora, Schadonia, Steinia, Strangospora***)

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