

## **LECIDEA.SEG**

### **LECIDEA SEGREGATES REPORTED FOR NORTH AMERICA**

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(After Hertel, Poelt & Vezda, Wirth, and others,  
with revisions suggested by G. Rambold)

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#### **GENERAL "NATURAL" KEY**

**1. Apothecia (and mature asci) present. ....2**

**1. Apothecia (or mature asci) absent. .... KEY I.**

**2. Ascus apical structure distinctly visible in I<sub>2</sub>KI (1.5%), at least after pre-treatment with K. .... 3**

**2. Ascus apical structure indistinct. .... KEY II.**

**3. Asci with amyloid outer gelatinous wall layer (brownish in iodine); tholus lacking axial structures.** Apothecia lecideine or biatorine; hypothecium hyaline or dark; paraphyses simple or branched, usually with thickened tips, often anastomosing. Spores hyaline or brownish. Fulcra short-celled; pycnosporos (usually?) bacilliform, 3-5 x ca. 1 um. Mostly on rock. .... KEY III. SUBORDER BUELLIINEAE

**3. Asci of some other type, without such an outer wall layer; tholus often with axial structures.** Spores hyaline. Other characters various. .... 4

**4. Ascus apex with tholus more or less amyloid at the lateral parts, usually with a non-amyloid axial mass; without an external amyloid cap or internal amyloid tubelike structure; with or without an amyloid zone above the axial mass; spores non-halonate. Medulla usually I-. ... KEY IV. SUBORDER "LECANORIINEAE" Rambold & Triebel ined.**

**4. Ascus apex with tholus not or only weakly amyloid (with or without external amyloid cap or ring, or an internal amyloid tubelike structure); or tholus more or less amyloid at the lateral parts, but with an amyloid cap (or tube); spores halonate or not. Medulla I+ violet or I-. .... KEY V. SUBORDER "CLADONIINEAE" Rambold & Triebel ined.**

## KEY I. (STERILE LECIDEOID LICHENS)

1. **Thallus squamulose.** ..... 2
1. **Thallus crustose.** ..... 3
  2. **On soil or occasionally rock.** ..... Psora
  2. **On bark or wood.** ..... Hypocenomyce and Phyllopsora
3. **Thallus yellowish, C+ orange (xanthones).** ..... 4
3. **Thallus some other color, or if yellowish then C- or C+ red (no xanthones).** ..... 5
  4. **Thallus with discrete soralia.** On various substrates. .... Lecidella
  4. **Thallus entirely sorediate.** On bark or wood. .... Pyrrhospora quernea
5. **On rock.** ..... 6
5. **On other substrates.** ..... 8
  6. **Thallus with cephalodia.** ..... Amygdalaria
  6. **Thallus without cephalodia.** ..... 7
7. **Thallus bright yellow to dark green, leprose or granular, C-.** ..... Psilolecia
7. **Thallus not distinctly yellow or green; not leprose.** .....  
(Rimularia, Porpidia, Lecidea, and others)
8. **Thallus pale, granular to sorediate.** ..... 9
8. **Thallus dark, not sorediate.** ..... Placynthiella
9. **Thallus at least partly C+ red.** .....  
..... Trapeliopsis and Micarea
9. **Thallus C-.** ..... (various genera)

## KEY II. (ASCUS STRUCTURE NOT DISTINCTLY VISIBLE)

**1. Tholus of the asci more or less non-amyloid, or reduced.** Apothecia immersed to adnate, the disc concave to plane, black, dull, epruinose. Medulla I-. On non-calcareous rock or soil. .... (see KEY V: Tremolecia and Schaereria)

**1. Tholus of the asci usually thick, at least partly distinctly amyloid (sometimes only the small apical cap or tube is amyloid, making the tholus appear to be almost Tremolecia type).** Apothecia immersed to sessile, the discs various. Medulla I+ violet or I-. .... 2

**2. Tholus of the asci with amyloid lateral areas,** with or without an amyloid cap. .... 3

**2. Tholus of the asci without amyloid lateral areas.** ... 5

**3. Asci of the Trapelia- or Rimularia-type, the tholus with weakly to strongly amyloid cap and non-amyloid central area.** Apothecia biatorine, lecanorine, or lecideine; spores simple, not pseudoblastic. Pycnospores (usually?) bacilliform. Thallus often C+ red (gyrophoric acid); medulla I-. On various substrates. .... (see KEY V: AGYRIACEAE AND RIMULARIACEAE)

**3. Asci of the Lecanora-type, the tholus with scarcely developed ocular chamber and indistinct axial mass, without amyloid cap.** Apothecia usually biatorine, or rarely lecanorine; spores simple but usually with central plasma bridge ("pseudoblastic"). Pycnospores filiform. Thallus C-, usually containing miriquidic acid as main substance; rarely with norstictic acid only. On rock. .... (see KEY IV: Miriquidica)

**4. Paraphyses mostly simple; tholus of asci with tubelike structure. Thallus pulvinate-squamulose,** of thickly crowded but non-imbricate squamules with appressed margins, forming a flat crust, the squamules angular, 1-2(-4) mm wide, rather dark brown above and below, on black hypothallus. Apothecia lecideine. Pycnospores unknown. On acid turfy soil, alpine. .... (see KEY V: Lecidoma demissum)

**4. Paraphyses often branched or anastomosing; tholus of asci with or without tubelike structure. Thallus not squamulose, or at least not pulvinate.** Apothecia lecideine or not. Pycnospores bacilliform or filiform. Substrate and habitat various. ... (see KEY V: Micarea and Lecidea)

### KEY III. (BUELLIINEAE)

**1. Asci of the Teloschistes-type, swollen below the apex, with K/I+ dark blue apical cap and K/I+ weakly bluish apical area below that.**

Apothecia (in these genera) black, marginate at least when young; excipulum pale inside; spores hyaline, simple (in these genera). Thallus crustose, whitish or gray, C-. Other characters various. TELOSCHISTACEAE. .... 2

**1. Asci of the Fuscidea-type, subcylindrical, with K/I+ cap separated from K/I+ apical area by K/I- area.**

Apothecia brown or black; hymenium hyaline or brownish; spores often brownish-grayish while still in ascus. Thallus crustose, often C+ red; medulla I-. FUSCIDEACEAE. .... 3

**2. Paraphyses of Cephalophysis-type, strongly capitate thickened at tips, rather easily free.**

Apothecia epruinose, scabrid, to 0.3 mm diameter, becoming convex and immarginate; exciple rose-violet, K+ intense violet, pale inside; hypothecium dark brown; hymenium ca. 50 µm high; hymenium and epihymenium greenish, K-; asci subcylindrical; spores ellipsoid. Pycnospores unknown. Thallus mostly immersed, whitish, K-; medulla I-. On calcareous rock, arctic-alpine ..... Cephalophysis (leucospila)

**2. Paraphyses of a different type, branched above, the tips clavate, weakly thickened.**

Apothecia larger; margin including a few algae; hypothecium pale; hymenium hyaline; epihymenium K+ violet; asci clavate; spores oblong, 14-24 x 4-8 µm. Thallus crustose. On calcareous sandstone, Colorado. .... Apatopla (oblongula)

**3. Paraphyses swollen; epihymenium greenish or purplish, the pigment diffuse; hypothecium pale to dark brown; hymenium I+ blue; spore walls strongly thickened. Apothecia appearing lecanorine, or lecideoid but immersed in the thallus; disk black,**

epruinose; thalline exciple absent. True exciple and hypothecium dark brownish. Hymenium colorless or pale. Paraphyses simple or sparingly branched and anastomosing; tips without pigmented caps; asci clavate, 8-spored; apical dome narrow, not or weakly I+ blue but ascus apex surmounted with a strongly I+ blue, rather diffuse cap. Spores colorless or dark olive brown, ellipsoid, thick-walled, simple or with an indistinct septum. Pycnidia immersed; conidiogenous cells integrated in chains, cylindrical, acrogenous or pleurogenous; pycnospores bacilliform, simple, colorless. Thallus areolate, gray to blackish; medulla white to dark brown; hypothallus blackish. Photobiont chlorococcoid. No substances. On siliceous rock, montane. .... Orphniospora

**3. Paraphyses scarcely swollen; epihymenium brown, the pigment partly granular; hypothecium hyaline; hymenium I-; spore walls**

**moderately to strongly thickened. Apothecia biatorine, immersed to sessile; disk red-brown to brown-black.** Thalline exiple usually absent, at most poorly developed. True exciple  $\pm$  distinct, persistent or occulded, concolorous with disc or paler; inner part colorless or pale brownish; outer part brown or black-brown. Hypothecium colorless or pale straw; hyphae vertical. Epithecium brown. Hymenium colorless or sometimes pale brownish. Paraphyses 1.5-2  $\mu$ m wide, simple or sparsely branched, weakly conglutinated in water, especially at the apices, becoming  $\pm$  free in K, a brown pigment surrounding the 1-2 uppermost cells; upper cell clavate, to 5  $\mu$ m wide. Asci 8-spored, subcylindrical to clavate, with a thin external and internal K/I+ dark blue cap, surrounded by a thick, K/I+ pale blue, gelatinous apical cap. Spores colorless, sometimes brown when old,  $\pm$  spherical to usually ellipsoid, rarely elongate, straight to curved or bean-shaped, typically simple, but to 7-septate in "Rhopalospora". Pycnidia immersed in thalline warts at thallus margin; pycnospores cylindrical, with obtuse apices, or ellipsoid. Containing orcinol para-depsides and tridepsides; also fumarportocetraric, alectorialic and fatty acids. Thallus rimose to regularly areolate; pale brownish to dark brown; medulla white; prothallus commonly present. Upper cortex undifferentiated, sometimes with a layer of brownish surface cells; lower cortex absent. Medulla usually I-, rarely I+ blue. Photobiont chlorococcoid. On siliceous rock or rarely acidic bark, usually in nutrient-deficient sites. .... Fuscidea s. lato (including Rhopalospora, with septate ascospores)

#### KEY IV. (LECANORIINEAE)

**1. Asci Lecanora-type, the tholus only partly amyloid, with distinct or indistinct non-amyloid axial mass extending down from the top through the center;** apothecia often lecanorine (with algae in the margin or below hypothecium). Pycnosporos usually filiform.

LECANORACEAE ..... 2

**1. Asci Bacidia-type or Biatora-type (or Lecanora-type in Lecidella?), the tholus usually entirely amyloid, or at least without a non-amyloid axial mass (but sometimes with non-amyloid ocular chamber visible below the tholus), the structure sometimes difficult to see;** apothecia not lecanorine, but sometimes pseudolecanorine (with margin paler than disc). ..... 7

**2. Apothecia (often) deep red to red-brown or brown-black and with the epihymenium K+ reddish purple or black-red (in section), with outer part of exciple orange-red, or (e.g., P. elabens) apothecia pure black, but...** Apothecia biatorine, sessile, mostly soon convex and immarginate; thalline exciple absent; true exciple of conglutinated, thick-walled, radially oriented hyphae; hypothecium colorless; hymenium strongly gelatinized, colorless, I+ blue; paraphyses usually simple or branched towards apices, 1.5-2 um wide, septate, constricted at the septa, the tips weakly thickened; epihymenium hyaline or red-brown, with brownish granules, or (P. elabens) blackish; asci broadly clavate, with undifferentiated amyloid mass in the tip (Lecanora type according to Hawksworth, which would seem to imply a non-amyloid axial mass and amyloid ring); outer ascus wall not amyloid; spores ellipsoid to broadly ellipsoid, simple, rather thick walled, brown when old, smooth, without distinct perispore. Pycnidia unknown. Thallus superficial, finely granular-sorediate or subareolate, pale, often yellowish, C+ orange (xanthones) or C-, KC+ yellow (usnic acid), or whitish, C-, KC-. Anthraquinones (usually?) in apothecia. Photobiont trebouxoid. On bark or wood (in N. American species; some others occur on rock). ..... Pyrrhospora

**2. Apothecia not both yellow to red and K+ simultaneously; exciple not red-orange.** Other characters various. On rock, soil, bark or wood. .... 3

**3. Ascus apex when mature completely amyloid (except ocular chamber), without axial mass. Paraphyses mostly simple and easily freed in water.** Apothecia usually black, lecideine or biatorine; hypothecium hyaline to orange-brown; epihymenium usually blue-green, at least when young; spores broadly ellipsoid, 11-19 x 6-10 um. ....(Lecidella--young asci)

**3. Ascus apex when mature with non-amyloid axial mass. Paraphyses mostly branched and at least moderately coherent.**

Apothecia pale or black, biatorine or lecanorine; hypothecium hyaline; epihymenium variously colored; paraphyses 1.5-2  $\mu$ m wide, spores mostly ellipsoid to narrowly ellipsoid. .... 4

**4. Apothecia lecideine, sessile, subconcave to plane or subconvex, the margin distinct and persistent, the exciple rather strongly developed, the inside pigmented and often carbonaceous, not "cellular"; hymenium often 70  $\mu$ m or more high; spores narrowly ellipsoid (l:w = 2.3-3.3:1), thin-walled.** Apothecia black, shiny, epruinose; thalline exciple absent; true exciple well developed, persistent, raised, black, opaque; hyphae dark-pigmented; hypothecium pale yellow-brown to blue-green in upper parts, dark red-brown to brown-black below, K-; hymenium colorless in lower parts, dull blue or  $\pm$  vivid blue-green to emerald green above; paraphyses simple (to branched?), 1-2  $\mu$ m thick, rather strongly conglutinated, only occasionally anastomosing, the walls gelatinized, the tips clavate-thickened to 3.5  $\mu$ m; epihymenium mostly dark (greenish to blue-green or emerald green, or blackish); asci 8-spored, clavate, smooth (not cross-striated), the outer wall of the ascus rather thin; tholus Lecanora-type; spores simple, colorless. Thallus immersed or  $\pm$  superficial. Pycnidia immersed; conidogenous cells elongate, ampuliform, enteroblastic, arising singly or in small groups; pycnosporangia curved, thread-like, simple, colorless. Photobiont chlorococcoid. No substances. On rock (usually? siliceous) or parasitic on other lichens. .... Carbonea

**4. Apothecia usually biatorine or lecanorine, sessile or sometimes immersed, the exciple weakly developed, the inside pale, non-carbonaceous; hymenium 45-75  $\mu$ m; spores mostly more broadly ellipsoid.** Other characters various. On rock, soil, moss, bark or wood. .... 5

**5. Tholus of the asci with scarcely developed ocular chamber and indistinct axial mass. Thallus containing miriquidic acid or lobaric acid.** Exciple hyaline or pigmented inside; hypothecium hyaline or dark. paraphyses mostly branched and anastomosing, apically thickened (mostly 3-5  $\mu$ m thick); spores simple but often with central plasma bridge ("pseudoblastic"), 3.5-8  $\mu$ m wide. Mostly on rock (except Protoparmelia ochrococca) .... 6

**5. Tholus with well developed ocular chamber and distinct axial mass. Thallus not containing miriquidic acid or lobaric acid.** Exciple hyaline inside; hypothecium hyaline; paraphyses simple or branched and anastomosing, the tips clavate or capitate; epihymenium various; spores simple. Other characters various. On all substrates. .... Lecanora s. lato

**6. Thallus containing miriquidic acid (K-, C-, KC-, P-; a  $\pm$**

**peacock blue spot on TLC plates) as main substance in almost all species, but some species containing other substances (with positive reactions), including norstictic acid or lobaric acid.**

Apothecia black or dark brown, remaining immersed or becoming sessile, usually biatorine, or rarely lecanorine; thalline exciple usually absent; proper exciple well developed, with radially arranged hyphae 5-7  $\mu\text{m}$  wide at outer edge (in water) or reduced (in species with immersed apothecia), at least the outer part dark greenish or sometimes brownish, never black and brittle; photobiont cells usually absent, but occasionally present in inner part of exciple; hypothecium hyaline or dark violet-brown; epihymenium olive to pale green, N+ red, rarely brownish, N-; hymenium colorless, I+ blue; paraphyses  $\pm$  branched and anastomosed, the apices  $\pm$  clavate and surrounded by a closely adhering pigmented hood. Asci clavate, 8-spored, probably Lecanora type but apical cushion often weakly defined and ocular chamber scarcely developed; tholus weakly amyloid; outer wall of ascus amyloid. Spores simple, occasionally with a false cytoplasmic septum, rarely 1-septate when old, ellipsoid to usually oblong-ellipsoid. Pycnidia immersed; pycnosporangia filiform, 15-28 x 0.5-1  $\mu\text{m}$ , curved, simple, colorless. Thallus crustose, continuous or scattered areolate, brown to brown-black or gray to white; areoles corticate, often with a distinct epinecral layer; medulla I-; black prothallus sometimes present. Photobiont chlorococcoid. On acidic rock, rarely on wood. Boreal-montane ..... Miriquidica

**6. Containing lobaric acid (K-, C-, KC+ red-violet, P-) or norstictic acid (K+ yellow/red, C-, KC-, P+ orange), without miriquidic acid.**

Apothecia lecanorine (in North American species, at least when mature); exciple poorly developed, the outer part hyaline or brown; hypothecium hyaline; epihymenium brown; tholus of asci distinctly amyloid; outer wall of ascus non-amyloid except in concentrated iodine; spores ellipsoid to fusiform. Pycnosporangia bacilliform to filiform. Thallus areolate to subsquamulose, pale to dark brown. On rock or bark. .... (Protoparmelia)

**7. Paraphyses over 3  $\mu\text{m}$  thick, swelling greatly in water,** simple or branched and anastomosing, each with a gelatinous coat; not or scarcely thickened at tips, the apical cells with "internal cap" (inner wall pigment, often violet-brown); asci clavate, 8-spored, Bacidia-type, with large amyloid tholus and narrow non-amyloid axial mass below it; spores simple, colorless, ellipsoid, without a distinct perispore,  $\pm$  thick-walled. Apothecia immersed, adpressed, or sessile, the disc black, cup-like to strongly convex; margin swollen, or not developed; exciple biatorine, lecanorine, or reduced; true exciple thin,  $\pm$  inconspicuous; hypothecium delicately ochre to brown in basal part. Hymenium or epihymenium with purplish or greenish, N+ red pigments. Pycnidia immersed, the wall colorless except for green pigmentations around the ostiole; fulcra of Parmelia-type, the conidiogenous



cells in chains, pleurogenous; pycnospores bacilliform, oblong-ellipsoid to shortly filiform,  $\pm$  straight, simple, colorless, 5-15  $\mu$ m long. Thallus superficial, warted or cracked-areolate, pale, whitish to yellow-orange,  $\pm$  glossy; medulla I-, C-, K+ yellow or red or K-; prothallus occasionally visible between areoles, often forming a dark border to thallus. Photobiont chlorococcoid. Containing various depsidones in the medulla, and atranorin and/or usnic acid in the cortex. On rock (or sometimes bark or wood in *T. atra*). ..... LECANORACEAE S. LATO: Tephromela

**7. Paraphyses 1.5-2  $\mu$ m thick, not swelling.** Other characters various. .... 8

**8. Thallus squamulose, the upper side yellow-orange.** Thallus forming rosettes, with outer squamules elongated, medulla K+ red. Apothecia black, immarginate, convex; exciple lecideine, rudimentary; paraphyses mostly simple, the tips scarcely thickened; epihymenium red-brown; asci with small ocular chamber, but without axial mass; surrounded by amyloid gelatin; spores globose. Pycnospores similar to those in Lecanactis abietina. On calcareous rock. .... XANTHOPSORELLACEAE: Xanthopsorella texana

**8. Thallus crustose, or if squamulose then not yellow-orange.**  
 Spores mostly ellipsoid. Other characters various. .... 9

**9. Paraphyses Lecidella-type, mostly simple and easily freed (in water, and especially in K), 1.5-2  $\mu$ m wide, the ends usually slightly clavate thickened, rarely capitate.** Apothecia usually black (or red-brown in shade), lecideine or biatorine, usually constricted at base, sessile; thalline exciple absent; true exciple usually thick, of radiating hyphae, dark green, blue-black or brown, at times crystalline, not black and friable; hypothecium hyaline to yellowish, orange-brown or red-brown; hymenium colorless to pigmented, I+ blue; epihymenium usually blue-green, at least when young, later sometimes green-black-brown; asci 8-spored, clavate, Lecanora-type, the tholus strongly amyloid, the wall thick, I+ orange-red in concentrated iodine; spores simple or rarely 1-septate, broadly ellipsoid, 11-19 x 6-10  $\mu$ m, rather uniformly thick-walled, lacking a distinct perispore. Pycnidia immersed; pycnospores filiform, 11-27  $\mu$ m. Thallus immersed or superficial, ecorticate, whitish, grayish or yellowish, continuous to verrucose-areolate, smooth, warty or sorediate, not areolate-squamulose, I-, sometimes C+ orange (xantheses); prothallus absent or black to blue-black. Photobiont chlorococcoid. Atranorin, chloratranorin, zeoring, diploicin and a range of xantheses frequent (not all in the same species); psoromic acid in one species. On various substrates, often nitrophilous. Widely distributed. .... Lecidella

**9. Paraphyses mostly coherent.** Spores narrower. Other characters various. .... 10

**10. On non-calcareous rocks.** Apothecia sessile, constricted at base; discs black, concave or plane to somewhat convex, epruinose; margin thick or thin, often folded, prominent, persistent; true exciple dark brown at surface but paler internally, brownish, K+ intense purplish red, not carbonaceous, of radially oriented, wide hyphae, almost pseudoparenchymatous in parts; hypothecium hyaline to pale or dark brown; hymenium 35-50  $\mu\text{m}$ ,  $\pm$  colorless to bluish tinged; I+ deep blue; epihymenium green or blue-green, K-, N+ purple; paraphyses mostly simple to sparingly branched and septate, coherent, not markedly expanded at the tips, which are immersed in a greenish epihymenial gel; asci cylindrical-clavate, Bacidia-type, 8-spored; spores simple, narrowly ellipsoid, colorless, 6-11 x 3-5  $\mu\text{m}$  (Wirth, 1980; Hafellner, 1984), smooth, lacking a distinct epispore. Pycnidia unknown. Thallus immersed or superficial and areolate, fairly well-developed, grey or white, I-, C-, K-. Photobiont chlorococcoid. Atranorin in the cortex, the pigment 2-chloroemodin in the exciple and sometimes hypothecium; unidentified products. On somewhat basic, siliceous rock, montane. .... BACIDIACEAE: Adelolecia (pilati)

**10. On other substrates.** Tholus with often weakly developed ocular chamber and axial mass, and somewhat amyloid outer gelatin. Apothecia sessile, plane to convex; paraphyses tips little thickened; asci clavate; spores often becoming septate. Other characters various. .... 11

**11. Spores oblong-ellipsoid (to fusiform). Pycnospores bacilliform.** Apothecia pale brownish to brown-black, biatorine or occasionally lecanorine (or lecideine?), becoming immarginate; paraphyses thin, mostly simple, gelatinized and coherent. Thallus squamulose (sometimes finely so, appearing crustose), often isidiate or sorediate. On bark or wood. PHYLOPSORACEAE. .... 12

**11. Spores ellipsoid, thin-walled. Pycnospores filiform.** Apothecia sessile, biatorine, pale, whitish to red-brown or dark brown but never black, not pruinose, sometimes with a reddish brown pigment (especially in hymenium and upper exciple), but never with purplish, greenish, or very dark brown (carbonaceous) pigmentation, convex and immarginate, or at first  $\pm$  top-shaped with flat disk and shallow margin, occasionally tuberculate; true exciple soon reflexed, well developed in sections, hyaline inside, chondroid, composed of radiating hyphae 2-2.5  $\mu\text{m}$  wide, with terminal cells sometimes to 4  $\mu\text{m}$  wide, tightly bound in a gel-matrix that does not dissolve or markedly swell in K; outer edge sometimes covered by a narrow gel layer; hypothecium pale, chondroid, of interwoven hyphae 1-2  $\mu\text{m}$  wide in a dense gel-matrix; subhymenium distinct, somewhat opaque, often forming a straw-to brownish colored zone; hymenium 60-80(-100)  $\mu\text{m}$  tall, without a well defined epithecium and without granules or oil droplets, I+ blue; paraphyses coherent even in K, 1.5-2  $\mu\text{m}$  thick, rather thin-walled, simple or sometimes

sparingly branched and anastomosing; tips  $\pm$  swollen (to 3  $\mu$ m wide) but sometimes clavate (to 5  $\mu$ m), not surmounted by distinct apical cap or hood; epihymenium sometimes brownish or yellowish. Asci 8-spored, cylindrical-clavate, lateral walls 0.7-1  $\mu$ m wide, Biatora-type, with K/I+ blue apical dome penetrated from below by a narrow, K/I- apical cushion surrounded by a narrow, deeply K/I+ blue zone, the wall K/I- but surrounded by a K/I+ blue outer layer; ocular chamber poorly developed or not apparent. Spores colorless, ellipsoid or oblong, to oblong-fusiform, simple to 3(-5)-septate, smooth, without a distinct perispore. Pycnidia unknown. Thallus crustose, effuse, sometimes membranous in part but mostly verrucose or granulose, not isidiate or sorediate, creamy whitish to greenish, usually ecorticate; prothallus sometimes visible when granules are scattered, white, arachnoid. Photobiont chlorococcoid. Chemistry various, but most species with no substances detectable by TLC. On various substrates, usually on mossy rocks or the trunks of old trees (often overgrowing byrophytes or plant debris), on somewhat acidic substrata, in relatively undisturbed habitats. .... LECANORACEAE S.L.: Biatora (Coppins, 1992 lists "Mycobilimbia" as a synonym, but does not include the species that are now considered to belong to that genus)

**12. Hypothecium very thick (150-250  $\mu$ m), intensely gelatinized, appearing chondroid. Thallus microphylline, more or less coralloid or isidiate,** not sorediate; (usally?) C-. Apothecia brown or red-brown, more or less convex; epihymenium brown. Mostly subtropical. ... Phyllopsora

**12. Hypothecium shallow and not appearing chondroid. Thallus not coralloid or isidiate,** sometimes sorediate; usually more or less peltate or shell-like, the squamules mostly 1.5 mm or more in diameter, but sometimes small and appressed; C+ red or C-. Apothecia dark, black or red-brown, flat or convex; epihymenium bluegreen to brown. Mostly boreal. .... Hypocenomyce

ADD?:

LECANORACEAE: Psorinia conglomerata

Asci Porpidia-type (at least in the M. hypnorum group; M. sabuletorum is described as having thick-walled asci, thickish paraphyses, spores with a warted perispore, and purplish and greenish pigments in the apothecia). .... FAMILY?: Mycobilimbia

## KEY V. (CLADONIINEAE)

**1. Asci Tremolecia-type or Schaereria-type, the tholus  $\pm$  non-amyloid (even with pre-treatment with K), or reduced.** Apothecia immersed to adnate, the disc concave to plane, black, dull, epruinose, marginate; hymenium mostly under 100  $\mu$ m high; paraphyses tips somewhat thickened. Pycnospores bacilliform. Thallus crustose (to subsquamulose); medulla I-. On non-calcareous rock (or rarely soil?). ..... 2

**1. Asci of other types (Rimularia-, Trapelia-, Porpidia- or Lecidea-types), the tholus thick and well developed, at least partly weakly to distinctly amyloid at least after pre-treatment with K (sometimes only the small apical cap or tube is amyloid, making the tholus appear to be almost Tremolecia-type).** Apothecia immersed to sessile, the discs and margins various; hymenium sometimes very high. Pycnospores bacilliform or filiform. Thallus crustose or squamulose; medulla I+ violet or I-. ..... 3

**2. Asci of the Tremolecia-type, broadly clavate, the tholus thick and well developed but  $\pm$  non-amyloid (even when pre-treated in KOH), without a distinct ocular chamber or internal apical beak, the wall red in concentrated iodine, with a thin I+ blue outer gelatinous coat; spores ellipsoid, 9-16 x 5-9  $\mu$ m, thin-walled, the young ones sometimes slightly halonate, but perispore mostly indistinct.** Apothecia lecideine, more or less innate, to 0.5 mm diameter, the disc black, generally concave, saucer shaped; margin very thin, entire, usually quite prominent, black or rarely orange, persistent; thalline exciple absent; true exciple well developed, somewhat raised, composed or radially arranged, thick hyphae, dark brown to  $\pm$  black and friable, entirely carbonaceous, not "cellular"; hypothecium conspicuous, brown-black; exciple and hypothecium K+ purple; hymenium I+ blue; paraphyses ca. 2  $\mu$ m wide, branched and anastomosing, regularly septate, not markedly swollen at the apex; epihymenium olive brown or bluish brown. Asci 8-spored. Spores simple, smooth. Pycnidia immersed; pycnospores bacilliform. Thallus rust-red to blackish, epilithic, thin, areolate-chinky or areolate, smooth, dull, K-, C-, I-, with black hypothallus. Containing only an unidentified rust-colored pigment in the cortex. Photobiont trebouxoid. On hard, iron-high siliceous rocks, arctic-alpine. ....  
TREMOLECIACEAE: Tremolecia (atrata)

**2. Asci of the Schaereria-type,  $\pm$  cylindrical or rarely clavate, thin-walled, with a single wall layer, not thickened apically, the tholus more or less non-amyloid and reduced, only the outer gelatinous layer faint bluish in concentrated iodine; discharge by splitting of the apex; spores globose to short ellipsoid, not halonate.** Apothecia lecideine or lecanorine,  $\pm$  immersed or sessile, plane, marginate; thalline exciple absent; true exciple persistent,

black, darkish brown in section, paler inside, K-, of  $\pm$  globose cells, without algae; hypothecium  $\pm$  dark brown; subhymenium usually hyaline; hymenium I+ weakly blue (ascus walls); paraphyses free (at least in K), mostly simple, occasionally branched above, 1.5-2  $\mu$ m wide, not anastomosing; apical cells often swollen and sometimes  $\pm$  moniliform; epihymenium greenish and K+ purple (or occasionally with purplish granules that are K+ intense violet, HCl+ green), or violet and K+ bright green; occasionally discolored brown in old material. Spores simple, uniseriately,  $\pm$  biseriately or irregularly arranged, colorless, smooth, lacking a distinct epispore. Pycnidia immersed; conidogenous cells subcylindrical, enteroblastic, acrogenous; pycnosporos bacilliform, simple, colorless. Thallus areolate (areoles often somewhat dispersed and convex) to  $\pm$  squamulose, mostly dark (gray or reddish brown to brown), C+ red (gyrophoric acid) or C-; prothallus often well developed, black. Photobiont Trebouxia. Medulla I-. On siliceous rocks, especially granite and schists, sometimes overgrowing mosses (or soil?), upland to montane. .... SCHAEERERACEAE: Schaereria

**3. Asci of the Trapelia- or Rimularia-type, the tholus with weakly to strongly amyloid lateral areas and non-amyloid central area;** hymenium under 100  $\mu$ m high; paraphyses branched; spores ellipsoid. Thallus often C+ red (gyrophoric acid); medulla I-. .... 4

**3. Asci of some other kind, the tholus without amyloid lateral areas.** Paraphyses branched or not. Thallus C+ red or C-; medulla I+ violet or I-. .... 8

**4. Asci of the Rimularia-type, clavate, the tholus with strongly amyloid lateral areas and apical cap (or tube); outer wall of ascus thick, amyloid.** Apothecia round or elongated, the discs black; exciple lecideine or lecanorine; hypothecium brown to carbonaceous black, concolorous with and continuous with the exciple; paraphyses coherent, anastomosing, 2  $\mu$ m wide, the tips weakly thickened; epihymenium olive or brown. Thallus white to brown-black, crustose, areolate, usually with no epinecral layer. On non-calcareous rock or parasitic on other lichens. RIMULARIACEAE. .... 5

**4. Asci of the Trapelia-type, narrow, the tholus with weakly amyloid lateral areas and distinctly amyloid apical cap.** Apothecia round, the discs pale brown to black; exciple biatorine or pseudolecanorine, pale inside; paraphyses free or coherent, anastomosing or not. Thallus pale or dark, crustose to squamulose. Other characters various. AGYRIACEAE. .... 6

**5. Paraphyses persistent. Hypothecium dark brown to black. Apothecia roundish to angular,** the disk expanded or (in "Mosigia") at first punctiform; lecideine, sessile and stipitate, less often sunken in the thallus,

or (especially in "Mosigia") lecanorine or aspicilioid, immersed; marginate, the discs plane, often (but not always) umbonate or gyrose. Excipulum entirely dark, similar to that of Porpidia; hypothecium continuous with the true exciple; hymenium I+ blue; epihymenium brown; paraphyses richly branching and anastomosing, septate, usually thin (under 1  $\mu$ m) and non-moniliform, the apices pigmented but not swollen; asci broadly clavate (cylindrical-clavate according to David, 1992), with tholus of Rimularia-type (with an amyloid I+ cap which may have a slight tubular paling in the bottom center, the tube broadened to the base, a pale region, and then two lateral staining regions [actually a tubular region]; spores 8, non-halonate, ellipsoid, unicellular, hyaline or sometimes brownish when old. Thallus superficial, whitish to dark brown, continuous to distinctly areolate or bullate, sometimes sorediate or isidiate, C+ red or C-, K+ red or K-, P+ yellow or P- (often gyrophoric acid, sometimes stictic or norstictic acid or other substances); medulla I+ violet or I-; hypothallus present or absent. Photobiont chlorococcoid. Pycnospores short-ellipsoid to bacilliform, simple, colorless, ca. 4 x 0.2  $\mu$ m. Mostly on siliceous rock or parasitic on other lichens over rock; a few species on bark or moss. Widely distributed, mainly in arctic-boreal to montane or alpine areas. .... Rimularia sensu lato (including "Mosigia", with aspicilioid apothecia, and several species of uncertain placement, with thick, moniliform paraphyses)

**5. Paraphyses soon disappearing. Hypothecium colorless. Apothecia elongated to  $\pm$  round or angular, the disc slit-like,** not umbonate or gyrose; thalline exciple absent; true exciple opaque, of dark brown, conglutinated, anastomosing and radiating hyphae; paraphyses branched; hymenium colorless, I+ blue; spores hyaline, simple, ellipsoid. Pycnospores unknown. Thallus areolate, gray, C-, K+ red, P+ yellow (norstictic acid); medulla I-; hypothallus present. Photobiont chlorococcoid. On rock, not parasitic. Arctic. .... (Lithographa tesserata)

**6. Paraphyses tips irregularly  $\pm$  capitate, capped with dark brown or red-brown. True exciple of brown-walled, pseudoparenchymatous cells. Thallus dark green-brown to blackish, sometimes tinged reddish or chestnut brown,** effuse, granular-verrucose or leprose, or of isidiate-granular goniocysts or areoles, C-, K-, P-. Goniocysts or areoles with an outer layer of brown-walled pseudoparenchymatous hyphae, colorless within. Photobiont ? Chlorella. Apothecia biatorine, red-brown to brown-black or black, more or less innate, or adpressed to sessile, soon immarginate; thalline exciple absent; true exciple well developed but often reflexed, C-; hypothecium dark brown; hymenial gel I+ green-blue; paraphyses ca. 2  $\mu$ m thick, coherent, gelatinized, simple to often branched but only weakly anastomosing, the tips thickened; epihymenium dark brown; asci clavate or cylindrical-clavate, Trapelia-type, the apical dome not, or weakly I+ blue, but with amyloid cap; outer wall of ascus amyloid; spores simple (to 1-septate), ellipsoid, often containing a single large

oil drop and several smaller droplets. Pycnospores unknown. No substances. On acidic, lime-free substrata, particularly bark, wood or soil, less often on rocks. .... Placynthiella

**6. Paraphyses tips not brown-capitate. True exciple hyaline to pale (and not pseudoparenchymatous?). Thallus pale, usually not brownish or blackish,** crustose to squamulose. Apothecia adpressed, constricted at base, yellow-brown to reddish or almost black, biatorine, pseudolecanorine, or lecideine, sessile or emergent; exciple often C+ red; thalline exciple pronounced or absent; true exciple of colorless hyphae, the gel matrix occasionally weakly pigmented, but never dark brown; hypothecium (usually?) hyaline. Hymenium hyaline; epihymenium hyaline or sometimes paraphyses tips slightly swollen with an external coating of pigment. Epihymenium pale or dark. Asci thin-walled, 8-spored; apical dome I- or + weakly blue. Spores simple, ellipsoid, colorless or faint pink, smooth, without distinct perispore. Upper cortex of entangled hyphae only present in representatives with distinctly squamulose thalli. Gyrophoric acid and traces of lecanroic acid often present. Pycnidia immersed; pycnospores cylindrical to thread-like. .... 7

**7. Paraphyses under 1.7  $\mu$ m thick, mostly easily free, often branched but little anastomosing, not thickened at tips; asci cylindrical or subcylindrical (clavate-cylindrical); spores 14-32 x 6-14  $\mu$ m. Apothecia mostly small, to 0.2-0.5(-1.5) mm diam., biatorine, bursting through thallus cortex, the pseudolecanorine margin soon disappearing; at first globose and appearing perithecia-like, then splitting at apex and margin appearing  $\pm$  lobed; true exciple varying from relatively weak and of short-celled, thin-walled hyphae (T. coarctata) to well developed and of long-celled, pachydermatous hyphae (T. mooreana); Thallus usually crustose, sometimes squamulose. Photobiont chlorococcoid. On siliceous rock or soil, or sometimes wood. .... Trapelia**

**7. Paraphyses 2-3.5  $\mu$ m thick, coherent, anastomosing, the tips weakly thickened; asci subcylindrical to clavate; spores 6-16 x 3-7  $\mu$ m. Apothecia more robust, (0.2)0.5-1.5(-2.5) mm diam., with more massive excipular and "hypothecial" tissues, and usually a proportionally shallower hymenium. Apothecia biatorine to lecideine, sessile, usually marginate, without pseudolecanorine margin, disk-like from start, expanding without splitting. Photobiont chlorococcoid (including Chlorella and Pseudochlorella). Thallus granular, or squamulose to small foliose; On soil or wood. Purvis questions the distinctness of this genus from Trapelia; sterile specimens cannot be definitely referred to either genus, and the key under Trapelia should also be tried for such sterile specimens. .... Trapeliopsis**

**8. Ascus apex Lecidea-type, with an external amyloid cap, but without at most a short, indistinct internal tube.** Hypothecium

hyaline or pigmented; paraphyses simple or branched, anastomosing or not, 1.5-2 um wide ..... 9

**8. Ascus apex Porpidia-type, with both an external cap and a distinct internal tube.** Other characters various. .... 12

**9. Asci (usually?) clavate, usually with at most a short amyloid tube; outer wall of ascus not amyloid. Apothecia lecideine,** sessile or immersed, usually black, mostly plane to moderately convex, usually with a distinct margin; epihymenium often greenish or bluish; spores ellipsoid or sometimes globose. Thallus immersed, or superficial and variously colored, usually rimose or areolate, never slimy; medulla I+ violet or I-. Algae trebouxoid or protococcoid. .... LECIDEACEAE: Lecidea

**9. Asci clavate or subcylindrical, with a more or less definite amyloid tube, the outer wall amyloid. Apothecia biatorine,** adnate to sessile (or stipitate), pale to dark. Medulla I-. Algae various. MICAREACEAE. .... 10

**10. Apothecia bright- to deep yellow, eventually with reddish or greenish tone, or blackish,** K-, adnate or sessile, soon convex to  $\pm$  globose and immarginate, occasionally becoming tuberculate. Thallus often also bright yellow or greenish, but sometimes dull green or whitish gray; leprose or granular-areolate, of  $\pm$  distinct goniocysts interconnected by filamentous hyphae, C-, K-. Photobiont Trebouxia-like or Stichococcus. Thalline exciple absent; true exciple poorly developed, often reduced to a narrow zone at base of apothecia, with protruding, hyaline, thin-walled, gelatinized radiating hyphae; hypothecium hyaline or pale, I-; hymenium to ca. 30 um high, laterally reflexed, variously pigmented, I+ blue; epihymenium often not clearly delimited; paraphyses simple or slightly branched and anastomosing, the tips not or slightly thickened; asci 8-spored, cylindrical-clavate, the apical dome K/I+ pale blue with dark blue apical tube diverging towards the apex, the wall colorless with a k/I+ dark blue outer layer, Porpidia-like. Spores cylindrical, oblong-ovate, clavate or teardrop-shaped, 3-7 x 1.5-2(-3) um, simple, colorless, without a perispore. Anamorphs, where known, hyphomycetous with discrete enteroblastic conidiogenous cells arising directly on the thallus surface; conidia ovoid to pyriform, colorless, adhering in chains, simple. With rhizocarpic or gyrophoric acids, or no substamnes. In sheltered,  $\pm$  humid situations, usually on overhanging surfaces of siliceous rocks, rarely on soil or humus, boreal-arctic. .... Psilolecia

**10. Apothecia and thallus not distinctly yellow, at most dirty yellowish.** Hymenium and spores (usually?) larger, or if spores small then often septate. Other characters various. .... 11



**11. Apothecia strongly constricted at base, with short stipe between granules of thallus; exciple distinct;** hypothecium green-black to brown-black above, purple-black below; epihymenium olive-brown; spores oblong to oblong-ellipsoid or subfusiform, rarely becoming septate, 10-13(-16) x 3-5(5.5)  $\mu\text{m}$ . Thallus white or greenish-white, granular to subcoralloid, K-. On soil or moss. Coppins includes this under Micarea. ..... Helocarpon (crassipes)

**11. Apothecia sessile, not stipitate, whitish, yellowish, grayish, bluish, brownish or blackish, plane to convex or globose, often (but not always) without exciple;** hypothecium and epihymenium variously pigmented; paraphyses mostly branched and often anastomosing, to 1.7  $\mu\text{m}$  wide, some species also with stouter unbranched paraphyses; apices not or slightly swollen, without a dark brown apical cap. ASCi 8-spored, clavate to cylindrical-clavate, in K/I with blue outer layer and apical dome and unstained wall, the apical dome with an apical cushion that in some species is surrounded by a faint to distinct dark cylindrical "ring-structure". Spores colorless, smooth, without persipore, mostly narrowly ellipsoid-fusiform, to ovoid or acicular, septate or not. Conidomata pycnidia, or rarely sporodochia; pycnidia immersed, sessile or stalked; conidiogenous cells enteroblastic, short-ampulliform to cylindrical, acrogenous; conidia colorless, of 3 types: (a) macroconidia, curved, thread-like or helicoid, often septate, rarely ellipsoid, (b) mesoconidia, cylindrical, ellipsoid or ovoid, simple, often bicuttulate, mostly 1-2  $\mu\text{m}$  wide; (c) microconidia,  $\pm$  cylindrical, simple, eguttulate, to 1  $\mu\text{m}$  wide. No substances, or sometimes with gyrophoric acid. Apothecia mostly under 1 mm diam., epruinose, adpressed to sessile. Thalline exciple absent; true exciple absent to well developed, composed of branched radiating hyphae, lax in K or bound by dense pigment. Hymenium I+ blue. Hypothecium colorless or pigment. Thallus immersed or superficial, effuse, of  $\pm$  spherical granules (goniocysts), convex to  $\pm$  globose areoles, or a rimose or scurfy crust, the areoles sometimes dissolving into soredia; when fresh often greenish and slimy;  $\pm$  ecorticate but sometimes with a colorless amorphous outer layer; prothallus indistinct. Algae green, usually "micareoid" (small, thin-walled, 4-7  $\mu\text{m}$  diam., frequently in pairs); a few species with cephalodia containing Nostoc or Stigonema. On wide range of acidic substrates; rarely tolerant of nutrient enrichment. .... Micarea

**12. Spores (in N. American genera) usually halonate at least when young,** often rather large (to 25  $\mu\text{m}$  or more long). Hymenium often to 100  $\mu\text{m}$  or more high; paraphyses branched and anastomosing; asci thick-walled, surrounded by thin, amyloid, gelatinous layer, the tholus weakly amyloid with more strongly amyloid cylinder. Pycnospores bacilliform (in N. American genera) to filiform. On rock. PORPIDACEAE ..... 13

**12. Spores not halonate.** Hymenium under 100  $\mu\text{m}$  high. Other characters various. .... 17

**13. Cephalodia present,** globose, rose-gray to brown-black, immersed to tuberculate, between the areoles. Spores often rather large (often over 20 um long), with a compact, gelatinous episporium (halonate). Apothecia black or brown-black, flat to concave, sessile or more often deeply immersed in or between areoles; thalline exciple brown; true exciple absent, or often poorly developed, of conglutinated, radially oriented hyphae; hypothecium thick,  $\pm$  colorless to pale brown, or dark brown to black and carbonaceous, then well developed and cupulate, K+ reddish; hymenium often 100-140 um or more high, I+ blue (orange-red in Lugol's solution); paraphyses (paraphysoid-like hyphae) under 2 um thick, forming a network, branched and anastomosing, septate, especially above, where they are almost moniliform, not or slightly swollen at apex. Asci 8-spored, elongate-clavate, Porpidia-type, with a thin outer amyloid layer and a thickened tholus penetrated by a pore, the sides of which stain deep blue in iodine. Spores ellipsoid, simple, colorless, smooth. Thallus areolate, often coarsely so, to weakly squamulose, often dispersed, creamy, rosy, grayish or brownish, smooth, without epinecral layer; containing depsides or depsidones; medulla I-; hypothallus indistinct or absent. Photobiont Trebouxia-like, with Stigonema in the cephalodia. Pycnidia immersed; conidia bacilliform. Gyrophoric acid often present, sometimes with lecanoric acid; other orcinol depsides or  $\beta$ -orcinol depsidones in some species. On moist, somewhat base-rich siliceous rocks, especially basalts, boreal-arctic or montane. .... Amygdalaria

**13. Cephalodia absent.** Other characters various. .... 14

**14. Paraphyses over 2 um thick. Apothecia immersed (sometimes leaving pits) or emergent, often becoming convex and immarginate;** red-brown to brown-black (not pure black, at least when wet), naked or  $\pm$  pruinose; exciple lecideine, generally persistent and black; hypothecium  $\pm$  colorless to pale brown to red-brown or orange-brown; epihymenium yellow brown to red-brown; paraphyses branched and occasionally anastomosing, septate, scarcely or markedly swollen and pigmented at apices; hymenium under 100 um high, I+ pale blue in part (orange-red in Lugol's solution); asci 8-spored, elongate-clavate, Porpidia-type. Spores ellipsoid, simple,  $\pm$  colorless, smooth, with a gelatinous perispore when young. Pycnidia  $\pm$  immersed; conidiogenous cells in chains; conidia borne laterally, bacilliform, simple. No substances. Thallus immersed or thin, whitish, ochraceous, or gray to brown, granular or  $\pm$  areolate, without epinecral layer; often containing no substances; medulla I-; hypothallus absent, or  $\pm$  black. Photobiont Trebouxia. On calcareous rock. .... Clauzadea

**14. Paraphyses to 2 um thick. Apothecia usually plane and marginate at least when young, or immersed in thallus.** Medulla I+ violet or I-. Other characters various ..... 15

**15. Apothecia immersed**, black to gray, more or less marginate, non-umbonate; hypothecium hyaline to brown; hymenium orange-red in Lugol's solution; paraphyses under 2  $\mu$ m thick. Thallus crustose, brown, covered by epinecral layer; containing depsides or depsidones; hypothallus present. On siliceous or calcareous rocks. .... Immersaria (athroocarpa)

**15. Apothecia sessile with constricted base**, regularly marginate; discs black (or pruinose); exciple entirely carbonaceous, distinct from the usually paler hypothecium (as seen in very thin sections) or not; hypothecium pale brown to brown-black; hymenium 60-120(-145)  $\mu$ m high; epihymenium brown or green; hymenium blue in Lugol's solution. Thallus epilithic or endolithic, without epinecral layer; hypothallus present or absent. Other characters various. .... 16

**16. Thallus usually containing long-side chain orcinol depsides,  $\beta$ -orcinol depsidones, or sometimes dibenzofurans (substances include stictic, norstictic, 2'O-methylsuperphyllinic, 1'O-methylmicrophyllinic, confluent and 2'O-methylperlatolic acids).** Apothecia scattered to clustered, sometimes in concentric rings, hemiangiocarpic, emerging from small pruinose dots on thallus, subimmersed or becoming sessile, sometimes rather large (to 4 mm diam.); disc dark brown to black, pruinose or naked, with a distinct true exciple (sometimes excluded with age); thalline exciple absent; true exciple dark brown (outer edge dark green in some species), but sometimes paler brown in inner part, composed of conglutinated, radiating hyphae often to 5  $\mu$ m or more in diameter; hypothecium dark brown to brown-black, K- or K+ reddish in parts; hyphae irregularly arranged; subhymenium hyaline. Hymenium 80-150  $\mu$ m tall, colorless or pale greenish above, I+ blue; epithecium usually distinct, brown to greenish brown, rarely blue-green, N+ rose pink to purple. Paraphyses septate, branched, anastomosing, netlike, slightly swollen at apices but without dark apical caps. Asci 8-spored, clavate to subcylindrical, Porpidia-type, lightly cross-striated or smooth, the outer wall amyloid; spores simple, rather large (often over 13  $\mu$ m long),  $\pm$  ellipsoid, occasionally with one or both ends acuminate; perispore well developed, 2-7  $\mu$ m thick. Pycnida rare; conidogenous cells elongate-ampulliform, in a single layer, enteroblastic, acrogenous; conidia bacilliform. Thallus thick to inconspicuous, tartareous, continuous to areolate-cracked, whitish, grayish, or ochraceous to orange; medulla I+ violet or I-; prothallus absent, or present (especially between adjacent thalli), black or sometimes orange, thin; soredia present or absent, either forming irregularly and diffusely in cracks in thallus, or more commonly forming discrete, regular, round soralia. Photobiont chlorococcoid. On siliceous, rarely calcareous, rocks, rarely on bark, wood, or artificial materials, mainly boreal-montane, in various habitats. Very close to Amygdalaria, and perhaps a synonym of

it. .... Porpidia

**16. Thallus lacking lichen substances.** Apothecia sessile, ± constricted below; disc black, sometimes pruinose, convex; true exciple well developed, raised, of strongly compacted, dark brown hyphae under 5 µm diameter; hypothecium colorless, greenish to dark brown. Hymenium colorless or greenish, I+ blue; epithecium greenish to brownish. Paraphyses branched and anastomosed, septate, the apices not markedly swollen. Asci 8-spored, elongate-clavate, with a thickened I+ blue tholus, containing a more densely amyloid, tubular pore, Porpidia-like, the walls frequently lightly cross-striate; spores ellipsoid, simple, thin-walled, 10-13 µm long; gelatinous epispore thick. Pycnidia black, scattered on surface of substratum or immersed in thallus; conidogenous cells ± cylindrical; conidia bacilliform. No substances. Thallus immersed or superficial, continuous, grayish or white; medulla, when developed, I+ violet; prothallus absent. Photobiont trebouxoid. On calcium-containing rocks, arctic-alpine to montane. .... Farnoldia

**17. Thallus pulvinate, of thickly crowded but non-imbricate areoles or squamules with appressed margins,** forming a flat crust, the squamules angular, 1-2(-4) mm wide, rather dark gray-brown above and below, often on black hypothallus; upper cortex plectenchymatous; lower cortex undifferentiated, but lowest medullary hyphae deep brown, attached directly to substratum; medulla I-, the hyphae 3-4 µm thick, thin-walled; algae chlorococcoid, dividing into 2-4 daughter cells, in clumps. Apothecia ± immersed, lecideine, dark red-brown, plane to convex, becoming immarginate; true exciple of parallel hyphae; outer part pale brown, inner part colorless; hypothecium hyaline; hymenium colorless, I+ blue; paraphyses straight, thin-walled, strongly conglutinate, only slightly branched (towards tips) and anastomosed; apices globose, with thin dark brown or red-brown apical cap; asci thin-walled, clavate, with well developed, K/I+ pale blue apical dome and K/I+ dark blue tubular structure, Porpidia-like. Spores simple, ellipsoid or ovoid, thin-walled, smooth, without perispore. Conidiomata unknown. No substances. On acid turfy or gravelly soil, rarely on bare rock, on exposed mountain sides and summits, alpine. .... LECIDOMATACEAE: Lecidoma (demissum)

**17. Thallus of discrete or imbricate, mostly rounded squamules, often with ascending margins,** with or without hypothallus. Paraphyses tips only slightly thickened. Other characters various. .... 18

**18. Asci surrounded by amyloid gelatin.** Hypothecium mostly hyaline. Apothecia plane, marginate, black, the exciple lecideine. Squamules pale olive-brown above, epruinose, with green-black margins, with blue-green rhizoids below. On rock. ....

PSORULACEAE: Psorula rufonigra

**18. Asci without amyloid gelatin.** Hypothecium pigmented or not. Apothecia biatorine, mostly red or brown, soon convex and immarginate. Thallus crustose or squamulose (color above various; without greenish margins and rhizoids). PSORACEAE. .... 19

**19. Thallus squamulose**, the squamules usually brown, red, or yellowish above, often whitened by pruina, white or brownish below, the hypothallus pale or absent; upper cortex thick, well developed, of anticlinally oriented, thick-walled hyphae with shortly cylindrical to round lumina, mixed with remnants of dead algae; epinecral layer usually well developed; lower cortex of two types: (1) of  $\pm$  periclinally arranged, long-celled, closely conglutinated,  $\pm$  brown-pigmented hyphae and lacking crystals of calcium oxalate, or (2) of  $\pm$  anticlinally arranged, short celled, only partly conglutinated, colorless hyphae densely covered with calcium oxalate; lower cortex sometimes poorly developed to absent; often attached by a well developed hyphal net. Medulla well developed, I-. Algae chlorococcoid, in dense, continuous layer. Apothecia sessile, marginal or laminal, red-brown to black, usually flat or weakly convex when young, later becoming immarginate and strongly convex to semi-globose, K+ black-red or K-; pruina white, yellow, or absent. Thalline exciple absent; true exciple annular, colorless to pale brown, of radiating hyphae, usually indistinct; hypothecium hyaline to pale brown or orange-brown, filled with crystals of calcium oxalate. Hymenium I-. Paraphyses simple or sparingly branched, strongly conglutinated, the apical cell slightly swollen. Asci 8-spored, clavate, with a well developed, I+ blue tholus containing a deeper I+ blue tube; ocular chamber absent. Spores colorless, simple, ellipsoid, smooth, without a thick perispore. Pycnidia frequent, immersed; ostiole colorless; conidia elongate-bacilliform, simple, colorless. Cortex, medulla and exciple often contain calcium oxalate and lichen products. On soil or rock, mostly in desert areas. Psora lurida differs from the above description in several important characters and will ultimately merit transfer to another genus. .... Psora

**19. Thallus crustose**, smooth, continuous to rimose, endolithic to epilithic, whitish to gray-green or pale brown to yellowish. Photobiont chlorococcoid. Apothecia  $\pm$  flat to strongly convex, soon immarginate, yellow to orange or orange-red to deep red or brown, K+ black-red; thalline exciple absent; true exciple poorly developed, of colorless branched hyphae; hypothecium hyaline or yellowish or brown, occasionally  $\pm$  violet; hymenium colorless to orange, I+ blue; epithecium with orange granular material (anthraquinone), K+ red; paraphyses 2-3.5  $\mu$ m wide, rather conglutinate, sparingly branched and anastomosed; apices not or scarcely swollen. Asci 8-spored, cylindrical-clavate, Porpidia-type; spores simple, colorless, ellipsoid or globose, rather thick-walled, without a thickened perispore. No substances in thallus. Usually on calcareous rock. .... Protoblastenia



## INCERTAE SEDIS:

**Spores 16 per ascus.** Thallus crustose, often wide-spreading, membrane-like or slightly uneven-scurfy, effuse; prothallus absent. Photobiont chlorococcoid, the cells ellipsoid. Apothecia scattered, adpressed to sessile; disk dark brown-black, strongly convex; thalline exciple absent; true exciple rudimentary, of  $\pm$  undifferentiated vertically arranged hyphae. Hymenium I+ blue. Hypothecium pale to dark brown, of  $\pm$  vertical hyphae. Paraphyses sparse, simple or sparingly branched, in a  $\pm$  uniform gelatinous matrix, not swollen at apices. Asci clavate-cylindrical, thin-walled, without a tholus, with a K/I+ blue, distinct apical pore. Spores globose or slightly ellipsoid, simple, colorless, thick-walled and distinct. Pycnida black; conidogenous cells elongate-ampulliform, enteroblastic, acrogenous; conidia simple, ellipsoid, colorless. No substances. Mainly on disturbed soils. ....  
SUBORDER? FAMILY?: Steinia

**Spores very large and thick-walled.** Thallus crustose. On bark. .... SUBORDER? FAMILY?: Japewia  
(Mycoblastus would also have to be keyed out here)

..... Gypsoplaca (macrophylla)