

# **CRUSTOSE LICHENS WITH ROUND APOTHECIA AND GREEN ALGAE (CHLOROCOCCOID OR TRENTEPOHLIOID)**

After Poelt & Vezda, and others

Rev. 2/94

The first set of keys, with Roman numerals, are arranged by spore type, and then by natural characters (many of them esoteric) or artificial characters. There is a fair amount of overlap, which probably can be reduced by pulling out certain groups (as I have done with foliicolous taxa, ones with Trentepohlia, and ones with yellow to orange thallus, although for the moment I have also left them in the spore-based keys, meaning even more overlap!) To avoid some of the repetition, I have tried to put keys to the large "sensu lato" genera in separate documents. I have also done this with one family (THELOTREMATACEAE), and I may do well to do the same with several other families where spore number, color, or septation is highly variable. Genera with mazaedia and/or stalked ascocarps are keyed in a separate set of keys in a different file (Caliciales genera).

The second set of keys, with capital letters, are arranged by external characters (or ones seen easily under a lens or dissecting scope), and then by mostly artificial characters, saving microscopic features (especially the more esoteric ones) till last. These should be helpful for recognizing some of the more common or distinctive genera, but it will take a lot of work to make them complete, and to account for the tremendous variability within the larger, more common, "sensu lato" genera.

## **DISCOLICHEN KEY I: SPORES MORE THAN 8, HYALINE**

### **I-A. Algae Trentepohlia. Spores 1- or more-septate. (See Key VI-A-1)**

### **I-B. Algae protococcoid. Spores simple or rarely septate.**

- 1. Spores over 32 per ascus, under 8 um long and 4 um wide, hyaline, simple or rarely 1-septate. .... 2**
- 1. Spores 32 or fewer per ascus, mostly over 9 um long or 4 um wide. ....13**
  - 2. On rock, or if not then thallus well-developed, areolate-squamulose. Disk dark brown or black, sometimes bluish pruinose. .... 3**
  - 2. On bark, wood, moss, or resin, or if on soil then thallus indistinct or not evident. Thallus never areolate-squamulose. .... 6**
- 3. Apothecia immersed in thallus areoles or with thalline margin. Thallus usually well-developed, cracked-areolate to squamulose, yellow, white, or brown; without distinct hypothallus. Tholus present, I-. Cortex paraplectenchymatous. [If thallus yellow and lobed, see Pleopsidium]. Acarosporaceae. ....Acarospora**
- 3. Apothecia sessile, at least when mature; without thalline margin, with proper margin. ....4**
  - 4. Thallus well-developed, areolate, radiate, with conspicuous black hypothallus.**

- Apothecia appearing between the areoles.** Asci with uniformly I+ blue tholus, without axial body and ocular chamber. Cortex of anticlinal hyphae. Alpine. Catillariaceae? .....Sporastatia
- 4. Thallus poorly developed or absent, not areolate-radiate; no hypothallus. Apothecia adnate or sessile.** Acarosporaceae. Tholus present, I- or almost, without axial body and ocular chamber. ....5
- 5. Epithecium carbonaceous; paraphyses netlike interwoven, indistinctly septate, the tips not thickened. Disc umbonate, verrucose-wrinkled to gyrose.** .....Polysporina
- 5. Epithecium brown, not carbonaceous; paraphyses simple, septate, with clavate tips. Disc smooth.** Thallus ecorticate. ....Sarcogyne
- 6. Apothecia almost or entirely closed, with punctiform ostiole, therefore perithecium-like.** Asci without apical thickening, I- or almost. Thelocarpaceae. ....Thelocarpon
- 6. Apothecia open, with distinct disc, at most cup-shaped.** .....7
- 7. Apothecia with thalline margin. Spores simple or 1-septate.** Ascus tips with inner and outer narrow amyloid layers separated by a non-amyloid layer, with a weakly amyloid outermost coating. Fuscideaceae. ....Maronea
- 7. Apothecia with proper margin, without thalline margin. Spores simple.** .....8
- 8. Lichen consisting of a cup-shaped, immersed blackish disc surrounded by ± radiating, triangular whitish gray lobes. Spores 2-celled.** On ± calcareous soil. ....Solorinella (astericus)
- 8. Thallus constructed differently. Spores 1-celled.** .....9
- 9. Apothecia pale greenish yellow, often somewhat translucent, mostly ± perithecium-like.** .....(Thelocarpon)
- 9. Apothecia brownish, reddish, to dull black, with pale, at most brownish hypothecium. Asci amyloid.** .....10
- 10. Asci without tholus.** Apothecia biatorine, reddish, the disc cup-shaped deepened, the exciple thickish. Paraphyses simple. Ascus tips scarcely thickened, with a small amyloid ring structure in the center, without axial body and ocular chamber, with a more weakly amyloid outer coating. Thelocarpaceae. ....Sarcosagium (campestre)
- 10. Asci with distinct tholus.** Apothecia mostly soon convex, with thin, flat or soon disappearing margin. ....11
- 11. Ascus wall thickened above, with I+ blue tholus (narrow amyloid areas next to the endoascus), with at most a very thin I+ weakly blue external coating.** not mucilaginous and disintegrating. Paraphyses branched and ± anastomosing below, simple above. Apothecia immarginate. Ascus tips with axial body. No substances. Scoliciosporaceae. ....Strangospora
- 11. Ascus wall strongly mucilaginous; tholus I- or I+ blue.** Paraphyses simple to much-branched above. ....12
- 12. On soil or moss; thallus lichenized.** Ascus tips with narrow inner and outer I+ blue outer caps and I+ blue outer coating, without axial body and ocular chamber. No substances. Apothecia immarginate. Mainly on basic substrates. Biatorellaceae. ....Biatorella
- 12. On resin of trees; thallus non-lichenized.** .....Sarea resinae

- 13. Apothecia brown-black, subglobose, immarginate.** Asci with I+ blue tholus. Spores spherical. No substances. Mainly on acid substrates. ....Steinia
- 13. Apothecia yellow or brown, marginate at least when young.** Asci with I+ blue tholus, with axial body. ....14
- 14. Apothecia, and often thallus,  $\pm$  distinctly yellow.** ..... Candelariella
- 14. Apothecia and thallus not yellow.** .....15
- 15. Spores non-septate.** .....(Lecanora sambuci)
- 15. Spores septate.** ..... (a few Lecania spp.)

## DISCOLICHEN KEY II. SPORES 8 OR FEWER, HYALINE, NON-SEPTATE.

### II-A. Algae Trentepohlia (See Key VI-A-2).

### II-B. Algae protococcoid or "micareoid", green, globose.

1. Spores over 40  $\mu$ m long, often thick-walled, often fewer than 4 per ascus. .... 2
1. Spores under 40  $\mu$ m (usually under 30  $\mu$ m) long, mostly 8 per ascus, thin-walled (but may have gelatinous halo). .... 5
  2. Apothecia  $\pm$  black (sometimes bright red inside), lecidine, sessile, often convex or subglobose, often over 2 mm wide. Hypothecium  $\pm$  pale. On bark or wood. Lecanorales: Mycoblastaceae. .... Mycoblastus
  2. Apothecia  $\pm$  pale, lecanorine with usually flat or concave disc, or immersed in thallus or thalline warts; not bright red inside. Paraphyses branched and anastomosing, lax. Hypothecium pale. Fulcrum exobasidial. .... 3
3. Discs with central pore opening into hymenial cavity; paraphyses present. Thallus with cephalodia. Apothecia  $\pm$  embedded in thalline warts. Medulla P+ orange, K+ yellow or red. On bark or rock, Pacific Coast. Lecanorales: Coccotremataceae. .... Coccotrema
3. Discs without central pore; paraphyses absent. Thallus without cephalodia. Lecanorales: Pertusariaceae. .... 4
  4. Apothecia sessile, with an open, pink to brown or yellowish disc. Apothecia and thallus often (but not always!) C+ red. Spore walls only moderately thickened. .... Ochrolechia
  4. Apothecia immersed one to several in thalline warts and opening by a pore, or if sessile then disc C-, dark or densely pruinose, usually not pinkish or orangish. .... Pertusaria
5. Ascocarps  $\pm$  elongated. .... (see Lirelliform genera: Xylographa and Ptychographa)
5. Ascocarps round to angular, immersed to sessile or stipitate. .... 6
  6. Apothecia or thallus or both  $\pm$  distinctly yellow. .... 7
  6. Apothecia at most pale greenish or pinkish yellow; if thallus yellow then apothecia dark, or reddish or bluish. .... 9
7. Thallus and apothecia K+ purple. On soil or moss. Apothecia lecanorine. Fulcrum endobasidial. Lecanorales: Teloschistaceae. .... Fulgensia
7. Thallus and apothecia K-. Asci with large I+ blue tholus. Paraphyses  $\pm$  simple. Lecanorales: Candelariaceae. .... 8
  8. Thallus marginally lobed. On rock, Sonoran Desert. .... Candelina
  8. Thallus crustose to squamulose, or if lobed then not in Sonoran Desert. On various substrates. .... Candelariella
9. Apothecia lecanorine (with thalline margin at least when young, or at least with algae below the hypothecium), or aspicilioid (immersed in thallus and opening by a pore or having a  $\pm$  concave disc). .... 10
9. Apothecia without a thalline margin (but sometimes immersed between areoles, or with a pale algae-less margin), lecidine (with blackish discs) or biatorine (pale discs), with or

**without a proper margin.** .....Lecidea s. lato (see separate key) (if apothecia yellow to red and K+ purple or red-black, see Protoblastenia; if apothecia pinkish to brown and stalked, see Baeomyces; if no exciple, also see Vezdaea)

**10. Apothecia immersed in thallus or thalline warts.** .....11

**10. Apothecia lecanorine.** .....12

**11. Asci I+ deep blue. Epihymenium N-.** Paraphyses anastomosing, not moniliform above; spores rather thick-walled. Thallus not lobed; no cephalodia. Fulcra exobasidial. On various substrates. Lecanorales: Pertusariaceae. ....Pertusaria

**11. Asci I- or pale blue. Epihymenium often N+ green.** Usually on rock. Lecanorales: Hymeneliaceae. ....Aspicilia s. lato (see separate key)

**12. Thallus granulose-squamulose, yellow-brown, with indistinct cephalodia (containing Nostoc). On moss.** Thalline margin granular to squamulose. Paraphyses 1-2 mm wide; spores ellipsoid, fusiform or ovoid, rough-walled, 19-26 x 8-12  $\mu$ m. Asci clavate, with I+ blue tholus. Hypothecium yellow-brown. Lecanorales: Pannariaceae. ....Psoroma

**12. Thallus crustose to lobate or squamulose; if on moss then crustose and not yellow-brown.** .....13

**13. Thallus with conspicuous, lobed, pink-brown cephalodia; often lobed at margin, often C+ red. Asci cylindrical, I-.** Paraphyses under 1.7  $\mu$ m wide. Apothecia pink-brown,  $\pm$  sessile. Hypothecium hyaline. On rock. Lecanorales: Agyriaceae. ....Placopsis

**13. Thallus without cephalodia, C+ red or C-.** Asci clavate, tips I+ blue. Paraphyses over 1.7  $\mu$ m wide at least at tips. Apothecia sessile or semi-immersed. On various substrates. ....15

**14. Paraphyses anastomosing; spores rather thick-walled.** Thallus not lobed. Pertusariaceae. ....(see Ochrolechia and Pertusaria, above)

**14. Paraphyses  $\pm$  simple or anastomosing; spores mostly thin-walled.** .....Lecanora s. lato (See separate key)

### III-A. SPORES 8 OR FEWER, HYALINE, 1-SEPTATE

#### III-A-1. Algae Trentepohlia (see Key-VI-A-3).

Ascocarps without thalline margin.

#### III-A-2-a. Algae green, $\pm$ spherical (protococcoid)

Apothecia with thalline margin, at least when young.

1. Spores 1 per ascus, 200-400 x 70-130  $\mu$ m. Hymenium 400  $\mu$ m high. Thallus white to grayish,  $\pm$  thick, warty-knotty, with sparse irregular soralia, C+ red. On soil or moss, rarely on bark or wood. Lecanorales: Pertusariaceae. ....Varicellaria

1. Spores usually 8 per ascus, under 30  $\mu$ m long and wide. Hymenium under 200  $\mu$ m. ....2

2. Apothecia and often thallus yellow, orange or red, K+ purple. Spores usually polarilocular when mature, the cells connected by a canal or isthmus. Lecanorales: Teloschistaceae. ....Caloplaca

2. Apothecia and thallus not yellow, orange or red, or if so then not K+ purple. ....3

3. Asci Teloschistes-type. Spores usually polarilocular when mature. Apothecia brown or black; epihymenium usually (but not always) K+ red-violet. Teloschistaceae. ....Caloplaca

3. Asci otherwise. Spores not polarilocular. ....4

4. Apothecia and often thallus yellow. Asci Candelaria-type. Candelariaceae. ....Candelariella

4. Apothecia not yellow. ....6

5. Spores not halonate. Asci Bacidia-type or Biatora-type. Conidia acrogenously formed, sickle-shaped or curved, filiform. Epithecial pigment, when present, reddish brown, K+ purplish. Biatoraceae. ....Lecania

5. Spores halonate, with perispore greatly swelling in K. Asci Catillaria-type. Conidia pleurogenously formed, bacilliform. Epithecial pigment K-. Catillariaceae. ....Halecania

**III-A-2-a. Algae green,  $\pm$  spherical (protococcoid)  
Apothecia without thalline margin.**

- 1. Exciple poorly developed or absent.** Hymenium consolidated by ascal gel. ....2.(see Micarea and Arthonia)
- 1. Proper or thalline exciple well-developed, at least when young.** ..... 3
  - 2. Paraphysoids present,  $\pm$  dark-capped; spores often macrocephalic. Photobiont not "micareoid".** ..... Arthonia
  - 2. Paraphyses present, not dark-capped; spores not macrocephalic. Photobiont usually "micareoid".** ..... Micarea
- 3. Spores with halo. Paraphyses anastomosing.** Thallus yellow, brown or gray. On rock. Rhizocarpaceae. ....Rhizocarpon
- 3. Spores without halo. Paraphyses  $\pm$  simple.** .....4
  - 4. Thallus squamulose to subfruticose.** ..... 5
  - 4. Thallus crustose.** ..... 7
- 5. On soil or rock.** ..... 6
- 5. On bark or wood.** Lecanoraceae. ....Hypocenomyce
  - 6. Algae in a  $\pm$  distinct layer below upper cortex. Lower cortex and cortical rhizines absent. Apothecia becoming convex and immarginate. Exciple cellular. Spores always septate.** Biatoraceae. ....Toninia
  - 6. Algae scattered in the thallus, dividing the medulla and cortex. Lower cortex and cortical rhizines present. Apothecia flat, with swollen margin. Excipulum plectencymatous. Spores partly simple.** Lecanoraceae. ....Psorinia (conglomerata)
- 7. On leaves.** [There may be other genera that also fit here] ..... 8
- 7. On other substrates.** ..... Catillaria s. lato (some species of Lecidea s. lato will also key out here)
  - 8. Apothecia sessile. Thallus ecorticate. Asci bitunicate.** Asci Byssoloma-type. Conidia pyriform. Lecanorales: Pilocarpaceae. .... Fellhanera
  - 8. Apothecia innate to erumpent. Thallus corticate. Asci unitunicate.** Epithelial alga present or absent; paraphyses simple; apothecia round. Exciple well developed. Thallus uniform or granular. Photobiont protococcoid or chlorococcoid. Apothecia round, the margin formed by remnants of ruptured tissue; exciple paraplectenchymatous, I+ red. Paraphyses clavate at tips. Asci thick-walled, 1-8-spored; spores colorless, transversely 1-several septate or muriform. Pycnoconidia septate, fusiform, bacillar to filiform. Graphidales: Thelotremaaceae. .... Asterothyrium (See Santesson--Foliicolous lichens)

**DISCOLICHEN KEY III-B.**  
**SPORES 8 OR FEWER, HYALINE, TRANSVERSELY SEVERAL SEPTATE**

**III-B-1-a. Algae Trentepohlia (see Keys VI-A-4-a,b).**

**III-B-2-a. Algae Protococcoid.**

**Apothecia with thalline exciple, at least when young.**

Hypothecium pale.

**1. Apothecia mostly 2-4 mm wide, pink, often on short stalks. Hypothecium yellowish. Asci unitunicate, I-. Fulcrum endobasidial. On moss, rotten wood or humus, in moist forests.**

Leotiales: Baeomycetaceae. .... Icmadophila

**1. Apothecia mostly under 2 mm wide, at most yellowish- or brownish-pink, usually red or brown to black. Hypothecium hyaline. Asci bitunicate, I+ blue. Fulcrum exobasidial.**

Lecanorales. .... 2

**2. Apothecia bright- to dark-red, K+ purple or blue. Spores acicular, 3-septate or more. Thallus yellow or grayish. .... 3**

**2. Apothecia at most red-brown, usually K-. Spores ellipsoid, fusiform or oblong, usually curved, mostly 1-3-septate. Thallus gray or brown, not yellow. On bark or wood. .... 4**

**3. Asci with ocular chamber and faintly I+ blue axial mass. Paraphyses thick, richly branched and anastomosing, not thickened at the tip. Epihymenium K+ magenta in hymenial gel, or K+ purple-gray crystals rapidly fading in solution; red pigment acetone insoluble. Hypothecium hyaline. Proper exciple thin. Ostiole of pycnidium without green pigment. Conidiophores Vobis type V. Thallus containing atranorin. On bark or sometimes rock. Haematommaceae. .... Haematomma**

**3. Asci without ocular chamber or axial mass. Paraphyses thin, with few branches and anastomoses, thickened at tip. Epihymenium K+ blue crystals fading to magenta and dispersing in solution; red pigment acetone soluble. Hypothecium pigmented. Ostiole of pycnidium with green pigment. Conidiophores Vobis type VI. Thallus without atranorin. On rock. .... Ophioparma**

**4. Spores long fusiform to acicular. Asci Lecanora-type. Apothecia  $\pm$  plane or convex, brown, with brown or grayish thallus, often entirely or partly K+ red. On moss or humus. Lecanoraceae. .... Bryonora**

**4. Spores  $\pm$  ellipsoid. Asci Bacidia-type or Biatora-type. Substrate various. .... Lecania**



**III-B-2-b. Algae Protococcoid.  
Apothecia without thalline exciple.**

- 1. Hymenium and asci I- (even after K).** ..... 2
- 1. Hymenium or asci at least partly I+ or K/I+ blue.** Spore walls not swollen. .... 6
  - 2. Ascocarps ascolocular; hamathecium of anastomosing paraphysoids. Exciple absent or indistinct.** Asci bitunicate, I-, subglobose to pear-shaped. Apothecia  $\pm$  flat, black or paler, often irregular in outline. Paraphyses anastomosing. Arthoniales: Arthoniaceae. .... Arthonia
  - 2. Ascocarps ascohymenial; hamathecium of simple to branched or weakly anastomosing paraphyses. Exciple distinct.** ..... 3
- 3. Asci bitunicate.** Thallus pale yellow to greenish yellow or orange-yellow, K+ violet-purple [?--anthraquinones absent according to Tehler]. Apothecia sessile, constricted at base; disc yellow orange to orange or brownish; margin pale orange; exciple K+ purple or blue-violet [?]. Asci with inner apical apparatus and inner wall layers, non-amyloid, (1-)2-8-spored; spores with lens-shaped locules. On bark. Teloschistales: Letrouitiaceae. .... Letrouitia
- 3. Asci unitunicate.** Spores with  $\pm$  swollen outer walls. Exciple mostly composed of radiating hyphae. .... 4
  - 4. Paraphyses non-septate (even in I), dense, unbranched.** Apothecia small, Gyalecta-like, immersed at least at first in a greenish gray thallus. Ascus wall somewhat thickened at the apex. On various acidic substrates. Ostropales: Stictidaceae. .... Absconditella
  - 4. Paraphyses septate (sometimes visible only in I).** ..... 5
- 5. Paraphyses branched and anastomosing. Thallus with or without hyphophores.** Graphidales: Gomphillaceae. .... 6
- 5. Paraphyses mostly simple, articulated. Thallus without hyphophores.** Graphidales: Solorinellaceae. .... Gyalidea
  - 6. On leaves.** Thallus crustose, attached by rhizoidal hyphae, undifferentiated, uniform, ecorticate but with a  $\pm$  cartilaginous corticiform layer. Apothecia adnate, round to elongate and lirelliform, unbranched, with a brown-black, carbonaceous, proper exciple lateral to the hymenium, initially covering hymenium, later rupturing, in marginal part with distinct, irregularly oriented hyphae; hymenium I- (epiplasm I+ reddish brown); hypothecium light brown; paraphyses thin, branched and reticulate; asci oblong to spheroid, unitunicate, I-, thin-walled at maturity, (1-)2-8-spored; spores transversely 3-8-septate to submuriform or multicelled muriform, fusiform to elongate and  $\pm$  cylindrical, usually with rounded ends, hyaline, I+ violet, walls thin. Pycnidia adnate; fulcrum endobasidial; pycnospores simple, bacilliform or fusiform. Photobiont chlorococcoid (palmelloid). On leaves. Tropical. .... Aulaxina
  - 6. Not on leaves.** Thallus with hyphophores. .... Gyalideopsis
- 7. Spores with halo,  $\pm$  ellipsoid, straight, 1-3-septate, often over 25  $\mu$ m long.** Paraphyses anastomosing. Proper exciple  $\pm$  well-developed. Apothecia black. Asci I+ blue only at the apex. Fulcra exobasidial. Thallus yellow, gray or brown. On rock. Lecanorales: Rhizocarpaceae. .... Rhizocarpon
- 7. Spores without halo.** On various substrates. .... 8
  - 8. Exciple absent.** ..... 9
  - 8. Exciple distinct.** ..... 10
- 9. Asci loose, not bound by gelatin.** Asci  $\pm$  cylindrical, thick-walled, apex thickened, I+ blue

except for an apical pore. Lecanorales: Vezdaeaceae. ....Vezdaea

**9. Asci bound in gelatin.** Apothecia round, becoming convex to subglobose. Asci unitunicate, I+ blue with I+ blue tholus,  $\pm$  clavate. Thallus mostly greenish, often with goniocysts. Photobiont "micareoid", cells small, often in pairs. Lecanorales: Micareaceae. ....Micarea

**10. Spores finely filiform, to 100-200  $\mu$ m.** Asci unitunicate. Spores many-celled. Ascocarps dark. .... 10

**9. Spores much shorter, fusiform to acicular.** .... [See key under Bacidia]

**10. Apothecia short stipitate, urn-shaped. Spores to 1-1.2  $\mu$ m thick. On moss.** Asci unitunicate. Graphidales: Gomphillaceae. ....Gomphillus (americana)  
(This description based on G. calicioides; may not fully apply)

**10. Apothecia closely sessile to immersed, cup-shaped deepened. Spores to 2-5  $\mu$ m thick. On smooth barked trees.** Ostropales: Stictidaceae. .... Conotrema

## DISCOLICHEN KEY IV. SPORES 8 OR FEWER, HYALINE, MURIFORM.

### IV-A. Algae Trentepohlia (see Key VI-A-5).

### IV-B. Algae protococcoid, $\pm$ spherical, green.

**1. Exciple poorly developed or lacking; apothecia immersed in thalline warts or soralia, often scarcely visible; spores 100-170 x 25-50  $\mu$ m.** Ascospores with thickened septa and lenticular lumina. Thallus grayish, often K+ red. Often sterile. On bark or wood. Lecanorales: Phlyctidaceae. ....Phlyctis

**1. Exciple normally well-developed. Apothecia sessile, or if immersed then on rock or soil. Spores under 100  $\mu$ m long.** .....2

**2. Thalline exciple separated from deeply cupulate proper exciple by circular fissure; apothecia often immersed in thallus, with open disc or opening only by a pore.** On soil, rock, moss, or other lichens. Graphidales: Thelotremaaceae. ....Diploschistes

**2. Thalline exciple absent, or not separated from proper exciple; apothecia not deeply immersed or punctiform.** .....3

**3. Asci I- or I+ red.** .....4

**3. Asci usually I+ blue.** Spores with solid outer wall, but often surrounded by gelatinous halo. .... 7

**4. Asci bitunicate.** Thallus crustose, pale yellow to greenish yellow or orange-yellow, K+ violet-purple [?--anthraquinones absent according to Tehler]. Photobiont a green alga. Apothecia sessile, constricted at base; disc yellow orange to orange or brownish; margin prominent, pale orange, generally lighter than disc; exciple biatorine, K+ purple or blue-violet [?]. Paraphyses slightly branched and anastomosing. Asci with inner apical apparatus and inner wall layers, non-amyloid, (1-)2-8-spored; spores colorless, transversely septate, with lens-shaped locules, submuriform by several septa in some locules, or multicelled muriform. On bark. Teloschistales: Letrouitiaceae. ....Letrouitia

**4. Asci untunicate.** Spores with thick gelatinous outer wall; apothecia  $\pm$  pale, translucent. Apothecia mostly small, the discs concave at least at the beginning. .... 5

**5. Paraphyses simple, septae visible only in in I.** Apothecia Gyalecta-like, with flesh-colored to olivaceous or blackish disc. On various substrates, usually moist. Graphidales: Solorinellaceae. ....Gyalidea

**5. Paraphyses branched and anastomosing, thin, not distinctly septate.** Graphidales: Gomphillaceae. .... 6

**6. On leaves.** Thallus crustose, attached by rhizoidal hyphae, undifferentiated, uniform, ecorticate but with a  $\pm$  cartilaginous corticiform layer. Apothecia adnate, round to elongate and lirelliform, unbranched, with a brown-black, carbonaceous, proper exciple lateral to the hymenium, initially covering hymenium, later rupturing, in marginal part with distinct, irregularly oriented hyphae; hymenium I- (epiplasm I+ reddish brown); hypothecium light brown; paraphyses thin, branched and reticulate; asci oblong to spheroid, unitunicate, I-, thin-walled at maturity, (1-)2-8-spored; spores transversely 3-8-septate to submuriform or multicelled muriform, fusiform to elongate and  $\pm$  cylindrical,

- usually with rounded ends, hyaline, I+ violet, walls thin. Pycnidia adnate; fulcrum endobasidial; pycnospores simple, bacilliform or fusiform. Photobiont chlorococcoid (palmelloid). On leaves. Tropical. .... Aulaxina
- 6. Not on leaves.** Spores 2-8 per ascus. Apothecia brown to blackish, inconspicuous. .... Gyalideopsis (alnicola)
- 7. Paraphyses distinctly branched and anastomosing.** ..... 8
- 7. Paraphyses simple or furcate, or if anastomosing, then thallus on moss or humus.** Spores not halonate. .... 10
- 8. Thallus with campylidia. Not on rock. Spores not halonate.** ..... 9
- 8. Thallus without campylidia. On rock. Spores halonate, to 8 per ascus.** Disc dark brown to black. Hypothecium usually dark. Lecanorales: Rhizocarpaceae. .... Rhizocarpon
- 9. Epithecium with algae. Thallus felty.** ..... Sporopodium
- 9. Epithecium without algae. Thallus not felty.** Spores 1 per ascus. Exciple paraplectenchymatous; hypothecium purple-brown. Thallus thin. Lecanorales: Ectolechiaceae. .... Tapellaria
- 10. Spores olive-gray to gray-brown or dark brown, only weakly muriform, under 40 x 15 um, usually 8 per ascus. Fulcrum endobasidial.** Asci with Physcia-type apical apparatus. Lecanorales: Physciaceae. .... 11
- 10. Spores hyaline or very slightly brown when old, strongly muriform-many-celled, over 40 um long and over 15 um wide, often one or few per ascus. Fulcrum exobasidial.** Paraphyses  $\pm$  coherent. On moss, bark or rarely rock. .... 12
- 11. Apothecia lecidiane.** ..... Buellia (incl. Diplotomma)
- 11. Apothecia lecanorine.** ..... Rinodina (conradii)
- 12. On leaves.** ..... 13
- 12. On other substrates.** ..... 14
- 13. Apothecia sessile, constricted at base.** Thallus thin. Apothecia brown to brown-black; margin prominent; exciple paraplectenchymatous. Paraphyses simple to partially branched. Asci cylindrico-clavate, 1-4(-8)-spored; tholus distinct, I+ blue. Campylidia gray to brown. Pycnospores acicular, arcuate to spiral, multiseptate. Lecanorales: Ectolechiaceae. .... Calopadia
- 13. Apothecia innate to erumpent.** Epithecial alga present or absent; paraphyses simple; apothecia round. Exciple well developed. Thallus uniform or granular, corticate. Apothecia round, the margin formed by remnants of ruptured tissue; exciple paraplectenchymatous, I+ red. Paraphyses clavate at tips. Asci thick-walled, 1-8-spored. Pycnoconidia septate, fusiform, bacillar to filiform. Graphidales: Thelotremaaceae. .... Asterothyrium
- 14. Asci with amyloid tholus. Exciple of branched, radiating hyphae.** Paraphyses mostly branched and anastomosing. Apothecia blackish. On moss and humus, arctic-alpine. Lecanorales: Biatoraceae. .... Schadonia
- 14. Asci thick-walled, without apical wall-thickening and tholus. Exciple paraplectenchymatous.** ..... 15
- 15. Apothecia black to brown-black, without parietin, K-.** Paraphyses brown-capped. Thallus minutely squamulose. On bark, moss and humus, arctic-boreal. Lecanorales: Lopadiaceae. .... Lopadium
- 15. Apothecia red-yellow to dirty orange, with parietin, K+ red-purple.** On moss, shrubs, or rarely rock. Lecanorales: Brigantiaeaceae. .... Brigantiaea

## DISCOLICHEN KEY V. SPORES BROWN (TO GREENISH OR BLACKISH).

### V-A. SPORES BROWN, SIMPLE

#### Algae Chlorococcoid.

1. Apothecia pertusarioid. Pertusariaceae. .... Melanaria
1. Apothecia lecideine or biatorine. .... 2
  2. Apothecia dark reddish brown; epithecium K+ purple (in section); thallus C+ orange. Spores only slightly brownish. Lecanoraceae. .... (Pyrhospora quernea)
  2. Apothecia not deep red and K+ purple (in section); thallus C-or C+ red. Fuscideaceae. .... 3
3. Hypothecium dark brown, K+ purplish; epithecium olive-green, K+ green intensifying sometimes with additional brownish, K+ purplish pigment. .... Orphniospora atrata
3. Hypothecium colorless or pale straw; epithecium brown, never with K+ greenish or purplish pigments. .... Fuscidea

### V-B. SPORES BROWN, 1-SEVERAL TRANSVERSELY SEPTATE

#### V-B-1. Algae Trentepohlia (See Key VI-B-1-a. )

#### V-B-2. Algae Chlorococcoid

1. Spores at least when ripe with halo (gelatinous episore), or the inner colored wall layer covered by a hyaline outer layer. Paraphyses mostly branched and anastomosing. Asci Rhizocarpon-type. Rhizocarpaceae. .... 2
1. Spores without a halo or hyaline outer layer, often under 25 um long. Paraphyses often simple, not anastomosing. Asci Lecanora-type. Physciaceae. .... 3
  2. Spores with in inner dark wall around both lumina, surrounded by an outer hyaline wall, under 25 um long. Apothecia angular to shortly lirelliform. On calcareous rock. .... Poeltinula (cerebrina)
  2. Spores with halo; often over 25 um long. Apothecia round to angular. Thallus usually areolate to verrucose or squamulose, often on a black hypothallus, yellow, gray or brown. Paraphyses branched and anastomosing. Almost always on siliceous rock. .... Rhizocarpon
3. Apothecia lecanorine (to aspicilioid). Spore walls often unevenly thickened. .... Rinodina s. lato (see separate key)
3. Apothecia lecidiene (sometimes surrounded by or partly immersed in thallus, but not aspicilioid). Spore walls uniformly to weakly unevenly thickened. .... Buellia s. lato (see separate key)

**V-C. SPORES BROWN, MURIFORM.**

**V-C-1. Algae Trentepohlia (see Key VI-B-2).**

**V-C-2. Algae Chlorococcoid**

**1. Spores at least when ripe with halo (gelatinous epispore), or the inner colored wall layer covered by a hyaline outer layer. Paraphyses mostly branched and anastomosing. Asci Rhizocarpon-type. Spores with halo; often over 25  $\mu$ m long. Apothecia round to angular. Thallus usually areolate to verrucose or squamulose, often on a black hypothallus, yellow, gray or brown. Almost always on siliceous rock. Rhizocarpaceae. ....Rhizocarpon**

**1. Spores without a halo or hyaline outer layer, often under 25  $\mu$ m long. Paraphyses often simple, not anastomosing. Asci Lecanora-type. Spores without halo; often less than 25  $\mu$ m long. Physciaceae. .... 2**

**2. Apothecia lecanorine (to aspicilioid). Spore walls often unevenly thickened. ....Rinodina s. lato (see separate key)**

**2. Apothecia lecidienne (sometimes surrounded by or partly immersed in thallus, but not aspicilioid). Spore walls uniformly to weakly unevenly thickened. ....Buellia s. lato  
(see separate key)**

## DISCOLICHENS KEY VI. THALLUS WITH TRENTEPHOLIA

Rev. November 6, 1997

(Also see the natural key in ARTHONIALES.GEN.WPD)

### VI-A. SPORES HYALINE (AT MOST SLIGHTLY BROWNISH WHEN OLD).

#### V-A-1. Spores hyaline, more than 8 per ascus.

Spores transversely 1-several-septate.

**1. Spores to 12, rarely to 8 or 16. Apothecia with pale ochre-yellow discs and whitish margin.** Paraphyses not hooked,  $\pm$  swollen at tips. Gyalectaceae. ....  
Cryptolechia (carneolutea)

**1. Spores to 16 or more. Apothecia very small, red-brown.** Paraphyses  $\pm$  hooked at tips. On bark. Gyalectaceae. ....Pachyphiale

#### VI-A-2. Spores hyaline, 8 or fewer per ascus, non-septate.

Apothecia aspicilioid, 0.3-0.5(-0.7) mm diam., pink (especially when wet); hymenium pale, not bluegreen, K-, N-, 85-125(-140)  $\mu$ m; epipsamma absent. Thallus immersed to usually well developed. Asci bitunicate. On calcareous rocks. Arizona. Lecanorales: Hymeneliaceae. ....Hymenelia

#### VI-A-3. Spores hyaline, transversely 1-septate.

Ascocarps without thalloid margin.

**1. Ascomata ascolocular. Hamathecium of  $\pm$  branched and anastomosing paraphysoids. Asci usually globose or subglobose to pyriform. Ascocarps without distinct margin, usually immersed, often irregular, stellate, or elongate and divided. Spores straight. Thallus usually immersed.** Epithecial hyphae sparsely branched. Hamathecium I+ blue or red. Hypothecium pale brown, K+ olive-black. Exciple parathecial, the plectenchyma laxly intricate. Ascocarps multiascal, usually stellate or elongated. Ascocarps multiascal. Asci with hemiamyloid (K/I+) layer in endotunica, bitunicate. Ascospores ellipsoid to narrowly fusiform, often one end more pointed than the other; cells often unequal. On bark, wood, rock, soil, or lichens. ....Arthonia

**1. Ascomata ascohymenial. Hamathecium of simple to sparsely branched or anastomosed paraphyses. Asci usually clavate to cylindrical. Ascocarps with distinct, true exciple, usually sessile, shape various. Spores curved. Thallus usually superficial.** ..... 2

**2. Ascospores  $\pm$  distinctly brown when mature.** ..... (see Key VI-B: Melaspilea)

**2. Ascospores hyaline. Asci unitunicate. Ascospores with  $\pm$  cylindrical cell lumina. Ascocarps with a single margin, or zeorine but without a separation between the two margins. Ascomata without attached cortical remnants after breaking through upper layer; periphyses absent.** ..... 3

**3. True exciple black.** [The details of these two genera, other than ascus type, may need to be revised]. ..... 4

**3. True exciple pale.** Asci cylindrical, wall not thickened at apex. Thalline exciple absent. Ascospores 8 per ascus,  $\pm$  ellipsoid or fusiform. Apothecia sessile, whitish yellow to orange-red. No lichen substances. In humid, shaded or sheltered habitats, mostly on acid bark, sometimes over mosses. Gyalectales: Gyalectaceae. .... Dimerella

**4. Asci Lecanora-type.** Apothecia rather large, roundish to elongated, when rounded, then often with 2-sided "eingeschlagenen" margins. Spores rather large, thick-walled. On bark or stone. Lecanorales: Lecanoraceae. .... Megalaria (grossa)

**4. Asci Biatora-type.** Apothecia small, round, rapidly convex. Spores thin-walled. Exciple  $\pm$  well-developed, at least when young, composed of parathecium and radiating amphithecium, not markedly thickened or striate. Lecanorales: Biatraceae. .... Catinaria



**VI-A-4-a. Spores hyaline, 8 or fewer per ascus, transversely several-septate.  
Ascocarps with thalline margin, at least when young.**

- 1. Ascomata ascolocular. Hamathecium of  $\pm$  branched and anastomosing paraphysoids. Hypothecium and/or true exciple usually dark,  $\pm$  black and friable, or if pale then true exciple absent. Asci with hemiamyloid (K/I+) layer in endotunica, bitunicate. .... 2**
- 1. Ascomata ascohymenial. Hamathecium of simple to sparsely branched or anastomosed paraphyses. Hypothecium and true exciple usually pale. Asci various. .... 3**
  - 2. Ascocarps (pseudothecia) with distinct, pale thalline or false thalline exciple. Ascospores dark brown or grayish black when mature. Thallus corticate, often C+ red. .... (see Key VI-B)**
  - 2. Apothecia with an indistinct thalline exciple. Spores at most finally brownish. True exciple poorly developed, of usually intertwined hyphae; poorly developed thalline exciple present. Ascomata to 0.5 mm across, usually elongated, without cortex. Disc and proper exciple pruinose. Hypothecium usually carbonaceous. Asci clavate, thickened at the apex, with an internal I+ blue ring. Ascospores fusiform, 3-septate. Pycnospores usually bicilliform. Thallus thin, weakly differentiated, usually whitish, containing calcium oxalate. With roccellic acid. On bark, usually in open and  $\pm$  dry habitats. .... Schismatomma**
- 3. Ascospores  $\pm$  distinctly brown when mature. .... (see Key VI-B: "Sclerophyton" occidentale)**
- 3. Ascospores hyaline. Ascospores 1- to multiseptate or muriform. Asci unitunicate. .... 4**
  - 5. Ascospores with  $\pm$  lens-shaped or globose cell lumina, mostly attenuate, transversely septate to muriform. Ascocarps sometimes with thalline margin surrounding a proper margin, the two margins separated by a crack. Discs immersed and crater-like in appearance. On bark or wood, in moist areas. .... THELOTREMATACEAE (see separate key)**
  - 4. Ascospores with  $\pm$  cylindrical cell lumina. Ascocarps with a single margin, or zeorine but without a separation between the two margins. .... 5**
- 5. Ascomata at first deeply immersed in thallus, after breaking through cortex, remnants of cortex remaining attached to disc margins; periphyses present or absent. .... 6**
- 5. Ascomata without attached cortical remnants after breaking through upper layer; periphyses absent. True exciple pale. Asci (8-)16-48-spored; spores 3-15-septate; apothecial disc red-brown to orange. Gyalectales: Gyalectaceae. .... (Pachyphiale)**
  - 6. Apothecia when dry separated from surrounding thallus through a crack; periphyses absent. On calcareous rocks. Ostropales: Stictidaceae. .... Petractis**
  - 6. Ascomata when dry not separated from surrounding thallus through a crack; periphyses present. On bark or wood. Ascomata opening punctiform with fringed, crenulate or fissured aperture. True exciple of small, thin-walled, angular cells. Asci clavate to cylindrical. Ascospores multiseptate or muriform. No lichen substances. Ostropales: Odontremataceae. .... (Ramonia)**

**VI-A-4-b. Spores hyaline, 8 or fewer per ascus, transversely several-septate.  
Ascocarps without thalloid margin.**

- 1. Ascomata ascolocular. Hamathecium of  $\pm$  branched and anastomosing paraphysoids. Hypothecium and/or true exciple usually dark,  $\pm$  black and friable, or if pale then true exciple absent. Asci with hemiamyloid (K/I+) layer in endotunica, bitunicate. .... 2**
- 1. Ascomata ascohymenial. Hamathecium of simple to sparsely branched or anastomosed paraphyses. Hypothecium and true exciple usually pale. Asci various. .... 9**
  - 2. Ascocarps without distinct margin.** Asci usually globose or subglobose to pyriform. Spores straight. Ascomata usually immersed, often irregular, elongate and divided. Thallus usually immersed. .... 3
  - 2. Ascocarps with distinct, true exciple.** Asci usually clavate to cylindrical. Spores curved. Ascomata usually sessile, shape various. Thallus usually superficial. .... 4
- 3. Epithecial hyphae sparsely branched. Hamathecium I+ blue or red. Hypothecium pale brown, K+ olive-black. Exciple parathecial, the plectenchyma laxly intricate. Ascocarps multiascal, usually stellate or elongated. Ascospores 1-7-septate, ellipsoid to narrowly fusiform, often one end more pointed than the other; cells often unequal. On bark, wood, rock, soil, or lichens. .... Arthonia**
- 3. Epithecial hyphae reticulately branched. Hamathecium I-. Hypothecium dark brown to carbonaceous, K-. Exciple unorganized ascostromatic, the plectenchyma coalescently intricate. Ascocarps uniascal, roundish. Spores usually becoming muriform when mature. On bark or wood. .... (Arthothelium)**
  - 4. True exciple poorly developed, of usually intertwined hyphae.** Ascomata to 0.5 mm across, usually elongated, without cortex. Disc and proper exciple pruinose. Hypothecium usually carbonaceous. Asci clavate, thickened at the apex, with an internal I+ blue ring. Ascospores fusiform, 3-septate. Pycnosporos usually bicilliform. Thallus thin, weakly differentiated, usually whitish, containing calcium oxalate. With roccellic acid. On bark, usually in open and  $\pm$  dry habitats. .... Schismatomma
  - 4. True exciple well developed. .... 5**
- 5. Ascomata epruinose; margin shiny. Ascocarps monocarpocentral, without hymenial bands. Asci Bactrospora-type, cylindrical, with a large amyloid apical dome, easily separated from ascogenous hyphae when squashed in K. Base of excipulum delimited in medulla or substrate. Without lichen substances. Excipulum hyphae undifferentiated. Ascospores acicular, cylindrical, or biclavate, fragmenting in some species. On bark, rarely rock, in humid areas. .... Bactrospora**
- 5. Ascomata (at least disks) pruinose; margin matt or shiny. Ascocarps pluricarpicentral, with hymenial bands. Asci of other types, clavate, with at most a thin amyloid structure, difficult to separate from ascogenous hyphae when squashed in K. Base of excipulum extending towards medulla or substrate. With lichen substances. .... 6**
  - 6. Ascocarp margin shiny, epruinose. Excipulum hyphae not differentiated. Paraphysoids scarcely branched and somewhat anastomosing. Ascospores thick-walled, with thick and very reactive perispore, and with differentiated endospore. Pseudoepithecium with granules and/or crystals soluble in K. Asci abietina-type. With lecanoric or gyrophoric acids only. On bark, rarely rock, in humid**

- areas. .... Cresponea
- 6. Ascocarp margin matt, pruinose. Excipulum hyphae differentiated in the margin. Paraphysoids moderately to strongly branched and anastomosing. Ascospores thin-walled, with at most thin perispore and scarcely differentiated endospore.** Excipulum and pseudoepithecium with granules and/or crystals insoluble in K. Ascospores fusiform to cylindrical. Often with other lichen substances in addition to lecanoric or gyrophoric acids. On bark, wood, or rock. .... 7
- 7. Ascocarps sessile, constricted at base. Ascus abietina-type, with only a relatively wide amyloid structure at the tip of the endoascus. Spores oblong-fusiform to curved, sometimes fragmenting, without gelatinous halo, perispore present, thin and reacting in mature spores.** Without erythrin, confluent acid, and anthraquinones; with lepralic acid. On bark, rarely rock, in humid areas. .... Lecanactis
- 7. Ascocarps immersed to sessile, not or scarcely constricted at base. Ascus grumulosa-type, with at most a very tiny amyloid structure. Spores oblong-fusiform to cylindrical, not fragmenting, with gelatinous halo, perispore absent.** With erythrin, confluent acid, anthraquinones, and unidentified substances; without lepralic acid. On bark or rock, in  $\pm$  arid areas. .... Lecanographa
- 8. Ascospores  $\pm$  distinctly brown when mature.** .... (see Key VI-B: Melaspilea and "Sclerophyton" occidentale)
- 8. Ascospores hyaline. Ascospores 1- to multiseptate or muriform. Asci unitunicate.** .... 9
- 9. Ascospores with  $\pm$  lens-shaped or globose cell lumina, mostly attenuate, transversely septate to muriform. Ascocarps sometimes with thalline margin surrounding a proper margin, the two margins separated by a crack.** Discs immersed and crater-like in appearance. On bark or wood, in moist areas. .... THELOTREMATACEAE (see separate key)
- 9. Ascospores with  $\pm$  cylindrical cell lumina. Ascocarps with a single margin, or zeorine but without a separation between the two margins.** .... 10
- 10. Ascomata at first deeply immersed in thallus, after breaking through cortex, remnants of cortex remaining attached to disc margins; periphyses present or absent.** .... 11
- 10. Ascomata without attached cortical remnants after breaking through upper layer; periphyses absent.** .... 12
- 11. Apothecia when dry separated from surrounding thallus through a crack; periphyses absent. On calcareous rocks. Ostropales: Stictidaceae.** .... Petractis
- 11. Ascomata when dry not separated from surrounding thallus through a crack; periphyses present.** On bark or wood. Ascomata opening punctiform with fringed, crenulate or fissured aperture. True exciple of small, thin-walled, angular cells. Asci clavate to cylindrical. Ascospores multiseptate or muriform. No lichen substances. Ostropales: Odontremataceae. .... Ramonia
- 12. True exciple black.** .... 13
- 12. True exciple pale.** Gyalectales: Gyalectaceae. .... 15
- 13. Ascospores 1-septate.** .... 14
- 13. Ascospores 3-septate at maturity, often with a thin perispore; true exciple very thick, becoming strongly radially fissured and crenate in older apothecia.** Graphidales: Gomphillaceae. .... Sagirolechia

- 14. Asci Lecanora-type.** Apothecia rather large, with thick-walled spores. Lecanorales: Lecanoraceae. .... Megalaria (grossa)
- 14. Asci Biatora-type.** Apothecia small, with thin-walled spores. Lecanorales: Biatoraceae. .... Catinaria
- 15. Ascospores > 8 per ascus, 3-15-septate.** ..... 16
- 15. Ascospores 8 per ascus.** Ascus wall not thickened at apex. Thalline exciple absent. Ascospores  $\pm$  ellipsoid or fusiform. .... 17
- 16. Asci to (8-)12(-16)-spored; apothecial disc pale yellow-brown.** Paraphyses tips hooked. .... Cryptolechia (carneolutea)
- 16. Asci (8-)16-48-spored; apothecial disc red-brown to orange.** Paraphyses tips not hooked,  $\pm$  swollen. .... Pachyphiale
- 17. Ascospores 1-septate.** Apothecia sessile, whitish yellow to orange-red. No lichen substances. Asci cylindrical. In humid, shaded or sheltered habitats, mostly on acid bark, sometimes over mosses. .... Dimerella
- 17. Ascospores 3- or 5- to 13-septate (usually muriform).** Apothecia pale yellowish to dark brown; with a distinctly raised margin. True exciple of narrow, never distinctly angular, cells. On  $\pm$  nutrient-rich or  $\pm$  base-rich soil, mosses, bark or rock. .... (Gyalecta)

**VI-A-5. Spores hyaline, 8 or fewer per ascus, muriform.**

**1. Ascomata ascolocular. Hamathecium of  $\pm$  branched and anastomosing paraphysoids. Hypothecium and/or true exciple usually dark,  $\pm$  black and friable, or if pale then true exciple absent. Asci bitunicate.** Asci with hemiamyloid (K/I+) layer in endotunica. Ascocarps without distinct margin. Asci usually globose or subglobose to pyriform. Spores straight. Ascomata usually immersed, often irregular, elongate and divided. Thallus usually immersed. Ascospores weakly or strongly muriform, mostly broadly ellipsoid and rounded at both ends. Epithecial hyphae reticulately branched. Hamathecium I-. Hypothecium dark brown to carbonaceous, K-. Exciple unorganized ascostromatic, the plectenchyma coalescently intricate. Ascocarps uniascal, roundish. On bark or wood. .... Arthothelium

**1. Ascomata ascohymenial. Hamathecium of simple to sparsely branched or anastomosed paraphyses. Hypothecium and true exciple usually pale. Asci unitunicate.** ..... 2

**2. Ascospores with  $\pm$  lens-shaped or globose cell lumina, mostly attenuate, transversely septate to muriform. Ascocarps sometimes with thalline margin surrounding a proper margin, the two margins separated by a crack.** Discs immersed and crater-like in appearance. On bark or wood, in moist areas. .... THELOTREMATACEAE (see separate key)

**2. Ascospores with  $\pm$  cylindrical cell lumina. Ascocarps with a single margin, or zeorine but without a separation between the two margins.** ..... 3

**3. Ascomata at first deeply immersed in thallus, after breaking through cortex, remnants of cortex remaining attached to disc margins; periphyses present or absent.** Ascomata when dry not separated from surrounding thallus through a crack; periphyses present. On bark or wood. True exciple of small, thin-walled, angular cells. Asci clavate to cylindrical. No lichen substances. Ostropales: Odontremataceae. .... Ramonia

**3. Ascomata without attached cortical remnants after breaking through upper layer; periphyses absent.** True exciple pale. Ascospores 8 per ascus. Ascus wall not thickened at apex. Thalline exciple absent. Ascospores  $\pm$  ellipsoid or fusiform. Apothecia pale yellowish to dark brown; with a distinctly raised margin. True exciple of narrow, never distinctly angular, cells. On  $\pm$  nutrient-rich or  $\pm$  base-rich soil, mosses, bark or rock. Gyalectales: Gyalectaceae. .... Gyalecta

## VI-B. SPORES BROWN OR BLACKISH WHEN MATURE.

### VI-B-1-a. Spores brown, 8 or fewer per ascus, transversely 1-several-septate.

Ascomata with thalloid margin at least when young.

**1. Ascomata ascolocular. Hamathecium of  $\pm$  branched and anastomosing paraphysoids. Hypothecium and/or true exciple usually dark,  $\pm$  black and friable, or if pale then true exciple absent. Asci with hemiamyloid (K/I+) layer in endotunica, bitunicate. .... 2**

**1. Ascomata ascohymenial. Hamathecium of simple to sparsely branched or anastomosed paraphyses. Hypothecium and true exciple usually pale. Asci various. Ascospores 3-septate. Thallus thick, dirty white to yellowish white, crustaceous, becoming rough and thickly sprinkled with small soredia,  $\pm$  marginally zonate, with poorly defined hypothallus. Apothecia black, circular to elongate and difform, with slightly developed white exciple. Asci lecanoralean. Spores 12.5-18 x 4-7.5  $\mu$ m. On bark. California. .... "Sclerophyton" occidentale Herre**

**2. Ascocarps (pseudothecia) with distinct, pale thalline or false thalline exciple. Ascospores dark brown or grayish black when mature. Thallus corticate, often C+ red. .... 3**

**2. Apothecia with an indistinct thalline exciple, or thalline exciple absent. Spores at most finally brownish. .... (see Key VI-A)**

**3. Ascocarps immersed at least when young. Paraphysoids richly branched, not widened and reticulate at the tips. Ascospores  $\pm$  constricted in center, with gelatinous sheaths. Pycnospores filiform. Thallus crustose. .... 4**

**3. Ascocarps constricted sessile; discs round to irregular, often pruinose; hypothecium thick, carbonaceous. Paraphysoids thick, branched and anastomosing. Asci nassaceous. Pycnospores rod-shaped to filiform. Ascospores 3-septate. Thallus thick, crustose to subfruticose; cortical hyphae anticalinal. On calcium-rich rock or bark. Coastal. .... 5**

**4. True exciple narrow or not evident. Thallus thin, uniform. Ascomata immersed, often forming groups or lines. Thalline exciple (true or false) usually present. True exciple brown above, pale below; hypothecium brown. Paraphysoids thick (2-2.5  $\mu$ m). Ascospores 3-septate, oblong-ovoid,  $\pm$  constricted in the center. On bark, wood, or rock. .... Sclerophyton**

**4. True exciple very thick. Thallus crustose, areolate to convolute, white creamy, thick, well developed. Ascocarps at first lirelliform, becoming round; disk and exciple black, with whitish pruina; hypothecium brown; ascospores 5-7-septate, 20-30 x 5-6  $\mu$ m, usually with gelatinous sheath. On rock. San Luis Obispo Co., California. .... Llimonaea (occulta)**

**5. On bark. .... 6**

**5. On rock. .... 7**

**6. Medulla absent or indiscernible. Microconidia bacilliform. Thallus crustose, effuse. Thallus C-, K- or yellowish, P+ yellow (psoromic acid) or P-. Thallus white without creamy tinge. Discothecia circular, not or only slightly undulating. Ascomata (0.2-)0.5-1(-1.6) mm diam., rounded. Cortex usually present on thallus and ascomatal margin. On bark of various trees and shrubs, in coastal or near-coastal areas. California. .... Sigridea (californica)**

**6. Medulla distinct. Microconidia filiform. Thallus crustose to lobate to subfruticose.**

Cortex often C<sup>+</sup> red, rarely K<sup>+</sup> yellowish, KC<sup>+</sup> often reddish, rarely P<sup>+</sup> red or yellow. Erythrin, lecanoric acid, roccellic acid, schizopeltic acid, atranorin and unidentified substances; norstictic and psoromic acids sporadic or rare. Thallus white or white-gray to dark brown or yellowish. .... Roccellina

7. Thallus crustose, not lobate or subfruticose. Cortex composed of anticlinal hyphae, often obscured by crystals. Hypothecium sharply defined towards the completely white medulla. .... Dirina

7. Thallus crustose to lobate to subfruticose. Cortex composed of mixed and intertwined hyphae (mostly not anticlinal), usually translucent and without crystals. Hypothecium extending to the substrate or fusing with the lower brown part of the medulla. .... Roccellina

**V-B-1-b. Spores brown, 8 or fewer per ascus, transversely 1-septate.  
Ascomata without thalloid margin.**

**1. Ascomata ascolocular. Hamathecium of  $\pm$  branched and anastomosing paraphysoids. Hypothecium and/or true exciple usually dark,  $\pm$  black and friable, or if pale then true exciple absent.** Asci with hemiamyloid (K/I+) layer in endotunica, bitunicate.

**1. Ascomata ascohymenial. Hamathecium of simple to sparsely branched or anastomosed paraphyses. Hypothecium and true exciple usually pale.** Asci various. .... 2

**2. Ascospores dark brown or grayish black when mature.** Thallus corticate, often C+ red. **Ascocarps immersed at least when young.** Paraphysoids richly branched, not widened and reticulate at the tips. Ascospores  $\pm$  constricted in center, with gelatinous sheaths. Pycnosporos filiform. Thallus crustose. True exciple narrow or not evident. .... (see Key VI-B-1-a Sclerophyton)

**2. Spores at most finally brownish.** .... (see Key VI-A)

**3. Ascospores 1-septate. Thallus immersed, often evanescent or scarcely apparent.** True exciple dark brown to black. Thalline exciple absent. Hypothecium colorless to brown. Hamathecium of thread-like, sparsely branched to anastomosed paraphyses. Asci bitunicate, elongate-clavate, generally thickened at the apex, usually with I-, K/I- apical dome and an internal ocular chamber. Pycnosporos long. Thallus usually with no substances, rarely with an unidentified pigment. On bark, more rarely rock or other lichens. .... Melaspilea

**3. Ascospores 3-septate. Thallus thick, dirty white to yellowish white, crustaceous, becoming rough and thickly sprinkled with small soredia,  $\pm$  marginally zonate, with poorly defined hypothallus.** Apothecia black, circular to elongate and difform, with slightly developed white exciple. Asci lecanoralean. Spores 12.5-18 x 4-7.5  $\mu\text{m}$ . On bark. California. .... ("Sclerophyton" occidentale Herre)



**VI-B-2. Spores brown, 8 or fewer per ascus, muriform.**

**Ascospores with  $\pm$  lens-shaped or globose cell lumina, mostly attenuate, transversely septate to muriform. Ascocarps sometimes with thalline margin surrounding a proper margin, the two margins separated by a crack.** Discs immersed and crater-like in appearance. On bark or wood, in moist areas. .... THELOTREMATACEAE (see separate key)

## ALTERNATIVE, FIELD-ORIENTED KEYS

2/94

Very Preliminary

### A. THALLUS BRIGHT YELLOW, ORANGE, OR RED

- 1. Thallus K+ purple. .... 2
- 1. Thallus K-. .... 4
  - 2. Spores 1-septate to polarilocular. .... Caloplaca
  - 2. Spores simple. .... Fulgensia
- 3. On rock. .... A-1
- 3. On other substrates. .... A-2

## A-1. ON ROCK

### A-1-a. Thallus red, orange, or rusty.

- 1. Apothecia aspicilioid or immersed. .... 2
- 1. Apothecia lecideine. .... 3
  - 2. Growing submerged in mountain streams. .... Ionaspis (lacustris)
  - 2. Growing on dry rock. .... Acarospora (sinopica)
- 3. Apothecia very tiny. .... Tremolecia (atrata)
- 3. Apothecia larger. .... 5
  - 4. Spores muriform (?). .... Rhizocarpon oederi
  - 4. Spores simple, colorless. .... 5
- 5. .... Porpidia
- 5. .... Lecidea

**A-1-b. Thallus greenish yellow to bright yellow or orangish yellow.**

- 1. Thallus entirely leprose. .... 2**
- 1. Thallus at least partly corticate. .... 3**
  - 2. .... Chrysothrix**
  - 2. .... Psilolecia**
- 3. Apothecia lecanorine or immersed. .... 4**
- 3. Apothecia lecideine or biatorine. .... 6**
  - 4. Apothecia immersed. .... Acarospora**
  - 4. Apothecia lecanorine. .... 5**
- 5. Discs yellow. .... Candelariella**
- 5. Discs not yellow. .... Lecanora**
  - 6. Apothecia biatorine. .... 7**
  - 6. Apothecia lecideine. .... 9**
- 7. Apothecia bright red. .... Ophioparma**
- 7. Apothecia not red. .... 8**
  - 8. .... Candelariella**
  - 8. .... Psilolecia**
- 9. Spores large, with halo. .... Rhizocarpon**
- 9. Spores smaller, without halo. .... Buellia**

ADD: Eiglera (flavida)

## **A-2 ON SUBSTRATES OTHER THAN ROCK**

### **A-2-a. Apothecia lecanorine or biatorine.**

1. .... Candelariella
- 1.

### **A-2-b. Apothecia lecideine.**

1. **Parasitic on other lichens.** ..... 2
1. **Not parasitic.** ..... Arthorhaphis
  2. .... Catolechia (wahlenbergii)
  2. .... Epilichen (scabrosus)

## B. APOTHECIA PERTUSARIOID OR ASPICILIOID

### B-1. On rock, soil, moss, or other lichens

1. Apothecia with a proper margin visible between the disc and thalline margin, and separated from the latter. On rock, soil, moss, or other lichens. .... Diploschistes
1. Apothecia without such margins (thalline margin may occasionally appear double in a few Pertusaria spp.). ....
  2. On rock. .... 3
  2. On other substrates. ....
3. Thallus with cephalodia. .... 4
3. Thallus without cephalodia. .... 5
  4. Disc without a pore in the center. .... Amygdalaria
  4. Disc with a pore in the center. .... Coccotrema (maritimum)
5. With Trentepohlia. Discs often pale (and epruinose). .... Hymenelia
5. With green algae. Discs dark (or pruinose). .... 6
  6. .... Pertusaria
  6. .... 7
7. .... Sporastatia
7. .... Acarospora
  8. .... Aspicilia
  8. .... Bellemeria

## **B-2. On bark or wood**

**1. Apothecia with a proper margin visible between the disc and thalline margin, and separated from the latter. .... Thelotrema**

**1. Apothecia without such margins (thalline margin may occasionally appear double in a few Pertusaria spp.). .... 2**

**2. Thallus with cephalodia. .... Coccotrema**

**2. Thallus without cephalodia. .... 3**

## C. APOTHECIA LECANORINE

### C-1. On rock.

1. With cephalodia. .... Placopsis
1. Without cephalodia. .... 2
  2. Discs bright red. .... Haematomma
  2. Discs not bright red. .... 3
3. Discs yellow. .... 4
3. Discs not yellow. .... 5
  4. .... Candelariella
  4. .... Lecanora
5. Discs C+ red. .... Ochrolechia
5. Discs C-, C+ yellow, or C+ orange. .... 6
  6. Discs densely white pruinose, C+ yellow. .... Lecanora
  6. Discs epruinose to densely pruinose, C-. .... 7
7. Thallus brown. .... 8
7. Thallus not brown. .... 11
  8. .... Rinodina s. lato
  8. .... 9
9. .... Lecania
9. .... 10
  10. .... Protoparmelia
  10. .... Lecanora
11. Apothecia often large, the margin very thick, often curved over disk when young, the disc pinkish, orangish, or yellowish. .... Ochrolechia
11. Apothecia small, or if large then usually with thin margin and  $\pm$  dark or deeply colored disk. .... 12
  12. Discs black. .... 13
  12. Discs not black. ....
13. .... Rinodina
13. .... 14
  14. .... Tephromela
  14. .... 15
13. .... Lecania
13. .... Lecanora



## C-2. On other substrates

### 1. Discs black. ....

Rinodina s. lato

Pertusaria

Tephromela

Lecanora

Lecania

### 1. Discs not black. ....

2. Lecania

2. Lecanora

## D. APOTHECIA BIATORINE

- 1. Apothecia yellow, orange, or red, K+ purple. .... 2
- 1. Apothecia some other color, or at least not K+ purple. ....
  - 2. .... Brigantiaea
  - 2a. .... Caloplaca
  - 2a. .... Protoblastenia
- 3. Apothecia bright red or red-orange. ....
- 3. Apothecia not bright red or red-orange. .... 4
  - 3a. .... Pyrrhospora
  - 3a. .... Haematomma
- 4. Apothecia bright or deep yellow. .... 5
- 4. Apothecia some other color, at most pale or weakly yellowish. ....
  - 5. .... Candelariella
  - 5. .... Lecanora
- 6. Thallus C+ red. .... 7
- 6. Thallus C-. .... 8
  - 7. .... Trapelia
  - 7. .... Trapeliopsis

**D-1. On rock.**

Absconditella

Lecidea s. lato

**D-2. On other substrates.**

Absconditella

Dimerella

Lecidea s. lato

Catillaria s. lato

Bacidia s. lato

Biatorella s. lato

Micarea

Mycobilimbia

## E. APOTHECIA LECIDEINE

### E-1. On rock.

- 1. Thallus with cephalodia. .... 2
- 1. Thallus without cephalodia. .... 3
  - 2. .... Amygdalaria
  - 2. .... Rhizocarpon (hensseniae)
- 3. Thallus mottled brown and bright yellow. .... Rhizocarpon (bolanderi v. sulfurosum)
- 3. Thallus not mottled brown and yellow. .... 4
  - 4. Thallus brown. .... 4a
  - 4. Thallus not brown. .... 7
- 4a Areoles peltate, concave. .... 5
- 4a. Areoles not peltate, concave to flat or convex. .... 6
- 5. Spores muriform. .... Rhizocarpon bolanderi
- 5. Spores simple. .... Lecidea
  - 6. Spores septate or muriform. .... Buellia and Rhizocarpon
  - 6. Spores simple. .... Lecidea s. lato
- Discs umbonate, often becoming gyrose. .... Polysporina

Sarcogyne

Buellia s. lato

Lecidea s. lato

Rhizocarpon

Arthonia

**E-2. On other substrates.**

**1. Hypothecium bright red. ....** Mycoblastus (sanguinarius)

**1. Hypothecium not bright red. ....** 2

Lecidea s. lato

Buellia s. lato

Catillaria s. lato

Bacidia s. lato

Toninia

Arthonia

Lopadium