

PYRENOLICHEN (AND RELATED NON-LICHENIZED) GENERA

After Poelt & Vezda (1981),
Harris (1975, 1998), and Aptroot (1991, 19);

Rev. November 18, 1998

KEY I. TO ORDERS AND FAMILIES

After Tehler;

- 1. Asci unitunicate. (OSTROPALES: STICTIDACEAE: Thelopsis)
- 1. Asci bitunicate. 2
 - 2. Ascocarps ascolocular. VERRUCARIALES (Group B).
 - 2. Ascocarps ascohymenial (or ascolocular according to Harris 1995). 3
- 3. Ascocarps apothecia, with pale exciple. LECANORALES. 4
- 3. Ascocarps true perithecia, with dark exciple. The distinctions between these orders is not given. 5
 - 4. Spores many (30-300) per ascus. Ascocarps (fruiting warts) mostly bright greenish yellow pruinose, rarely dull yellowish to pale brown. Asci 50-300-spored. (ACAROSPORACEAE: Thelocarpon)
 - 4. Spores 1-8 per ascus. Ascocarps apothecia, with pale wall. Spores rather large, simple, with \pm thick outer wall. (PERTUSARIACEAE: Pertusaria, Coccotrema, and immature Ochrolechia)
- 5. HYMENOASCOMYCETES. according to Harris 1995. 5A
- 5. LOCULOASCOMYCETES. according to Harris 1995. 5B
 - 5A. TRICHOTHELIALES: TRICHOTHELIACEAE
 - 5A. XYLARIALES: PLEUROTREMATACEAE
 - 5B. DOTHIDEALES (PLEOSPORALES according to Harris 1995). [Hassea also belongs here, but is of uncertain position within the order]. 6
 - 5B. PYRENULALES (MELANOMMATALES S. LATO according to Harris 1995, who adds the family Thelenellaceae, which Tehler puts in the Lecanorales: Coccotremataceae and Pertusariaceae). 8
 - 6. Ascospores colorless, 1-septate to muriform. Photobiont, if present, filamentous algae, but most genera are non-lichenized. 6a
 - 6. Ascospores brown or black, muriform. 7a
- 6a.
 - ARTHOPYENIACEAE
 - NAETROCYMBACEAE
 - MICROPELTIDACEAE
 - XANTHOPYRENIACEAE
 - DACAMPIACEAE
- 7a. Ascospores black. Photobiont cyanobacteria. PYRENOTRICHACEAE: Pyrenothrix
- 7a. Ascospores brown. Photobiont, if present, green algae. MYCOPORACEAE: Mycoporum

- 8. Perithecia usually in stromata; asci clavate; ascospores multiseptate with thick walls and lens-shaped cells.** TRYPETHELIACEAE: Astrothelium, Campylothelium, Laurera, Lithothelium, Parmentaria (= Pyrenula according to Harris, 1990), Polymeridium, Pseudopyrenula, Pyrenastrum (= Pyrenula according to Harris, 1990) Trypethelium
- 8. Perithecia usually solitary.** 9
- 9. On leaves with thallus growing under the cuticle of the host.**
STRIGULACEAE: Strigula (Harris 1995 includes non-foliicolous species)
- 9. On various substrates; if on leaves then usually with thallus superficial. Asci cylindrical. Ascospores multiseptate to muriform.** 10
- 10. Ascospores with \pm lenticular cells, colorless or brown.**
PYRENULACEAE: Acrocordia, Athracothecium, Eopyrenula, Parathelium (= Pyrenula according to Harris, 1990), Plagiocarpa (= Lithothelium according to Aptroot, 1991), Pyrenocollema, Pyrenula
- 10. Ascospores with cylindrical cells, colorless.** TRICHOTHELIACEAE (Harris 1995 puts this under Hymenoascomycetes: Trichotheliales): Clathroporina, Porina, Trichothelium, Zamenhofia (= Porina according to some authors)

Various other pyrenocarpous genera are not mentioned by Tehler.

KEY II. TO ORDERS AND FAMILIES

After Poelt & Vezda (1981),
Harris (1975, 1990, 1995), and Aptroot (1991, 19)

This is mostly quite different from Tehler's system, for groups A and C

1. Spores many (30-300) per ascus. 2
1. Spores 1-8 per ascus. 4
 2. Spores 1-3-septate. Asci unitunicate. ("UNITUNICATE ASCOHYMENIALS": OSTROPALES: STICTIDACEAE: Thelopsis)
 2. Spores simple. Asci bitunicate. 3
3. Ascocarps (fruiting warts) mostly bright greenish yellow pruinose, rarely dull yellowish to pale brown. Asci 50-300-spored. (LECANORALES: ACAROSPORACEAE: THELOCARPACEAE: Thelocarpon)
3. Ascocarps black, not yellow-green pruinose. On bark. VERRUCARIALES: VERRUCARIACEAE: Trimmatothele
 4. Ascocarps apothecia, with pale wall. Spores rather large, simple or muriform. LECANORALES. 5
 4. Ascocarps perithecia or pseudothecia, with dark wall. Spores mostly either smaller, septate or muriform, or thin-walled. 7
5. Spores simple, with \pm thick outer wall. (PERTUSARIACEAE: Pertusaria, Coccotrema, and immature Ochrolechia)
5. Spores muriform. Ascocarps perithecioid, with a filamentous hamathecium. [Aptroot placed these in "group A", but stated that these taxa are of uncertain position with group A and may not be closely related to each other, but they are distant from the other members of that group, and apparently closer to Group C according to Aptroot]. 6
 6. Ascus tips I+ strong blue. PERTUSARIACEAE sensu Tehler "MICROGLAENACEAE": Protothelenella
 6. Ascus tips I-. Involucrellum absent. Photobiont chlorococcoid. 7
6. Periphysoids present. Ascus with an indentation in apex. COCCOTREMATACEAE sensu Tehler: Chromatochromys
6. Periphysoids absent. Ascus apex without an indentation. PERTUSARIACEAE sensu Tehler: Thelenella
 7. Paraphyses gelatinized; hymenial gelatin IKI+ pinkish orange, orange-red or bluish; ascomata ascolocular; almost always growing on rock. Spores simple or with true septa. Asci thin-walled. Almost all lichenized, with chlorococcoid algae; sometimes with hymenial algae. BITUNICATE ASCOLOCLARIS: VERRUCARIALES: VERRUCARIACEAE ("GROUP B" of Aptroot, 1991)
 7. Paraphyses or paraphysoids persistent (or if gelatinizing, then hymenial gelatin IKI- and not growing on rock); ascomata ascohymenial (or ascolocular, according to Harris 1995); growing on bark, old wood, leaves, bryophytes, or rock. Hymenial algae absent. 8
8. Spores distoseptate (with unevenly thickened walls and rhombic to rounded or lens-shaped lumina). Asci thick-walled, with well developed endoascus. Ascocarps perithecia with a typical ostiole, solitary or in groups. Asci \pm distinctly bitunicate, thick- or rarely thin-walled, I-, with or without a corona or a nonamyloid less distinct ring structure. Spores

symmetrically transversely septate, 2- or more-celled or muriform. Interthecial hyphae \pm filamentous, branched and anastomosing or simple. Fulcra mostly simple. Photobiont predominantly trentepohlioid. ("GROUP C" of Aptroot, 1991).

8. Spores with true septa. Asci \pm thin-walled (according to Aptroot, but the taxa of uncertain position have a somewhat thickened wall at least at the tip). Endoascus well developed or not. "GROUP A" of Aptroot, 1991.

"GROUP A"
"BITUNICATE ASCOHYMENIALS" sensu Tehler, pr. p.

After Aptroot, Poelt, and others

Rev. 2/94

1. According to Poelt (& Aptroot?) ascocarps ascolocular with a non-filamentous, cellular hamathecium; however, Tehler places the order under Ascohymenials, and doesn't give any information for distinguishing it from Pyrenulales. Ascocarps with a loculus opening with a pore (rarely several loculi present with pores or a fissured opening or growing together in stromata). Asci typically bitunicate, nassasceous or not, I-, . Spores often assymmetric. Spores with true septa. Most members of the order are non-lichenized. Aptroot places this group close to MONOBLASTACEAE, but it would seem to be separate from the rest of Group A, as indicated by Poelt, and also by Harris 1995. A-1. BITUNICATE ASCOHYMENIALS: DOTHIDEALES sensu Tehler, pr. p. (LOCULOASCOMYCETES: PLEOSPORALES according to Harris 1995)

1. Photobiont usually filamentous green algae. Some taxa non-lichenized. BITUNICATE ASCOHYMENIALS: PYRENULALES sensu Tehler, pr. p. 2

2. Asci \pm thick-walled, at least at tip; ocular chamber present. Paraphysoids \pm branched or anastomosing. BITUNICATE ASCOHYMENIALS sensu Tehler, pr. p.: (LOCULOASCOMYCETES: MELANNOMATALES s. lato according to Harris 1995). 3

2. Asci thin-walled, without ocular chamber, cylindrical, with endotunica (endoascus) only as an apical thickening. Paraphysoids simple. Spores transversely septate or muriform, euseptate, with cylindrical cells, colorless. Perithecia solitary, upright. Periphyses lacking or weakly developed. Spores transversely septate or muriform, thin-walled. Mainly tropical and on bark. HYMENOASCOMYCETES: TRICHOTHELIALES sensu Harris 1995 (PYRENULALES sensu Tehler, pr. p.): TRICHOTHELIACEAE.

3. Spores simple to transversely septate. A-2-1-a MONOBLASTACEAE (including ACROCORDIACEAE): Monoblastia, Mycomicrothelia, Anisomeridium, Acrocordia

3 Asci thick-walled, the endoascus continuous. Aptroot places this closer to Porina and Belonia in the CLATHROPORINACEAE, between that family and the TRICHOTHELIACEAE but closer to the latter and possibly as a separate family; Poelt, Awasthi, Tehler, and Harris 1995 all place it separate from those two families. A-2-1-b. STRIGULACEAE s. str.: Strigula

**A-1. DOTHIDEALES sensu Tehler:
PLEOSPORALES sensu Harris (1995)
ARTHOPYRENIACEAE s. lato**

Mostly after Harris (1995)

- 1. Ascospores black, muriform. Photobiont cyanobacteria.** Thallus consisting of colorless spreading hyphae. PYRENOTRICHACEAE:: Pyrenothrix
- 1. Not as above.** 2
- 2.** DACAMPIACEAE: Dacampia, Eopyrenula
- 2. Not as above.** 3
- 3. Asci relatively thick tipped, lacking a chitinoid ring; paraphyses branched. Mature spores mostly muriform.** PLEOSPORALES: MICROPELTIDACEAE: Mycoglaena
- 3. Not as above.** 4
- 4. Asci obpyriform to obclavate with the wall in the upper third very much thickened and with virtually no stipe or with a broad, short stipe. Hamathecium consisting of very irregular, slightly gelatinizing and somewhat disarticulating physes which are almost entirely obscured by irregular oil droplets. Ascospores thin-walled, often collapsing, tending to turn yellow brown with a conspicuous granular ornamentation when old. Lichenized or not.** MYCOPORACEAE: Mycoporum
- 4. Not as above.** 5
- 5. Pseudoparaphyses sparse, course, short-celled, with \pm refractive, differentially staining areas at the tips, asci obovate, nearly estipitate, with obpyriform apical loculi without a nasse, often subtriangular in section, ascospores hyaline to brown, often granularly oriented, and microconidia that are shortly bacilliform.** NAETROCymbaceae
- 5. Not as above.** 6
- 6. Physes less intricately and densely branched and interconnected; asci cylindrical to clavate, stipitate; ascospores _____; microconidia rod-shaped.** Ascomata clypeate, asci in a basal layer, fissitunicate, cylindrical to clavate with an apical nase, ascospores colorless or brown, often granular ornamented, septum or initial septum submedian, 2-celled to muriform; microconidia rod-shaped to filiform. Physes often long and slender. Occasionally associated with Trentepohlia. On bark, less commonly old wood. Highest diversity in the tropics.
- ARTHOPYRENIACEAE s. stricto
- 6. Physes more intricately and densely branched and interconnected; asci differently shaped; ascospores differently shaped; microconidia elliptical.** XANTHOPYRENIACEAE

NAETROCYMBACEAE Hohnel ex R. C. Harris
After Harris (1995)

1. **Ascospores brown, 1-septate (rarely 3-septate when post-mature).** Tropical/subtropical (but poorly known). Jarxia D. Hawksw.
1. **Ascospores colorless (sometimes weakly tinted when postmature).** 2
 2. **Ascomata compound with several/many centra under a single clypeus.** Spores 1-3-septate transversely, without longitudinal divisions. Tomasellia
 2. **Ascomata with a single chamber.** 3
3. **Ascospores soleiform, 1-septate to submuriform.** Paraphyses very broad, conspicuously septate, Naetrocymbe (Arthopyrenia rhypona group)
3. **Ascospores narrowly fusiform (long cylindrical to filiform), arcuate, 1-5-septate.** Leptorhaphis (s. lato?--but excluding Celothelium and Rhaphidicyrtis)

XANTHOPYRENIACEAE Zahlbr.
After Harris 1995

1. Associated with cyanobacteria; pigment in ascomatal wall amorphous, located in the hyphal cell wall; ascospores thin-walled, readily collapsing, not becoming brownish and granular-roughened. Photobiont a cyanobacterium (Gloeocapsa, Hyella, or Nostoc, the cells orange or blue-green)..... Pyrenocollema Reinke

1. Parasitic or parasymbiotic on lichens with green algal photobiont; pigment in ascomatal wall fine granular, located between hyphae; ascospores with thicker wall, not readily collapsing (until overmature), becoming brownish and granular ornamented.
Zwackhiomyces

ARTHOPYRENIACEAE W. Watson, s. str.
After Harris (1995)

- 1. Ascospores brown, 2-celled to submuriform, usually granular ornamented.** Mycomicrothelia (not mentioned by Tehler)
- 1. Ascospores colorless.** 2
- 2. Ascospores 2-4-celled.** Arthopyrenia
- 2. Ascospores submuriform to muriform.** Involucrellum present. Ascus tips I-. Not, or only facultatively lichenized; photobiont, if present, Trentepohlia..... Julella (not mentioned by Tehler)

ADD:

Paraphyses slender, not conspicuously septate. Ciferriolichen (Arthopyrenia lapponina and cinchonae-group)

A-2. MELANOMMATALES s. lato
PYRENULALES SENSU LATO:
MONOBLASTIACEAE
(ACROCORDIACEAE, pr. p., and PLEOSPORACEAE, pr. p.)

After Harris (1990, 1995)

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- 1. Ascospores simple; ornamentation wart-like or peg-like.** Monoblastia (not mentioned by Tehler)
- 1. Ascospores 2-4-celled, granular ornamented or smooth.** 2
 - 2. Asci cylindrical, with very broad ocular chamber; ascospores in a single row in the ascus, colorless, 2-celled, oblong, granular ornamented; temperate regions..** Acrocordia (Pyrenulaceae according to Tehler)
 - 2. Asci variously shaped, with narrow ocular chamber; ascospores in a single row, in two rows or irregularly arranged, 2-4-celled, colorless or brown, ornamented or smooth; more common in tropical regions.** Microconidia and macroconidia borne in pycnidia. Anisomeridium (not mentioned by Tehler)

NAME CHANGES:

Pleurotrema = Ditremsis (at least for N. American spp.; Aptroot treats it as incertae sedis within "Group C")

A-3. PYRENULALES s. lato (TRICHOTHELIALES):
TRICHOTHELIACEAE s. str.
 (Syn. CLATHROPORINACEAE Vezda ad int.)

After Harris (1995), Awasthi, and Aptroot

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1. Ascomata usually small, essentially naked, with at most a thin covering of thallus (occasionally immersed in substrate); ascomata and thallus lacking oxalate crystals; ascomatal wall either some shade of red (Porina-yellow, Sagedia-red) or brown to blackish, often with blue or violet tones (Pseudosagedia-violet); some species with setose ascomata; muriform ascospores very rare; considerable diversity on leaves; distribution, except for foliicolous species, amphitropical. 2

1. Ascomata usually rather large, surrounded by well developed thalline wart or immersed in thallus; wart and thallus containing oxalate crystals; ascomatal wall some shade of yellow or red (Porina-yellow); ascomata not setose; muriform ascospores not uncommon; few species on leaves; distribution essentially tropical and subtropical. 3

2. Ascomata blackish; wall often with blue or violet tints, without orange or red tints, K+ purplish or K- (Pseudosagedia-violet); with a very strong tendency for multiseptate, elongate (even filiform) ascospores; setose species not uncommon. Trichothelium s. lato (including Pseudosagedia and Zamenhofia)

2. Ascomata reddish, sometimes darkening to black, lacking blue or violet tints, K+ more intensely orange or red (Porina-yellow); ascospores short, mostly 3-7-septate; setose species rare. Segestria

3. Black hypothallus lacking; thallus firmly attached to substrate, poorly organized, often verrucose; ascomata superficial, often somewhat constricted at base; few muriform-spored species; some foliicolous species known; mainly species of open, drier? Forest or scrub habitats, perhaps mainly tropical. Porina

3. Black hypothallus usually well developed; thallus often separating from substrate, usually well organized into cortical, algal and oxalate crystal layers, smooth, continuous, shiny; ascomata mostly immersed to weakly emergent, sometimes forming spherical warts projected below the almost foliose thallus; ascospores large, often muriform; no foliicolous species known; mostly species of shaded, closed, wet, tropical forests. Asci not thickened at the tip, with a chitinoid ring at the tip of the exoascus; paraphyses unbranched..... Clathroporina

ADD?

Perithecia lacking a crown of setae or spines, but with warts or a plate-like structure externally. Aspidothelium (not mentioned by Tehler, nor by Harris)

ADD (SOMEWHERE)

Spores 15-20-septate. Belonia

"GROUP B".
BITUNICATE ASCOLOCULARS sensu Tehler
VERRUCARIALES:
VERRUCARIACEAE

After Poelt & Vezda (1981)

Rev. 1/88

1. **Hymenial gelatin containing algae.** Spores usually muriform and brown when ripe, rarely only transversely septate.2
1. **Hymenial gelatin not containing algae.** 3
 2. **Thallus squamulose-foliose, brownish yellow to brown or gray, attached by rhizoidal hyphae or rhizines.** Perithecia immersed. Usually on soil or moss.
Endocarpon
 2. **Thallus crustose, endolithic to epilithic, continuous to warty areolate, often brownish.** Perithecia immersed to projecting. On rock, often where wet.
Staurothele
3. **Thallus distinctly set off from the substrate, squamulose-foliose or umbilicate, or with rhizines or rhizoidal hyphae, the squamules arising individually.** ...4
3. **Thallus crustose, often endolithic, to areolate or finely squamulose, or subsquamulose or sublobate, the areoles and lobes derived from the cracking of a primarily continuous thallus, without rhizines or rhizoidal hyphae, attached throughout or (Placocarpus) areoles subpeltate, with the marginal ones mostly free from the lower surface (this is often a difficult choice).** 8
 4. **Thallus small, shell-shaped, greenish blue, the curved-up margin \pm sorediate.** Mostly over mosses and other lichens.(Normandina pulchella)
 4. **Thallus without soredia, greenish gray to brown.**5
5. **Spores one (to rarely two-)celled.**6
5. **Spores distinctly and irregularly several celled.**7
 6. **Thallus foliose-umbilicate.** On wet or dry rock.Dermatocarpon
 6. **Thallus squamulose.** On soil, dry rocks, or (in one species) bark.Catapyrenium s. lato (see key to segregate genera in the file on Catapyrenium)
7. **Spores muriform, usually 2 per ascus. Thallus finely squamulose, paraplechtenchymatous throughout.** Perithecial wall three-layered. On moss over rock or bark. Agonimia (tristiuscula)
7. **Spores one- to several-septate transversely. Thallus squamulose-foliose, often small.** Mostly on soil or mosses. Placidopsis
 8. **Spores to very many per ascus, small, one-celled.** On bark of Umbellularia.Trimmathele (umbellulariae)
 8. **Spores to 8 or fewer per ascus.**9
9. **Spores one-celled (sometimes becoming two-celled in age).** 10
9. **Spores several celled.** Exciple, or at least involucrellum, partly or entirely carbonaceous 11
 10. **Thallus thick to very thick, crustaceous-effigurate, at margin \pm sublobate and**

mostly free from substrate, with lower cortex present; areoles fastened to substrate by a short stalk. Medulla very thick, densely inspersed with minute colorless crystals or granules, slowly I+ blue. Spores halonate (the gelatinous sheet being best developed in premature spores and then about 2.5 um thick). Upper cortex paraplectenchymatous. Placocarpus schaereri

10. Thallus usually thinner (with some exceptions) and not effigurate or lobed, or if so (V. lobata and forms of V. maura s. lato) then lobes and areoles completely and tightly attached to the substrate, without lower cortex. Medulla usually thinner, and (as far as I know) not densely inspersed nor amyloid. Spores not clearly halonate (but sometimes with some gelatin sticking to them). Upper cortex usually of anticlinal, palisade-like hyphae. On wet or dry rocks. Several spp. of "Catapyrenium" will also key out here. [If growing on soil and paraphyses persistent, see Thrombium]. Verrucaria (including Bagliettoa and Amphoridium)

11. Spores 1- to several-septate transversely, usually hyaline. Usually on rock, rarely soil. Thelidium (including Involucrethele)

11. Spores weakly to very strongly muriform, often becoming brownish. Usually on rock, sometimes on soil, rarely on bark. Polyblastia (including Amphoroblastia)

ADD?:

Paraphyses persistent. Thallus pale green, membranous, slimy (subgelatinous when wet), indeterminate. Photobiont Leptosira. Perithecia entirely immersed, the ostiole dark; involucrellum absent; exciple brown-black, widened towards the ostiole. Hamathecium of paraphyses, unbranched, thin, paraphyses absent. Asci elongate-cylindrical or narrowly clavate, thin-walled, with a well defined K/I+ blue apical cap; tholus ring-like, K/I+ blue with narrow, cylindrical axial mass; 8-spored. Spores simple, colorless, thin-walled, without distinct perispore. Conidiomata not known. No substances. On soil. VERRUCARIALES:
THROMBIACEAE. Thrombium

"GROUP C"
"BITUNICATE ASCOHYMENIALS" sensu Tehler:
"MELANOMMATALES" s. lato
INCLUDING PYRENULALES sensu Tehler

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1. Spores distoseptate, with rounded to rhombic or lens-shaped lumina, the walls \pm thickened. 2
1. Spores with true septa and \pm cylindrical lumina, the walls not thickened. (INCERTAE SEDIS, traditionally associated with group A, but placed outside both PYRENULACEAE and TRYPETHELIACEAE by Aptroot). 7
 2. Ascocarp wall cellular (textura angularis); ascocarps perithecioid; interthecial hyphae cellular pseudoparaphyses. PLEOSPORALES:
 PLEIOMASSARIACEAE: Eopyrenula (DACAMPIACEAE according to Harris 1995; PYRENULACEAE according to Tehler)
 2. Ascocarp wall hyphae (textura intricata), often heavily carbonized; ascocarps perithecioid or rarely mazaedioid; interthecial hyphae cellular pseudoparaphyses, true paraphyses or paraphysoids (trabeculate pseudoparaphyses). 3
3. Interthecial hyphae (cellular pseudoparaphyses or true paraphyses) simple or branched only above. 4
3. Interthecial hyphae (trabeculate pseudoparaphyses) anastomosing. 5
 4. Interthecial hyphae true paraphyses. Spores blackish, brown or red-brown, rarely colorless (then always without eusepta and endosporium formation not angular). Thallus not blackened around the ascomata. Ascocarps often with a distinct clypeus. Crystals, lichexanthone or anthraquinones sometimes present in thallus or ascocarps. Hamathecium I+ blue, or if I- (Pyrgillus), then ascocarps mazaedioid [this is based on Aptroot, 1991; in another article he states that the asci are I-]. Ascocarps mazaedioid or perithecioid and then usually solitary but sometimes aggregated, with or without pseudostromata; with upright, oblique, or horizontal ostioles, the ostioles or walls sometimes fused. Hamathecium colorless. Asci bitunicate, mostly cylindrical with a corona and well developed endoascus; with or without apical structures of several types. Spores transversely several septate to muriform, with thickened walls and rhombic or rounded lumina, distoseptate, with or without eusepta. Microconidia acrogenously formed, colorless, filiform, often curved. Thallus episubstratic. Usually lichenized. Mainly on bark, in rain forests or coastal areas, mainly tropical.
 PYRENULACEAE: Pyrenula, Lithothelium, Distopyrenis, Pyrgillus; Aptroot also includes Pyrenocollema, which Harris 1995 puts in PLEOSPORALES:
 XANTHOPYRENIACEAE
 4. Interthecial hyphae cellular pseudoparaphyses. Spores brown or red-brown. Thallus often blackened around the ascomata. Ascocarps without clypeus. Crystals, lichexanthone and anthraquinones absent. Lichenized or not. Hamathecium I-. Asci with rounded ocular chamber. Spores red-brown, symmetrically 3-13-septate to irregularly muriform. On bark, boreal-temperate. Only one genus reported for N. America; description not in bold is based on that genus. REQUIENELLACEAE:
Requienella

- 5. Ascospores apically without endosporium thickening, forming a germ pore; never lichenized.** MELANOMMATACEAE pr. p. (e.g., Caryospora) and ZOPFIACEAE (not treated)
- 5. Ascospores without germ pore; often lichenized. 6**
- 6. Ascocarps often in blackened stromata; ascospores with a thick (ca. 5 μ m) gelatinous sheath; asci with several rings above each other; never lichenized.** MASSARIACEAE and MASSARINACEAE (not treated).
- 6. Ascocarps never in stromata, but often in pseudostromata with non-carbonized tissues; ascospores without or with a thin (to 2 μ m) gelatinous sheath; asci without rings; often lichenized.** Hymenium I-. Asci cylindrical-clavate with a well developed endoascus and less distinct ring. Spores transversely several septate with thick walls and \pm lens-shaped lumina, colorless (Trypetheliaceae s. str.) or muriform, thin-walled, the lumina angular ("Laureraceae Vezda ad int."). Mainly on bark.
- TRYPETHELIACEAE s. lato: Trypethelium, Astrothelium, Pseudopyrenula; Laurera and Campythelium; Harris 1995 also puts Polymeridium here
- 7. Spores hyaline, constantly 3-septate. Hamathecial gel I-. Paraphyses rather loosely and reticulately branched; hymenium often interspersed; lichenized or not; spores 4-many-celled, endospore gradually filling lumen in age, not becoming brownish or ornamented. Hamathecium with gelatin. Ocular chamber present. Placed in TRYPETHELIACEAE by Harris, but spores with true septa and \pm cylindrical cells.** Polymeridium
- 7. Spores brown, more than 3-septate transversely, becoming muriform. Hamathecial gel I+ blue. 8**
- 8. Paraphyses anastomosing. End cells of spores brown.** Placed in PYRENULACEAE by Harris 1990, and has I+ blue hamathecial gel as in that family, but has anastomosing paraphyses, as in TRYPETHELIACEAE; placed in TRYPETHELIACEAE by Harris 1995. Lichenized. Anthracotheicum
- 8. Paraphyses simple. End cells of spores colorless.** [see PLEOMASSARIACEAE: Eopyrenula (leucoplaca)]

**C-1. MELANOMMATALES s. lato:
PYRENULALES sensu Tehler:
PYRENULACEAE Rabenh.**

After Harris (1990, 1995), and Aptroot (19)

1. Ascomata mazedoid, i.e., with amassing mature ascospores outside the asci on top of the ascocarps. Pyrgillus

1. Ascomata perithecioid. 2

2. Endospore well developed, thick, lining the whole wall; lumina rounded or angular. 4

2. Endospore poorly developed, with very thin thickenings, only visible at the septa or in the corners of the lumina; lumina nearly cylindrical or cubical. Spores muriform, dark brown. Lumina relatively small. Ascomata with an outer pseudostromatic shell. Mainly tropical and subtropical. Anthracotheceum

3. Spores at least 3-septate. (Mostly) lichenized. 4

3. Spores 1-septate. Non-lichenized. Ascus tip thickened, with a distinct apical chamber (may be necessary to use stain + KOH). Spore septum median. Physes coarse, relatively short, rather abruptly tapering; microconidia rod-shaped, to 15 µm long. Ascospores with unlayered endospore without pigment granules. Distopyrenis Aptroot

4. Spores brown or blackish. 5

4. Spores colorless, brown or red-brown, with rounded, relatively large lumina. Asci often with rounded or sagittiform ocular chamber. Ascospores ovate, 4-celled; ascomata not pigmented, simple or compound (astrothelioid or pyrenastroid); ostiole apical or lateral. Lithothelium

5. Physes long and slender. Spores with relatively small, often angular lumina. Asci without ocular chamber. Spores 4-celled to muriform. Lichenized; thallus usually conspicuous. Pyrenula s. lato

5. Physes relatively short and coarse. Thallus lichenized or not, often blackened around the ascocarps. Hamathecium gelatinized, I+ blue. Spores submuriform, brown, wall thickened (2-5 µm), with a very characteristic double layer of granules within it. Ascomata with eccentric ostiole, not resembling a graphid. On bark, mostly tropical. Granulopyrenis

NAME CHANGES:

Melanotheca = Pyrenula s. lato

Parathelium = Pyrenula s. lato (at least for N. American spp.; Aptroot, 1991, puts it in a separate family, tentatively called Pleomassariaceae)

Parmentaria = Pyrenula + Anthracotheceum (at least for N. American spp.)

Pleurotheliopsis = Pyrenula s. lato (Parmentaria) spp. (at least for N. American taxa)

Pyrenastrum = Pyrenula s. lato

Plagiocarpa = Lithothelium

X-REF. (see TRYPETHELIACAE):

Astrothelium (including? Pseudopyrenula)

**C-2. MELANNOMATALES s. lato:
PYRENULALES sensu Tehler
TRYPETHELIACEAE s. lato
(INCLUDING LAURERACEAE)**

After Harris (1990, 1995)

1. **Thallus not corticate, whitish.** 2
1. **Thallus corticate, green, tan, brown or orange.** 3
 2. **Ascospores with well developed endospore; lumina angular, 4-celled, 20-27 x 6-8 um; hymenium inspersed, also often yellow pigmented, K⁺ red.**
Florida. Pseudopyrenula subnudata
 2. **Ascospores with endospore not developed, lumina cylindrical, with 4-8 transverse septa or muriform.** Polymeridium
3. **Ascomata compound, solitary or in pseudostromata, several hymenia with a common ostiole or ostiolar plate.** Ascospores with well developed endospore, transversely septate or with a few cells longitudinally divided. Astrothelium
3. **Ascomata solitary or in pseudostromata, not fused and sharing a common ostiole or ostiolar plate.** 4
 4. **Ascomata in brown, usually slightly shiny pseudostromata containing yellow or orange pigments, K⁻ or K⁺ red; pseudostromal wall composed of brown, jigsaw puzzle-like hyphae; ascospores transversely septate or muriform.** Bathelium
 4. **Ascomata solitary or in pseudostromata which are not brown nor slightly shiny; if containing K⁺ purple pigment, then pseudostroma pruinose and ascospores 9-13 transversely septate; pseudostromal wall not composed of brown, convoluted hyphae.** 5
5. **Ascospores muriform. ("LAURERACEAE").** 6
5. **Ascospores transversely septate.** Ascospores less than 100 um long or if longer, then more than 5-septate. Trypethelium s. lato
 6. **Ostiole eccentric or lateral. Perithecia not in pseudostroma.** True Campylothelium does not occur in N. America according to Harris. Campylothelium
 6. **Ostiole apical. Perithecia in pseudostroma.** (If thallus ecorticate, white, UV+ yellow, see Polymeridium). Laurera

ADD to Natural Keys:

Paraphyses branched and anastomosed; hymenial gelatin I-; microconidia rod-shaped. Spores I+ violet; mesospore thickened from the beginning. Unnamed genus of Trypetheliaceae

Perithecia erumpent, \pm entirely superficial when mature, usually single, black, hemispherical or subglobose, usually with a distinctly applanate base, usually ostiolate. Spores ellipsoid or soleiform, 1-septate, the upper cell often somewhat larger, slightly constricted at septum, \pm verruculose or striate. Thallus indistinct, non-lichenized. On wood. FAMILY?: Kirschsteiniothelia

Pseudoparaphyses cellular, irregularly branched and anastomosed. Ascomata at first cushion-like, finally \pm apothecia-like with concave disc, sessile or \pm stalked. On rock (mostly non-calcareous). Spores halonate, usually 1-septate, with cells unequal (one round, the other \pm pointed), occasionally 3-septate, rarely submuriform with 1 longitudinal septum. Perithecia all black. (Note: this description is partly according to Clauzade & Roux, who state that this genus is distinctly lichenized, with Trentepohlia; however, according to Hawksworth, the genus is not lichenized, but may be "fortuitously?" associated with green coccoid algae or cyanobacteria; according to Staley, this name applies to non-lichenized "microcolonial fungi" for which ascocarps are unknown). FAMILY?: Lichenothelia

Ascus tip lacking a chitinoid ring. Paraphyses mostly simple. Spores cylindrical to fusiform. FAMILY?: (Robergia pupula)

C-2. MELANOMMATALES s. lato:
PYRENULALES sensu Tehler:
STRIGULACEAE Fr.

Ascomata solitary, not surrounded by pseudostromatic wart filled with dark granular material;
pycnidia solitary; macroconidia usually with eccentric attachment and bipolar gelatinous
appendages (except species with muriform ascospores?); on leaves, bark, wood or
rock. Strigula

**ARTIFICIAL KEY TO PYRENOLICHEN GENERA
OTHER THAN VERRUCARIACEAE**

1. Growing on leaves. KEY I
1. Growing on other substrates. 2
 2. Ascocarps mazaedioid. Pyrgillus
 2. Ascocarps perithecia or perithecioid. 3
3. Spores many (30-300) per ascus. (see Thelopsis, Thelocarpon, and Trimmatothele)
3. Spores 1-8 per ascus. 4
 4. Spores one-celled, hyaline. 5
 4. Spores 2- to several-celled, hyaline or brown. 6
5. Ascocarps true perithecia, \pm dark or at least with dark exciple. (If paraphyses gelatinized, see VERRUCARIACEAE). 6
5. Ascocarps actually pale, closed apothecia, with pale exciple. Spores usually over 20 μ m long, \pm ellipsoid. Paraphyses anastomosing. Thallus not slimy, mostly pale, grayish or yellowish. On various substrates. (see Pertusaria, etc.)
 6. Ascus tips I-. Spores with wart-like or peg-like ornamentation. On bark or (one species) rock. Monoblastia
 6. Ascus tips I+ blue. Spores not ornamented. Paraphyses thin, simple. Asci with amyloid ring. Thallus pale green, slimy. On soil or other substrates. Thrombium
7. Growing on rock. KEY II
7. Growing on bark or wood (or stems of herbaceous plants, or sometimes bryophytes). 7
 8. Spores brown when mature. KEY III
 8. Spores hyaline. 9
9. Ascocarps expanded above, with disc-like or warty protuberances. Aspidothelium
9. Ascocarps smooth. KEY IV

I. GROWING ON LEAVES.

After Awasthi

Rev. 2/94; probably quite incomplete

1. Thallus subcuticular. Spores 1-3-septate. Asci thickened at the tip, lacking a chitinoid ring at the tip of the exoascus; paraphyses simple (to sparsely branched).

..... Strigula

1. Thallus supracuticular. Paraphyses simple. 2

2. Perithecia with crown of setae. Trichothelium

2. Perithecia lacking crown of setae. 3

3. Perithecia expanded above with disc-like or wart-like protuberances.

Aspidothelium

3. Perithecia smooth or rarely with short hairs or small warts. Asci not thickened at the tip, with a chitinoid ring at the tip of the exoascus; paraphyses unbranched. Porina pr. p.

II. GROWING ON ROCK.

After various authors

1. **Thallus with protococcoid algae.** Spores muriform. Thallus crustose. On acidic rocks. [If paraphyses gelatinized, see VERRUCARIACEAE]. 2
1. **Thallus with Trentepohlia, or non-lichenized, or (Pyrenocollema) with bluegreen algae.** 3
 2. **Ascus tips I-.** Chromatochlamys
 2. **Ascus tips I+ blue.** Protothelenella
3. **Spores brown.** 4
3. **Spores hyaline.** 5
 4. **Pseudoparaphyses cellular, irregularly branched and anastomosed. Ascomata at first cushion-like, finally \pm apothecia-like with concave disc, sessile or \pm stalked.** Lichenothelia
 4. **Pseudoparaphyses generally unbranched and free. Ascocarps perithecioid, immersed in multi-carpic pseudostromata that are constricted at the base.** Photobiont Trentepohlia. Ocular chamber sagittiform. Lithothelium
5. **Ascocarp with more than one chamber; ostioles separate or united. Spores with 2 cells, small, 8-12 x 3-4 μ m; ascocarp not carbonaceous, rather soft. Usually on organic substrates.** (Strigula)
5. **Ascocarp with only one chamber (ascocarps may be aggregated in a pseudostroma, but not fused into a compound ascocarp). Ostioles erect.** 6
 6. **Ascocarp wall blue green, N+ reddish. Asci thin tipped with a chitinoid ring at the apex of the exoascus; paraphyses unbranched.** Porina s. lato
 6. **Ascocarp wall some other color.** 7
7. **Asci with more than 8 spores, thin tipped; hymenial gelatin or ascus sheath I+.** Thelopsis
7. **Asci with 8 or fewer spores.** 8
 8. **Spores long cylindrical to filiform.** Porina s. lato
 8. **Spores fusiform to oval.** 9
9. **Endospore thickened, dictyoseptate, without trace of eusepta.** Lithothelium
9. **"Mesospore" not thickened except in old age; lumina cylindrical.** 10
 10. **Photobiont a blue-green alga, blue-green, purplish or yellowish brown in color; mostly on calcareous rock, aquatic or in moist situations.** Pyrenocollema
 10. **Photobiont a green alga, usually Trentepohlia, or non-lichenized; mostly on bark and old wood but also on rock and soil, rarely aquatic.** 11
11. **Asci with a chitinoid ring at the tip of the exoascus; paraphyses not branched.** Porina s. lato
11. **Asci lacking a chitinoid ring; paraphyses branched and anastomosed except in Strigula.** 12
 12. **Paraphyses mostly with only a few branches; macroconidia commonly present, septate, fusiform, cylindrical or rarely filiform; asci usually cylindrical; spores often uniseriate.** Strigula
 12. **Paraphyses branched and anastomosed; macroconidia rarely produced, non-septate when present; asci often broader at one end; spores uniseriate or not. Spores**

oval to elliptic; spore wall ornamented with small granules, uniseriate.
Acrocordia

III. GROWING ON BARK OR WOOD. PARAPHYSES PERSISTENT; SPORES BROWN WHEN RIPE

After Poelt & Vezda (1981)

1. **Spores with lens-shaped lumina, the walls unevenly thickened.** Mostly on smooth bark, with Trentepohlia.2
1. **Spores with \pm cylindrical lumina, the walls not thickened.** 6
 2. **Interthecial hyphae cellular pseudoparaphyses. Spores brown or red-brown. Thallus often blackened around the ascomata. Ascocarps without clypeus. Crystals, lichexanthone and anthraquinones absent.** Lichenized or not. Spores red-brown, symmetrically 3-13-septate to irregularly muriform. On bark, boreal-temperate.
REQUIENELLACEAE: Requienella
 - 2, **Interthecial hyphae true paraphyses. Spores colorless, blackish, brown, or red-brown. Thallus not blackened around the ascomata. Ascocarps often with a distinct clypeus. Crystals, lichexanthone or anthraquinones often present in thallus or ascocarps.** Mostly tropical. 3
3. **Spores muriform.** Paraphyses thin, anastomosing. Perithecia in groups deeply sunken into brownish thallus, the ostioles united or "genähert". Pyrenula s. lato ("Parmentaria")
3. **Spores transversely septate only.** 4
 4. **Spores at least 3-septate. (Mostly) lichenized.** 5
 4. **Spores 1-septate. Non-lichenized.** On bark. N. America; not listed by Egan.
Distopyrenis Aptroot
5. **Spores brown or blackish, with relatively small, often angular lumina. Asci without ocular chamber.** Pyrenula s. lato
5. **Spores colorless, brown or red-brown, with rounded, relatively large lumina. Asci often with rounded or sagittiform ocular chamber.** Lithothelium
6. **Thallus with Trentepohlia algae, or lichenoid but not or only weakly lichenized.** 7
 6. **Thallus with protococcoid algae.** Spores \pm muriform. [If periphysoids present, ascus with an indentation, and spores at most brownish when overripe, see Chromatochlamys) Thelenella
7. **Spores 1-septate.** Asci thick-walled, typical bitunicate. Paraphyses often branched and anastomosing. Spores transversely septate. Epispore not warty. (Microthelia s. lato: Mycomicrothelia and Kirschsteiniotelia).
7. **Spores 3- or more-septate.** 8
 8. **End cells of spores brown.** Perithecia not in a stroma. Anthracotheceum
 8. **End cells or spores colorless.** Perithecia without involucrellum. Spore walls little thickened. Thallus pale. Eopyrenula (leucoplaca)

IV. GROWING ON BARK OR WOOD.
PARAPHYSES PERSISTENT, SPORES HYALINE, SEPTATE

After Aptroot, Harris, and others

- 1. Ascocarps combined in a receptacle, with fused ostioles, or in a pseudostroma without fused ostioles (may be completely immersed: dissect carefully). KEY IV-A**
- 1. Ascocarps solitary, or aggregated but without fused ostioles (and without pseudostroma?). 2**
 - 2. Most ostioles lateral or skewed. KEY IV-B**
 - 2. Most ostioles apical. 3**
- 3. Spores muriform when mature. KEY IV-C**
- 3. Spores transversely septate when mature. KEY IV-D**

**IV-A. Ascocarps combined in a receptacle or pseudostroma,
or with more than one chamber**

- 1. Ostioles united (fused) in a common disk or into a common opening; sometimes also in pseudostromata.** Mature spores transversely several septate. (if spores brown see Pyrenula s. lato). 2
- 1. Ostioles not fused. Ascomata in pseudostromata.** 3
 - 2. Thallus well developed. Ascomata usually in pseudostromata or deeply immersed.** Spores with 4 or more cells; ascocarp very carbonaceous and hard, often pigmented outside. Astrothelium
 - 2. Thallus less developed. Pseudostromata absent.** Ascocarps free, only the ostioles fused. Lithothelium (Syn.: Plagiocarpa)
- 3. Mature spores transversely septate.** 4
- 3. Mature spores muriform.** 5
 - 4. Spores euseptate only.** Tomasellia
 - 4. Spores at least partly distoseptate. Mature spores colorless, only old spores becoming brown.** (If spores brown, see Pyrenula). Trypethelium
- 5. Thallus well-developed, lichenized.** Laurera
- 5. Thallus only a whitish patch, non-lichenized.** Mycoporum

ADD?:

Perithecia not in stroma. Thallus epi- or endo-phloedal. Photobiont Trentepohlia. Perithecia embedded in thalline verrucae; excipulum black, with an oblique or inclined canal leading to ostiole. Asci bitunicate, 1-8-spored. Spores hyaline, many celled muriform, with mucilaginous sheath. Campylothelium

**IV-B. Asocarps solitary, or aggregated but ostioles not fused.
Most ostioles lateral or skewed.**

- 1. Mature spores transversely septate. 2**
- 1. Mature spores muriform.** Only old spores brown. (If mature spores brown, see Pyrenula sensu lato). Thelenella
 - 2. Paraphyses mostly unbranched; hymenial gelatin I+ blue green then orangish; microconidia filiform.** Spores distoseptate and euseptate, or euseptate only, brown when mature or only when old (If spores dictyoseptate and brown when mature, see Pyrenula sensu lato). Lithothelium (Syn.: Plagiocarpa)
 - 2. Paraphyses branched and anastomosed; hymenial gelatin I-; microconidia rod-shaped. 3**
- 3. Spores I-, euseptate only, the septa (mesospore) thin.** Spores 1-septate, colorless. Anisomeridium (syn. Ditremsis)
- 3. Spores I+ violet, dictyoseptate, the mesospore thickened from the beginning.**
..... Unnamed genus of Trypetheliaceae

IV-C. Asocarps solitary, or aggregated but ostioles not fused.

Most ostioles apical.

Mature spores hyaline, muriform.

1. Perithecia expanded above with disc-like or wart-like protuberances.

Aspidothelium

1. Perithecia smooth. (If mature spores brown, also see Protothelenella, Eopyrenula, Thelenella, Pyrenula, and Anthracotheicum, and Endocarpon) 2

2. Ascocarp wall carbonized. (if paraphyses gelatinized. see VERRUCARIACEAE) 2

2. Ascocarp wall not carbonized. (If mature spores brown, see Mycoglaena and Clathroporina). 3

3. Spores with hyaline gelatinous sheath. Thallus a whitish patch, non-lichenized.

Julella

3. Spores without gelatinous sheath. Thallus usually well-developed and lichenized.

Chromatochlamys

IV-D. Asocarps solitary, or aggregated but ostioles not fused.

Most ostioles apical.

Mature spores hyaline, transversely septate.

(If paraphyses gelatinized, see VERRUCARIACEAE)

1. Perithecia expanded above with disc-like or wart-like protuberances.

Aspidothelium

1. Perithecia smooth. 2

2. Spores distoseptate and euseptate, more than 1-septate. Paraphyses anastomosing. (If spores brown, see Pyrenula and Eopyrenula). 3

2. Spores euseptate only, the septa thin. 4

3. Spore lumina rounded. Pseudopyrenula

3. Spore lumina angular to diamond-shaped. Trypothelium (tropicum)

4. Most mature spores 1-septate. (If spores brown, see Mycomicrothelia, and "brown Ditremis"). 5

4. Most mature spores more than 1-septate. (If spores brown, see Eopyrenula). 11

5. Spores more than 5 times longer than broad. Paraphyses branched and anastomosed; ascus tip often appearing truncated; asocarps simple or multilocular. Leptorhaphis

5. Spores less than 5 times longer than broad. Hamathecium filamentous, with paraphyses. 6

6. Paraphyses simple. 7

6. Paraphyses branched. 8

7. Paraphyses (pseudoparaphyses) very broad, conspicuously septate. Periphysoids present; involucrellum containing host tissue. Ascospores with or without a warty epispor. Arthopyrenia s. str. (rhyponia group)

7. Paraphyses slender, not conspicuously septate. Ostiole simple; hamathecium of paraphysoids; asci fissitunicate; spores mostly < 20 μ m. Strigula

8. Paraphyses anastomosing. 9

8. Paraphyses only branched at the top. Ascocarp wall carbonized (rarely pale). Thallus usually immersed. Asci cylindrical. 10

9. Photobiont cyanobacterial. Pyrenocollema

9. Photobiont (if any) green. Spores less than 100 μ m long; ascus wall thin, with ocular chamber. [The genus is not listed by Egan, but the species are]. Ciferriolichen (Arthopyrenia laponina and cinchonae-group)

10. Spores \pm constricted at septa, usually one cell larger than the other, not ornamented. Paraphyses not septate; periphysoids absent; involucrellum entirely fungal. Anisomeridium (syn. Ditremis)

10. Spores not constricted at the septa, the cells equal, with a warty epispor (view in water, not K), uniseriate. Hamathecium of paraphysoids. Acrocordia

11. Ascocarp wall carbonized. 12

11. Ascocarp wall not carbonized. 14

12. Spores acicular to filiform or fusiform, almost as long as the ascus. Paraphyses branched and anastomosed; ascus tip often appearing truncated; asocarps simple or multilocular. Leptorhaphis s. lato

12. Spores fusiform, less than half the length of the ascus. 13
13. Ocular chamber absent; ascus tip with two tiny dense spots. Porina s. lato
13. Ocular chamber present; ascus tip hyaline. Strigula
14. Ascocarp wall green or blue green, N+ reddish; paraphyses branched. Asci relatively thick tipped, lacking a chitinoid ring; paraphyses branched. Mycoglaena
14. Ascocarp wall yellow to brown or red (or blue-green in Porina?); paraphyses simple. 15
15. Hymenial gelatin I-, mostly heavily inspersed. Asci thin tipped with a chitinoid ring at the apex of the exoascus; paraphyses unbranched. Porina s. lato
15. Hymenial gelatin I+ blue, not inspersed. Belonia

ADD:

Pseudosagedia (= Porina according to McCarthy)

Microthelia s. lato

- 1. On rock (mostly non-calcareous). Spores halonate. Lichenothelia
- 1. On organic substrates. Spores not halonate. 2
 - 2. Perithecia \pm immersed. Mycomicrothelia
 - 2. Perithecia erumpent, \pm entirely superficial when mature,
Kirschsteiniothelia

Microglaena s. lato

After Purvis, et al., 1992
(Also see Mayrhofer)

- 1. Ascus apex I+ blue. Photobiont Elliptochloris. Protothelenella
- 1. Ascus apex I-. Photobiont chlorococcoid. 2
 - 2. Periphysoids present. Ascus with an indentation in apex.
Chromatochromys
 - 2. Periphysoids absent. Ascus apex without an indentation. Thelenella

OTHER GENERA (not definitely reported for N. America?)

Photobiont a green alga, usually Trentepohlia, or non-lichenized; mostly on bark and old wood but also on rock and soil, rarely aquatic. Asci lacking a chitinoid ring; Asci often broader at one end. Spores fusiform to ovate, most commonly with one half of the spore shorter and/or narrower than the other, if oval then not ornamented and uniseriate; often biseriate or irregularly arranged in the ascus; 2-celled, breaking into part spores at maturity; septum eccentric or not; mesospore not thickened except in old age; lumina cylindrical; endospore not filling spore lumen in age, but spore wall may become brownish, thickened and ornamented in age. Paraphyses thick, short-celled and appearing almost parenchyma-like to slender and thread-like or gelatinizing, but not loosely and regularly reticulate, branched and anastomosed. Macroconidia rarely produced, non-septate when present; short or long rods, rarely filiform. Very rarely lichenized. Sporoschizon

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