

Ochrolechia Massal.
(LECANORALES: PERTUSARIACEAE)

After Brodo, and others

Rev. 5/94

Thallus crustose, uniform, continuous to uneven, warted, not distinctly areolate, often thick, rarely with spines and then appearing minutely dwarf-fruticose, rarely reduced to scattered convex warts, pale to dark gray, often tinged greenish; prothallus gray, well developed or absent; ecorticate or with a thin cortex of thin-walled anticlinal hyphae; medulla woolly; attached by medullary or prothallial hyphae. Soredia or isidia sometimes present.

Apothecia (often absent or immature in many species) at first immersed later sessile and constricted at base; disk at first punctiform, usually becoming expanded, round, yellowish or brownish pink, often white-pruinose; thalline margin mostly concolorous with thallus (but sometimes with few or no algae, or soon disappearing), prominent, well developed; true exciple usually narrow, but thick and dominant in some species (colored yellowish to pink at least next to the disc, forming an "excipular ring"); hypothecium pale; hymenium tall (150-200 μ m); paraphyses thin, densely branched and anastomosed; asci clavate, Pertusaria-like, unitunicate (but of several layers), uniformly thick walled, I+ blue; tholus I+ blue; spores 2-8, ellipsoid, rather large (over 20 μ m long), simple, hyaline; walls thick (thin or little thickened according to Rogers; this may be true relative to Pertusaria but not relative to Lecanora), smooth, even.

Pycnidia immersed in warts; fulcrum exobasidial; pycnospores oblong to cylindrical, straight. Lecanoric, gyrophoric, variolaric, atranorin, erythrin. Apothecia (especially the disks) and sometimes the thallus often C+ rose to red. Photobiont Trebouxia. On \pm acidic bark, wood, soil, or rock.

Distinguished from Pertusaria primarily by the thinner, uniform ascospore walls; some species presently placed in Pertusaria may belong in Ochrolechia. Distinguished from Lecanora by the ascus type, high hymenium, strongly branched and reticulate paraphyses, and large, relatively thick walls. The chemistry (frequent C+ reddish reaction) and color and general appearance of the apothecia are also helpful in recognizing Ochrolechia.

Many of the corticolous/lignicolous species of Ochrolechia in humid areas are frequently difficult to recognize, because they are often grazed by snails and the apothecia are often immature or damaged and distorted; however, if the discs or primordia are C+ red or rose one can usually be fairly certain the material belongs to this genus.

Determining whether it is the cortex, medulla, or both, that are reacting to C can sometimes be difficult. Sometimes the extreme outermost layer of the

cortex appears to be C-, and it takes a slight pressure or cut to bring out the red color, making it appear as though the reaction is in the medulla. However, slicing the margin and testing the inside will show that the reaction is in the cortex, not the medulla.

GROUP IA.
On bark or wood;
Thallus sorediate, isidiate or granular-isidiate.

(after Brodo, 1991)

1. Thallus distinctly isidiate, or with isidia breaking down into granules. Apothecial margin medulla C- or C+ red. Disks C+ pink or red. Without variolaric acid, except in O. subisidiata. 2

1. Thallus sorediate, without isidia. Apothecial margin medulla C- or C+ red. Disks sometimes (e.g., O. farinacea) C-. Without variolaric acid, except in O. gowardii, and in the European species O. alboflavescens and O. turneri] 5

2. Thallus medulla C-; cortex C+ red. Isidia coarse, 0.1-0.3 mm diam. to 1.2 mm long, knobby, persistent, growing out of or merging into verrucae; thallus rather thick. Thallus yellowish gray, thick, verrucose, ± covered by isidia; prothallus often conspicuous, paler than thallus. Apothecia often present; discs C+ red, rugose to almost pruinose, pale yellowish pink, sometimes becoming rosulate; margins thick, usually verrucose to isidiate, sometimes radiately striate. Spores (36-)456-65 x (17-)25-36 µm. On bark of deciduous trees (especially Quercus), in mostly hardwood forests, 760-1500 m, Appalachian and Ozark regions. [Note: O. subviridis, a European species that has been reported from N. America, apparently incorrectly, also keys out here; it has a very thick, radiating prothallus and smaller isidia soon breaking into granules] O. yasudae Vainio

2. Thallus medulla C+ red, cortex C+ red or C-. Isidia less than 0.2 mm diam., sometimes breaking into granules and forming a granular crust. On bark or wood. Southern to tropical. 3

3. Isidia largely remaining cylindrical and discrete; thallus cortex C+ red, usually containing lichexanthone (UV+ yellow-orange). West Indies, Mexico and South America. [O. isidiata (Malme) Vers.]

3. "Isidia" (pseudoisidia) soon breaking into granules and forming a granular crust; thallus cortex C- or C+ pale pink, lacking lichexanthone (UV-). 4

4. Contains variolaric acid; lacks hiassic acids. Apothecial discs pruinose-scabrose, C+ red. Apothecia adnate to ± immersed, 1.5-2.5

mm diam.; margins verruculose, flexuose, distinctly double, sometimes smooth adjacent to disk and rough on outside. Thallus yellowish white to yellowish gray, rugose to granulose-isidiate, thick. Thallus and apothecia UV-. Spores 25-38 x 14-18 um. Almost always on conifer wood and bark, in Juniperus-Pinus edulis woodlands, 1500-2250 m. Arizona and SW Texas. O. subisidiata Brodo

4. Lacks variolaric acid; contains 5-O-methylhiascic acid.

Apothecial discs lightly white pruinose, C+ red, K+ vivid yellow; with inner excipular ring; outer margin coarsely granulose, ecorticate. Hymenium densely interspersed; algal layer sparse. Thallus yellowish white, thin at edge, becoming thick and rimose. On bark, usually of palms. West Indies (esp. Lesser Antilles) and Florida. O. antillarum Brodo

5. Soredia effuse, on the surface of thick, white, verrucose thallus; all tissues C-. (see O. farinacea)

5. Soredia usually in more or less discrete soralia (sometimes confluent in places); soredia or apothecial disk C+ red [Note: "O. sorediosa", apparently a rare, perhaps disease-induced, sorediate morph of O. szatalaënsis from western Canada, also keys out here; the discs and apparently also the soredia are C-] 6

6. Thallus and soredia C-. Apothecia common, 1.0-3.5 mm diam.; disks yellowish pink to pale orange, heavily pruinose-scabrose, C+ red, K+ yellow; margin somewhat prominent, matt, even to rugose or verrucose; algal layer almost continuous below hypothecium; spores 29-45 x 19-28 um. Thallus gray to yellowish gray, thick, rugose to verruculose, with patches of white, coarsely granular soredia. Usually on conifer bark, especially Picea and Pinus. Europe; reported from Washington and Pennsylvania, but not confirmed. [Note: O. turneri, a European species apparently incorrectly reported from British Columbia, might key here; it contains variolaric acid] [O. alboflavescens]

6. Thallus and (or) soredia C+ pink to red (gyrophoric acid). 7

7. Thallus (soralia) UV+ orange (lichexanthone). 8

7. Thallus UV± white. 9

8. Thallus thin, becoming somewhat thicker in central areas but rarely verruculose or verrucose, usually yellowish gray.

Soralia abundant, small, pale, C+ red, K-. North temperate to southern boreal, mostly eastern (especially Great Lakes area), with scattered populations in the northwestern part of the continent; on bark of deciduous or coniferous trees, in a variety of well-lighted forest types. Apothecai rare. Contains gyrophoric and lecanoric acids and

lichexanthone, without hiascic acids. [Note: Howard's records of O. subviridis are based mostly on misidentification of this species]. O. arborea (Kreyer) Almb.

8. Thallus verrucose to undulating verrucose. New Mexico to Texas and Mexico; on conifer wood or bark. Also contains 4,5-di-O-methylhiascic acid. (sorediate morph of O. mexicana Vainio)

9. Thallus thin to partly immersed, membranous, thallus C-; only soredia C+ red. Contains variolaric acid. Thallus yellowish white, with discrete but irregular excavate soralia breaking through thallus leaving ragged margins, 0.5-1.0 mm diam.; soredia coarsely granular, yellowish white. Apothecia commonly present, 0.6-1.5 mm diam.; disc pruinose to pruinose-scabrose, C+ red, K+ yellow; margins C-; spores (2-)4/ascus, 44-65 x 22-33 um. On bark of Abies lasiocarpa, 1300-1650 m. Oroboreal, in western mountains (Idaho and Montana to NE British Columbia, rare. O. gowardii Brodo

9. Thallus usually thick, verrucose, often somewhat shiny. Cortex and soredia both C+ red (even when thallus thin). Lacking variolaric acid. Thallus yellowish white or gray, Apothecia rare (unknown in N. America); discs epruinose; margins C+ red (cortex). Thallus UV- (or pale white). Soralia large, irregular, usually beginning as small, scattered hemispherical masses of coarse granular soredia, yellowish white to pale orange. On deciduous and conifer tree bark and wood, in humid, forested habitats, such as along lake shores, in bogs, etc. Mostly boreal and subarctic, south to Wyoming, and in the Sierra Nevada range in California. O. androgyna (Hoffm.) Arn.

GROUP IB.
On bark or wood;
not sorediate or isidiate.

(after Brodo, 1991)

1. Apothecia (including discs) and thallus entirely C- or + yellow (without gyrophoric acid or other C+ pink/red substances); discs often UV(long-wave)+ yellow-orange, heavily pruinose-scabrose, usually yellowish to yellow-orange; margins thick, thallus colored (usually without inner excipular ring). Containing variolaric acid, almost always murolic, and neodihydromurolic acids, and an unidentified UV+ compound. Mostly western. 2

1. Apothecia (at least the discs) and sometimes thallus at least partly C+ pink or red (gyrophoric acid, ± other substances). Discs pruinose-scabrose or not, mostly pinkish or orangish, UV+ or -. With or without variolaric acid. 3

2. Thallus thin (especially on lignum), continuous to rugulose, pale gray, white to yellowish white. Apothecia scattered, not crowded, 1.0-2.5(-3.2) mm diam.; margins even and smooth to verrucose and rough, prominent or not, an excipular ring of thallus-like tissue rarely present. Algal layer generally sparse. Spores 45-65(-75) x 25-38 µm, 4-8/ascus. On bark or lignum of various kinds, Thuja plicata-Picea sitchensis forests, Quercus garryana stands, or subalpine forest, usually in open habitats, Pacific NW (northern CA to WA, Montana and SW Canada, with disjuncts in NW British Columbia and southern Alaska. O. szatalaënsis Vers.

2. Thallus becoming very thick, bullate to verrucose, white to yellowish white, often matt and pruinose to almost chalky. Apothecia usually crowded, 1.0-3.0 mm diam.; margins even, matt, rough, prominent. Spores 44-65 x 21-35 µm, 2-5/ascus. Algal layer fairly abundant in margin and usually thin but continuous under hypothecium. On bark (especially Quercus), coastal areas (to 850 m), northern California to southern B.C.. O. farinacea Howard

3. Apothecial margin cortex or medulla C+ pink to red (gyrophoric acid); discs pruinose-scabrose or not, UV+ or - [?--need to check]; variolaric acid present or absent. 4

3. Apothecial margin cortex and medulla C- or C+ yellow, but discs C+ pink or red, UV- or slightly yellow-orange, lightly pruinose to pruinose-scabrose, rarely epruinose; contains variolaric acid. 12

3. Apothecial margin medulla C+ red; cortex C+ or C-. 4

3. Apothecial margin medulla C-; cortex C+ red. 5

4. Apothecial margin cortex C+ red; thallus and apothecial margins UV(long wave)+ orange, containing 4,5-di-O-methylhiascic acid. Apothecial disks rarely pruinose, C+ red, K+ bright yellow; often showing an excipular ring; outer margin flaring, smooth, even to somewhat flexuose, hardly prominent above disk and merging with it, especially when young; ; spores 38-60 x 19-28 μ m. Thallus undulating, verrucose. On bark of all types, Appalachian - Great Lakes region: mixed hardwood forests, Picea-Abies stands, and bogs; southwestern U.S. (AZ & NM) to Mexico: Quercus-Pinus or Pseudotsuga stands, 580-3000 m.. O. mexicana Vainio (Chem. race I)

4. Apothecial margin cortex C-; thallus UV(long wave)+ or -; methylated hiascic acids present, or rarely absent; apothecial discs lightly to heavily white pruinose, rarely epruinose, light orange, smooth, C+ red, K+ bright yellow; without an inner excipular ring. Apothecia 0.6-2.0(-2.7) mm diam.; margins thick, matt, smooth and even, prominent or not; algal layer variable, usually well developed. Thallus yellow-gray, thin at edge, becoming rugose to verruculose with vermiform rugae. Spores 43-67 x 18-30 μ m. Southeastern U.S. (north to Massachusetts), west to southern California and Arizona; Mexico; pantropic. O. africana Vainio

5. Thallus UV+ yellow-orange; lacking 4,5-di-O-methylhiascic acid. (rare chemical race II of O. mexicana)

5. Thallus UV-. 6

6. Apothecial margin of most or all apothecia consisting entirely, or in part, of a smooth, salmon-pink [in my opinion, it's more of a yellowish orange, but the point is that it is not whitish or grayish], shiny tissue (this tissue is sometimes restricted to a ring around the inner edge of the apothecial margin). Western N. America. 7

6. Apothecial margin usually without pinkish tissue or excipular ring. 9

7. Apothecia 0.7-1.8 mm diam.; outer margin matt, frequently brittle and crumbling. Thallus thin and membranous to slightly areolate-rugose, yellow-gray. Discs C+ pink, K-, at most very lightly pruinose. Spores 34-55 x 19-27 μ m. Gyrophoric acid alone or with traces of lecanoric acid or unknown. On deciduous and coniferous trees in mixed forests and Thuja plicata-Tsuga heterophylla forests, 900-2000 m, Idaho and Montana, with disjuncts in Washington and NW British Columbia. O. montana Brodo

7. Apothecia (1.0-)1.5-4.5 mm diam.; outer margin remaining intact and even. Thallus usually thick, white to ashy gray or yellowish, rugose to verrucose. [This is not a very good choice, in my opinion; I have seen many specimens with small apothecia and a thin smoothish thallus that have spores too large for those of the other species and therefore seem to belong in O. oregonensis]. 8

8. Algal layer continuous below hypothecium-exciple; hymenium 180-280 um high; spores 40-58 x 20-31 um; apothecial margin usually thallus-colored, matt, thick, usually even, prominent, often rough, sometimes with disk-colored excipular ring next to disk. Almost always contains olivetoric and 4-O-demethylmicrophyllinic acids. Apothecia 1-3(-4) mm diam.; discs usually rugose but epruinose, C+ red. Thallus thin to moderately thick, continuous, rugose to verruculose, yellowish gray to yellowish white. On bark of various kinds (mainly deciduous), in Quercus forests and Populus stands, less frequently conifer stands, 0-1550 m, coastal to inland, California to southern B.C. O. subpallescens Vers.

8. Algal layer confined to lateral margin; hymenium over 320 um high; spores (50-)55-70(-75) x 28-41 um; apothecial margin thick, hard, often shiny. Thallus usually yellowish gray to grayish yellow, shiny or matt; cortex C+ red. Disk C+ red, K+ yellow. Lacking olivetoric and 4-O-demethylmicrophyllinic acids. Almost always on conifer bark or wood, mainly in Tsuga-Thuja or Pseudotsuga forests, 0-1220 m, along west coast from Oregon to Alaska, less common eastward, to Idaho and Alberta. O. oregonensis Magnusson

9. Apothecial margins mostly devoid of algae, very thick, prominent, usually thallus-colored. Thallus relatively thin, smooth and continuous, yellowish white. Hymenium 250-430 um high; spores rarely developed. Contains olivetoric acid. Apothecia 1.2-3.0(-4.5) mm diam.; discs epruinose, rugose, C+ red. Mainly on smooth-barked deciduous trees, especially Alnus, along west coast from California to Alaska, mostly lowland, especially along streams and beaches. O. laevigata (Räsänen) Vers. ex Brodo

9. Apothecial margins with a well-developed algal layer, thin or thick; thallus thin to thick and verrucose. 9

10. Apothecial discs pruinose and (or) scabrose. Usually contains variolaric acid. Apothecial margins usually smooth and even, thick. Thallus yellowish gray, thin to somewhat thick, continuous, becoming rugose, UV-; cortex C+ red; medulla C-. Apothecia 0.7-1.5(-2.2) mm diameter. Infrequent, on conifers and Betula, rarely Acer, in northern mixed forests (Appalachian - Great Lakes, with disjuncts in Idaho). O. trochophora var. pruiniroSELLA Brodo

10. Apothecial discs epruinose or slightly hazy. Variolaric acid absent in all but rare individuals. 11

11. Algae mainly confined to lateral parts of apothecial margins, but sometimes also below hypothecium. Lacking olivetoric and 4-O-demethylmicrophyllinic acids. Eastern. Apothecia 0.8-2(-3) mm diam.; margin low, becoming rugose to verrucose, rough and matt to shiny, usually with color and texture of thallus; discs C+ red. Spores 35-71 x (20-)23035 um. Thallus pale to

dark yellowish gray, less frequently yellowish white, usually shiny, thin at first, soon becoming rugose and then verrucose on most substrates, often quite thick. Mainly on oaks, maples and Thuja, in the Appalachian - Great Lakes region, NE to Nova Scotia. O. trochophora (Vainio) Oshio (including "O. pallescens var. rosella Tuck.", with rosulate apothecia--appearing compound)

11. Algal layer continuous below hypothecium, and often in the lateral margins as well. Usually contains olivetoric and 4-O-demethylmicrophyllinic acids. Western. Apothecia 1-3(-4) mm diam.; margins smooth to more frequently rough, even, prominent, sometimes with disk-colored inner ring; discs C+ red. Spores (35-)40-58 x 20-31 µm. Thallus yellowish gray to yellowish white, thin to moderately thick, continuous, usually rugose to verruculose; cortex C+ red; medulla C-. On deciduous trees or conifers, from B.C. to California. O. subpallescens Vers.

12. Algal layer thick, conspicuous below hypothecium. Contains protolichesterinic and lichesterinic acids. Apothecia large, flat, up to 5 mm diam.; margins relatively thin, prominent above disk or almost even, often rugose; discs usually pruinose to pruinose-scabrose. Thallus rugose to verruculose or verrucose, becoming fairly thick, yellowish gray. Spores (31-)36-57(-66) x 19-31 µm. Almost always on conifer bark (especially Pinus and Picea), common, mainly in eastern North America (Appalachian - Great Lakes areas): conifer forests in upland forests or associated with bogs, less common in southwest U.S. (AZ, NM, TX) and Mexico: pine forests, 1200-3150 m. O. pseudopallescens Brodo

12. Algal layer scanty or absent below the hypothecium. Lacking protolichesterinic acid. Apothecia 0.6-2.5 mm diam. 13

13. Thallus ± immersed, often reduced to a dark gray stain, occasionally visible as very thin yellowish white patches, C-. Apothecial margins white to usually pale orange yellow to orange-pinkish, smooth, mostly even, usually prominent; discs expanded in maturity, pruinose-scabrose, C+ red, K+ yellow; often becoming rosulate or irregularly fissured (when dry), remaining small into maturity, later broadening, 0.8-1.5(-2.0) mm diam. Lacks lichesterinic acid. Spores 38-62 x 19-32 µm. On conifers and lignum, sea level to subalpine, known from few scattered areas along west coast (northern CA to Queen Charlotte Islands, B.C.), with disjunct in northern Rockies of SW B.C. O. subathallina Magnusson

13. Thallus thin or thick, but always present; apothecial margins always thallus-colored, never disk-colored. [I find this to be a difficult choice to make]. 14

14. Thallus thin and membranous. Eastern. Apothecia generally less than 1.0 mm across; disc expanded when mature. Lichesterinic acid present

or absent. Northern boreal forest of Labrador. Ochrolechia sp. ("#8")

14. Thallus usually thin at edge, becoming thick and rugose or verruculose in older portions. Western. Thallus yellowish white or gray. Apothecia with white, thick, prominent margins (usually white, often matt, rough, or decomposing), 0.8-1.5(-2.5) mm across; disks often hardly expanded, giving the apothecium a pertusarioid appearance, usually heavily pruinose-scabrose, C+ pink, K+ bright yellow. Algal layer sparse, mainly in margin. Spores 38-62(-69) x (18-)22-33 um. Contains lichesterinic acid. Usually on conifer bark or lignum, especially Pinus, 0-1800 m. Pacific NW (central California to the Queen Charlotte Islands, BC, east to NW Montana), common. O. juvenalis Brodo.

Note: Reports of O. tartarea from N. America, at least for corticolous material, are erroneous, but it is still possible the species occurs here on rock (see Key III-B). North American reports of O. parella from bark or wood are also erroneous, based mostly on O. pseudopallescens or O. juvenalis; see Key III-B for info. on "O. parella" on rock. Ochrolechia pallescens is a primarily corticolous European taxon (considered to be usually C-, except for C+ red disks), of uncertain status until it can be typified, but N. American reports are based on misidentifications.

"Pertusaria leucostoma", a corticolous and terricolous species containing alectoronic and lichesterinic acids, may actually be an Ochrolechia (Brodo, 1988); it has pertusarioid apothecia opening by a pore. Otherwise Pertusaria spp. [usually?] lack these substances and have thick-walled spores, thin-walled asci dehiscing by a very distinctive bivalved, longitudinal split easily seen when stained with IKI]

I have encountered several difficulties in distinguishing species in this group from the Pacific NW.

ADD:

Medulla always C-, KC± wine-red (alectoronic acid); thallus ash-gray to yellow-white; verrucae concolorous with (or more white than) the thallus, characteristically possessing a pink to red-brown ostiole border; spores 4 (but variable), 32(±5) x 79(±19) um, uni- or biseriate. Corticolous on hardwoods and conifers (± hypophloedal), restricted to the western arctic. O. xanthostoma (Sommerf.) K. Schmitz & Lumbsch in K. Schmitz, Lumbsch & Feige

GROUP IIA.
On soil, moss, etc.;
sorediate or isidiate.

(Mostly copied, in abbreviated form, from Group I key. Need to modify, eliminating some taxa and adding others, and eventually combine into one key to sorediate/isidiate taxa?).

- 1. Thallus isidiate or apparently so, P-.** 2
- 1. Thallus sorediate, without isidia or isidioid structures, sometimes at least partly P+ orange or red-orange.** 3
 - 2. Thallus truly isidiate, with thick, knobby isidia 0.1-0.3 mm across and up to 1.2 mm long.** Prothallus often conspicuous, paler than thallus. Apothecial cortex and disks C+ red; medulla C-. Apothecia frequent; discs pruinose; margins thick, usually verrucose to isidiate, sometimes radiately striate; spores (36-)46-65 x (17-)25-36 μ m. Appalachian - Great Lakes region. [Note: Pertusaria spp., mostly arctic-alpine, also key out here; most are C-, but one apparently undescribed taxon (genus uncertain, but morphologically very similar to P. subdactylina) has C+ red-orange areas (apothecial primordia?). (see O. yasudae)
 - 2. Thallus without true isidia, but with papillae or spinulose or coralloid structures;** thallus cortex and medulla K-, C+ red, P-. Apothecia present or not; discs not pruinose; margins rather thin, smooth, entire; spores 25-40 x 15-26 μ m. Arctic-alpine. (see O. frigida)
- 3. Thallus, including soralia, and apothecial margins (cortex and medulla) C-, P-. Often fertile,** with large (1-3 mm) apothecia; discs C+ red. Spores small, 18-20 x 10-12 μ m. Not definitely known from N. America. [see O. alboflavescens]
- 3. Thallus, soredia or both C+ or KC+ red or pink. Almost always sterile.** 4
 - 4. Soredia in limited soralia.** 5
 - 4. Soredia over entire thallus.** 7
- 5. Thallus with round soralia over surface and usually spinulose outgrowths on thallus.** Thallus C+ red, KC+ red, P-. sorediate form of O. frigida
- 5. Thallus with soralia on raised verrucules of thallus, lacking spinulose growths.** 6
 - 6. Thallus K+ yellow, C-, KC+ red, P+ (yellowish-) orange, containing alectorialic acid.** Apothecia very rare; disk black-purple. Thallus of \pm closely crowded, \pm rounded warts, which mostly break up into somewhat raised, rounded, often almost spherical whitish (ochre when old) soralia. Reported from near Nome, Alaska. Thallus superficially similar to O. androgyna according to Thomson. (see Pertusaria geminipara)

6. Thallus K-, C+ red, P-, containing gyrophoric acid; soralia P-.

Apothecial discs, if present pale, yellowish to reddish or brownish. Soredia in limited soralia. Thallus usually thick, verrucose, UV- (or whitish), often somewhat shiny, yellowish white or gray, cortex and soredia both C+ red (even when thallus thin). Apothecia rare (unknown in N. America); discs epruinose; margins C+ red (cortex). Spores 8/ascus [erroneously given as 2 in Thomson's 1979 key]. Lacking variolaric acid; UV- (or pale white). Soralia large, irregular, usually beginning as small, scattered hemispherical masses of coarse granular soredia, yellowish white to pale orange. Mostly northern to subarctic (& arctic on moss or soil). [Description based on Brodo, 1991, for corticolous material]. (see O. androgyna)

7. Thallus or coarse granules which develop into soredia; C+ red, KC+ red; soralia P+ pale red-orange (unknown substance), but rest of thallus (and apothecia if present), P- (soralia only "sometimes" P+ red according to Thomson 1997). Thallus [at least medulla] K+ yellow, C+ red (erroneously given as C- in Thomson's 1979 description), KC+ red, containing gyrophoric acid. Apothecia usually occurring (?), scattered, (1-)2-4 mm wide, sessile; margin thick, smooth, entire to granulose; disc concave, becoming flat or convex, pink, pale yellow-brown or red-brown, roughened, K-, C+ pink, P-; epithecium ashy yellow; hypothecium grayish; hymenium hyaline, 180-200 um; paraphyses slender; spores 6-8, broadly ellipsoid, 20-54 x 23-28 um. Thallus white or ashy white to bluish gray, thin, coherent to scattered warty-granular, generally of irregularly rounded large warts provided with finely granular soralia which sometimes cover the thallus. On mosses and humus, sometimes on soil, arctic, Alaska to Greenland, south to Nova Scotia and Washington. [Description after Thomson; according to Purvis, this species is very similar to O. androgyna but thallus coarsely erose-sorediate, uniformly gray-white, delimited, without yellowish soralia, and P+ pale orange]. O. inaequatula

7. Thallus of abundant fine soredia; C+ red, KC+ red, P-. Thallus white, continuous, minutely granulose, subleprose, and totally granular sorediate. Apothecia sessile, round, to ca. 1 mm wide; margin white, subtumid, entire, farinose; disc concave, testaceous, epruinose, non-scabrid; thalline margin 185 um thick; proper margin 55.5 um thick. Epihymenium yellow-green, 18.5 um. Hymenium 205.5 um; hypothecium 2-layered, 22.2 + 37 um high. Spores 8, ellipsoid, 32-44 x 21-23 um. Thallus K-, C-, P-; disc C- red. On moss, Alaska. O. gyalectina (Nyl.) Zahlbr.

ADD:

Thallus white, divaricately branched, densely granular; granules globose to cylindrical, resembling isidia, sorediate; soredia cream-colored, granular, round to maculiform. Apothecia pedicellate, 1.5-2 mm wide or larger, margin concolorous with thallus, subtumid, round becoming undulate; disc concave, dark brown or brownish red, epruinose, smooth becoming scabrous. Thalline

margin 150-220 um thick; proper margin absent. Epihymenium 35-75 um thick, brown. Hymenium 110-150 um. Hypothecium yellowish, composed of two layers. Asci 148 x 25.9 um, 8-spored; spores 22.2-29.6 x 14.8-18.5 um. Thallus, soredia, disc and apothecial margin K-, P-, C+ red. On moss, Greenland, Labrador. O. frigida (syn. O. groenlandica Vers.)

GROUP IIB.
On soil, moss, etc.;
not sorediate or isidiate.

After Howard, Versegghy, Thomson, and Poelt,
with modifications after Brodo, 1991

1. Thallus and apothecia C- or C+ yellow, KC-, containing variolaric acid and almost always both murolic and neodihydromurolic acids, without gyrophoric acid or other C+ pink/red substances.

Apothecial disks heavily pruinose, often yellowish, sometimes UV+; margin thick. Thallus usually pale, yellowish. Spores often over 40 um long and 25 um wide. 2

1. Thallus and/or apothecia at least partly C+ red, KC+ red (gyrophoric acid, + or - other substances). Apothecia discs flesh-brownish nonpruinose. Apothecia scattered to crowded, with whitish margin and flat to concave discs. Spores mostly smaller. Arctic-alpine. 3

2. Thallus becoming rough and verrucose, moderately thin, smooth to granular-wrinkled or warted, yellowish white (to white, buff, or gray according to Thomson). Apothecia 1-3 mm diam., abundant, often closely crowded; discs pale yellowish or grayish buff, strongly white pruinose, only occasionally (ca. 10% of the populations) UV(long wave)+ yellow-orange; margin thick, entire, concolorous with thallus; spores (30-)50-75 x (25-)30-40 um. Containing variolaric, murolic, and neodihydromuralic acids in thallus and apothecia. On mosses and soil, (and plant bases and Selaginella according to Thomson), mostly arctic-alpine (reported from Alaska and northern Canada, south to Quebec in the east and to New Mexico and California in the west, but some of these records may be misidentifications); also frequent on soil in the dry interior of B.C. in a community including other arctic-alpine taxa. O. upsaliensis (L.) Massal.

2. Thallus continuous to rugulose, very thin, white to yellowish white, less frequently yellowish gray. Apothecia usually not crowded, sessile, 1-2.5(-3.2) mm diam.; disks usually pale orange-yellow, heavily pruinose-scabrose, relatively frequently (ca. 60% of the populations) UV+; margins thick, thallus-colored, even and smooth to verrucose and rough, prominent or not. Spores 45-65(-72) x 25-38 um. Often on Selaginella over rocks, in exposed areas, in temperate, lowland areas, Pacific NW, with a few disjuncts in western arctic coastal areas (to Alaska). (see O. szatalaënsis)

3. Parasitic on Grimmiaceous mosses. Thallus in the form of a very thin, membranous, whitish or greyish appearing, cobwebby prothallus

uniformly covering the moss; provided with scattered whitish granules or glomerules, which appear to be apothecial initials, K+ yellow, C+ red, P-. Apothecia adnate to sessile, 1-3 mm diam.; discs concave to becoming flat or convex, deep pink to yellowish or brownish red, smooth to roughened; epithecium brown; hypothecium brown; hymenium hyaline, 176-200 µm; paraphyses thin; spores 8, ovoid, 37-40 x 14-19 µm. Arctic, Alaska to Greenland, south to Quebec. O. grimmiae Lynge

3. On various substrates. Thallus white, yellowish, pinkish, grayish brown or gray, very polymorphic, beginning with a thin, membranous covering, which becomes thicker crust of granules or verrucae, which often grow into numerous, rapidly growing, ± branched prickles (spinulose processes), occasionally forming cylindrical coralloid branches, K-, C+ fleeting pink-orange (C- according to Thomson), KC+ red, P-, containing gyrophoric acid. Apothecia often common but sometimes absent, to 5 mm diam., sessile to adnate; margin thin to slightly thickened, entire or wrinkled, concolorous with thallus; disk flat, red-brown to brown, slightly roughened, epruinose, K+ red, C+ pink, P-; epithecium brown; hypothecium brown; hymenium hyaline, 130-180 µm; paraphyses thin; spores 8, ovoid, 26-43 x 15-26 µm. On soil, mosses, humus, plant remains, and base of shrubs, arctic-alpine, south to New Hampshire in the east, Colorado in the west. The sterile thalli of this and Lecanora epibryon are often growing together and sometimes very similar; L. epibryon is K+ yellow, C-(atranorin). O. frigida (Sw.) Lynge. [Note: O. tartarea, a European species reported, probably incorrectly, from N. America, also keys out here; it has a very thick, granular-verrucose thallus with spines or branches--see Key III-B]. 4

4. Thallus thin to granulose, not fruticose, with or without spinulose outgrowths, these short when present. f. frigida

4. Thallus branching, dwarf fruticose. 5

5. Thallus thick, blunt, papillate becoming coralloid, yellowish. f. gonatodes (Ach.) Lynge

5. Thallus thin, of branching, spinulose outgrowths. f. telephoroides (Th. Fr.) Lynge (including "O. pterulina (Nyl.) Howard")

ADD:

Thallus thin, white, expanded, uneven, weakly and irregularly verruculose; thallus margin slightly brownish, 2-3 mm wide, often ± filamentous. Apothecia numerous, hemispherical, strongly constricted at the base, to 0.7 mm wide and 0.5 mm high, towards the top flattened and brownish; disc punctiform, depressed, brown, to 0.2 mm wide. Spores 8 or often fewer, ellipsoid, 45-63 x 32-36 µm wide. Medulla C and KC+ red (gyrophoric acid, ± lecanoric acid), P-. Thallus generally off-white; verrucae always pertusariate, rarely fertile, always isolated, and often apically rufescent; epihymenium K-; sterile or spores 4, 35(±9) x 63(±14) µm, usually biseriate. Arctic-alpine. On

moss, Alaska. [See Dibben's Pertusaria monograph for full description]. O. bryophaga (Erichsen) K. Schmitz & Lumbsch in Schmitz, Lumbsch & Feige

**GROUP IIIa. On rock;
sorediate or finely isidiate
(isidia sometimes disintegrating into soredia);
apothecia often lacking.**

(After Howard and Versegghy,
with modifications after Brodo, 1991;
Probably incomplete

1. Thallus isidiate. Medulla C-; cortex C+ red. Isidia coarse, 0.1-0.3 mm diam. to 1.2 mm long, knobby, persistent, growing out of or merging into verrucae. Thallus yellowish gray, thick, tartareous and verrucose, with large, coralloid-branched isidia ("O. tuckermannii" morph) or thin, rimose, verrucose toward center, with small, cylindrical, simple to coralloid isidia ("O. pennsylvanica" morph) ± covered by isidia; prothallus often conspicuous, paler than thallus. Apothecia often present; discs C+ red, rugose to almost pruinose, pale yellowish pink, sometimes becoming rosulate; margins thick, usually verrucose to isidiate, sometimes radiately striate. Spores (36-)45-65(-74) x (17-)25-36(-40) um. Without variolaric acid. On rocks (often sandstones) in mostly hardwood forests, 760-1500 m, Appalachian and Ozark regions. [Note: O. turneri, a European species apparently incorrectly reported from British Columbia, has a completely C- thallus, containing variolaric acid]. O. yasudae Vainio

1. Sorediate, without isidia.2

2. Thallus and soralia C+ red, P-. Thallus thickish, coherent, warty-fissured, irregularly breaking up into granular to almost isidiate-sorediate surfaces. (see O. androgyna--"v. saxosum")

2. Thallus and soredia C-. Rare, western Canada. ("O. sorediosa" morph of O. szatalaënsis)

GROUP IIIb.
On rock;
not sorediate or isidiate;

(After Howard and Versegny, and Brodo, 1988 and unpubl.;
probably incomplete)

1. Apothecia ± pertusarioid, opening by 1 or more pores (or sometimes appearing lecanorine according to Thomson), in raised, basally constricted warts ca. 4-5 mm across, the disc or apical portion C+, KC+ red (gyrophoric acid) or C-, KC+ red (alectoronic acid), usually also with variolaric acid. Thallus yellowish or rosy white. Spores 8, ellipsoid, 36-87 x 25-45 µm. On calcareous or acidic rocks. Queen Charlotte Islands, British Columbia to Alaska. 2

1. Apothecia lecanorine, with expanded disc at least when mature, not in pertusarioid warts. 3

2. Gyrophoric acid abundant in the superficial ascomatal tissues (upper part of hymenium, sometimes extending into part of the disk); alectoronic acid minor, confined to discontinuous areas within the medulla; variolaric acid and lecanoric acid often present; sometimes lacking either variolaric or alectoronic acids (never both). Apothecial verrucae 4-5 mm broad, appearing as if apothecia of a Lecanora, projecting above thallus, often containing a number of deeply embedded apothecia with small pale, depressed ostioles showing in folds of upper side, ostioles, giving a rosulate appearance; underside almost umbilicate. Hypothecium pale to dark brown; epihymenium pale to yellow-brown or dark brown, K-; hymenium hyaline to pink; spores (4-6-)8, mainly biserial, walls double, both thin, outer and inner each 1-2 µm thick, smooth and without thickened tips, ovoid to ellipsoid, 16-74 x 9-45 µm. Thallus generally rather thick, minutely rimose-areolate and somewhat dispersed; margins indistinct; areoles flat or convex, yellowish or roseate white, lacking soredia and isidia. Cortex K-, C-, KC-, P-, UV-; medulla K-, C+ red, KC+ red, UV-, P-. On mountain tops.

Arctic. O. subplicans (Nyl.) Brodo subsp. subplicans

2. Gyrophoric acid in low concentration, confined to the epihymenium; alectoronic acid the major substance (in thallus and apothecia?); variolaric acid and traces of lecanoric acid also present. Apothecial verrucae usually hemispherical with 1-2(-3) ostioles and not rosulate. Thallus usually thin, rather smooth, continuous, only becoming rimose in patches. On the seacoast. O. subplicans subsp. hultenii (Erichs.) Brodo

3. Thallus C+ pink-orange (fleeting) or C-, but KC+ red (gyrophoric acid); discs C+ and KC+ red. Thallus papillate-coralloid, ochre-white, 3-6

mm thick, fragile; disc scabrous to smooth, pruinose or not. Usually on soil, etc. (see O. frigida)

3. Thallus C- and KC- (without gyrophoric acid); discs C+ red. [Note: rare saxicolous thalli of O. upsaliensis from Arctic-alpine areas will also key out here, but they have C- or + yellow discs). need more info on "O. howardii" to key out the following taxa. 4

4. Apothecia to 5(-8) mm diam.; discs pale brown to dull orange-pink. Thallus often very thick (to 3 mm or more), tartareous, often with numerous irregular warts forming an uneven, corrugate crust, sometimes with a paler zoned margin and a pale prothallus, pale to dark gray. Apothecia usually frequent, immersed and closed at first, rounded or irregular, scattered or crowded, sessile; thalline exciple thick, wavy. Discs concave to flat, not, or translucently, pruinose, the surface often scabrose-roughened, P-, K-, C+ orange-red, KC+ red; epithecium granular, the granules dissolving in K. Spores (35-)40-70 x 20-40 µm, broadly ellipsoid. Medulla P-, K-, C+ orange-red, KC+ red (gyrophoric, ± lecanoric acids). On siliceous boulders. A European species possibly incorrectly reported from N. America. [O. tartarea (L.) Massal.]

4. Apothecia 0.75-1.75 mm; disks pink-orange. margins thick, prominent. (O. parella sensu Howard; I am not certain whether this taxon is a good one, nor if it is saxicolous; more info. needed). "O. howardii Brodo ined."

ADD:

Several additional unidentified saxicolous species.

Thallus isidiate; isidia to 0.6 mm thick, 4-5 mm high, concolorous with thallus, K-. Apothecia lecanorine with expanded discs; discs nonpruinose. [Pertusaria trachydactyla Vainio]

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