

Candelariella Müll. Arg.
(LECANORALES: CANDELARIACEAE)

after Thomson (19__), Poelt (1969), Weber (unpubl.),
and others

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Thallus crustose, uniform or powdery, granular, nodular, warted, or squamulose, or indistinctly or sometimes markedly lobed at the margins, usually pale or deep yellow (greenish to orangish) from pulvinic acid derivatives, K-; attached to substrate by hyphae; upper cortex paraplectenchymatous; lower cortex absent.

Apothecia sessile, circular; thalloid margin usually persistent; true exciple usually indistinct; disk bright yellow, to yellow-brown, K-; hypothecium pale, usually with algae below; hymenium 50-75 µm tall, colorless, I+ blue; paraphyses usually simple, sometimes a few weakly branched near the tips; apices not or only slightly swollen; asci clavate, *Candelaria*-type, unitunicate, thick walled, clavate, I+ blue; tholus I+ blue; spores 8-32, simple, often biguttulate, a few thinly 1-septate, hyaline, thin walled, ellipsoid, \pm cylindrical with rounded ends, straight or curved, or tear-drop shaped, rarely quite elongated. Pycnidia immersed; wall colorless; fulcrum exobasidial (acrogenous); conidiogenous cells elongate-ampulliform, enteroblastic pycnosporous ellipsoid or bacilliform, somewhat constricted at the center. Photobiont *Trebouxia*. Calycin, pulvinic dilactone, pulvinic acid; P-, KC-, K-, C+ orange. On various substrates (basic to acidic rocks, bark, wood, soil, etc.), favored by mild eutrophication, and some species frequent in urban areas.

1. Marginal lobes clearly elongated, strongly convex, finger-like.

Spores many per ascus. Description mostly from Fink (as *C. crenulata*); needs to be checked with European literature: Thallus moderately thick, round, minutely granulate, crenately lobed, pale to lemon-yellow; apothecia 0.4-1.5 mm across, adnate to sessile, often crowded; disc flat to convex, pale to tawny yellow; exciple thin, concolorous with thallus, becoming crenate; spores 8 to many, ellipsoid, simple to 1-septate, the cells polar, 9.5-15 x 4.5-7 µm. On the seashore, Arctic [but not mentioned by Thomson, 1979]; reported by Fink (as *C. crenulata*) on rocks from Colorado (probably a misidentification) and Massachusetts. [if growing in the Southwest or Mexico, and spores 8/ascus, see *Candelina*]. *C. arctica* (Körber) R. Sant. in Vezda

1. Marginal lobes not or only weakly elongated (less than twice as long as wide). 2

2. Fertile; not sorediate. 3

2. Sterile; \pm sorediate. GROUP III.

3. **Spores 8/ascus.** GROUP I.
 3. **Spores 16-32/ascus, under 15 um long.** GROUP II.

I. SPORES 8/ASCUS

1. Spores acicular (to ellipsoid according to Fink), 25-46(-50) x 2-3(-5) um. Thallus lemon yellow to almost chartreuse yellow-green, composed of short branches crowded into a papillate crust, sometimes expanding into lobulate squamules toward the margin. Apothecia 0.8-1.5 mm across, sessile; disk flat to slightly convex, dull brownish yellow; margin thick, concolorous with thallus, becoming flexuous and crenate; spores 1-septate, "irregularly broken" within. On irrigated rocks over mosses. NE Colorado (endemic to that area according to Weber; also reported by Fink from Montana and Washington). C. spraguei (Tuck.) Zahlbr.

1. Spores elliptical or oblong, with rounded ends, under 20 um long, or if longer then 5-8 um wide. Thallus usually deep yellow or orange yellow, or not evident. 2

2. Apothecia biatorine, without algae. With grey prothallus; no yellow thallus. Thallus (at least in N. American material, according to Weber) distinctly squamulose, gray, with imbricate lobules (Hakulinen does not mention squamules or lobules). Squamules small, ascending. Apothecia 0.1-0.2 mm diam., sparse and dispersed, round then becoming ellipsoid; disc strongly convex to hemispherical from the beginning, yolk yellow, rough, matt; margin rolled under. Hypothecium 60-90 um. Hymenium 40-50 um. Asci clavate, 30-45 x 15-18 um. Epithecium granulate. Spores oblong-ovoid, slightly curved, partly appearing 1-septate, (9-)12-18(-21) x 4-6 um. Paraphyses unbranched, ca. 2-3 um wide, often septate. On bark (Juniperus, Acer), Colorado and S. Dakota. C. subdeflexa (Nyl.) Lettau

2. Apothecia lecanorine. Thallus yellow or indistinct to absent. Not parasitic on bark lichens. 3

3. Spores 10-12 x 3-4 um. Thallus indistinct. On rock. According to the type description, the thallus is K+ red; therefore this is almost certainly a species of Caloplaca (according to Weber, probably C. lamprocheila). "C. stenospora de Lesd."

3. Spores over 12 um long, over 5 um wide. 4

4. Thallus ± yellow. Apothecial margins light yolk-yellow to light reddish yellow, at most weakly greenish. Discs yellow to brown. 5

4. Thallus absent, or not yellow. 8

- 5. Thallus pale yellow or greenish. 6**
5. Thallus golden yellow. 7

6. On rock, with Placynthium. Apothecia rare, 0.5-1 mm wide, flat to slightly convex; margin crenate to sometimes lacking, yolk yellow. Epithecium granulose, yolk-yellow to orangish, matt. Hymenium 45-50 µm. Asci ventricose-clavate, 36-45 x 14-20 µm. Spores 12-15(-17) x 5-6 µm. Paraphyses unbranched, septate, 2.5-3 µm thick, tips clavate, to 3.5-4 µm (capitate, according to ?). According to Weber, this is an arctic species (known from Greenland but not U.S. or Canada), and the report from N. America (arid steppes of eastern Utah) is based on poorly developed C. rosulans. [C. dispersa (Räsänen) Hakul.]

6. On soil, humus, or moss. Thallus of very small round granules or becoming lobate, sometimes forming glomerules, often dispersed, matt, lemon yellow to yellow, flattened or convex. Apothecia adnate, plane to convex; margin concolorous with thallus, entire or becoming crenate, occasionally disappearing; disc yellow to olive yellow or grayish; epithecium granulose, yellow to yellow orange or greenish; hymenium 50-60 µm; paraphyses seldom branched; asci clavate to saccate; spores slightly curved, oblong-ellipsoid, simple or appearing 1-septate, (10-)14-18 x (4.5-)6-8 µm. Arctic-alpine in the west, south to Colorado and New Mexico. (Including C. terrigena var. placodiomorpha Hakul., with thallus thick, with sublobate margin; apothecia large, subcrenate). According to Weber, this species is simply a terricolous form of C. rosulans. C. terrigena Räsänen (syn. C. canadensis H. Magn.)

7. Thallus usually well developed, with crenulate or rosulate appearance, but variable, sometimes (according to Weber) essentially lacking (washed away, leaving the more firmly attached apothecia). Thallus areolate-squamulose, dispersed to more often confluent, usually well developed; regenerating when old; typically composed of squamule-like granules, in places forming 1-2 mm wide rosette-like structures; areoles often peltate; surface deep yolk yellow (to greenish gray or almost blackish when regenerating), opaque. Apothecia common, dispersed, 0.7-1.5 mm across, often stipitate; disc round then irregular, plane then somewhat convex, dark yellow, then greenish yellow or brownish tinged; margin distinct, entire to flexuose (crenulate according to Weber), ca. 0.1 mm wide, paler yellow than the thallus. Hypothecium 70-90 µm thick, intergrading with medulla. Epithecium granulose, yolk yellow to olivaceous. Hymenium 50-60 µm. Asci ventricose-clavate, 35-50 x 15-20 µm; spores curved, rounded at tips, partly appearing 1-septate, 12-18 x 4.5-6 µm. Paraphyses simple, partly capitate and articulate, 2-3 µm thick, tips 3-4 µm; cells 4-6 µm long. The f. minor (B. de Lesd.) Zahlbr., has apothecia 0.4-0.6 mm across, with margin granulose or absent. On non-calcareous

sedimentary or conglomerate rock, and volcanic rock, common throughout much of the inland, arid or semi-arid west (especially southwest), at lower elevations. C. rosulans (Müll. Arg.) Zahlbr.

7. Thallus scattered, often lacking; surface yellow or greenish gray or ashy, granular. Apothecia common, to 1.2 mm diam., widely dispersed or rarely or never crowded-confluent; margins entire to subcrenate, persistent, not granular or sorediate; disc plane to subconvex, darker yellow than margins, surface rather rough. Hymenium 60-75 µm; epithecium granulose, yellow to orange yellow; paraphys simple, slightly capitate to 3 µm, lax; spores oblong to ellipsoid, straight or curved, 12-30 x 5-7.5 µm, usually simple. Ch.: calycin and pulvinic dilactone. On calcareous or ultramafic rock, concrete or mortar, or old bones, sometimes on soil or old wood (according to Fink) or (according to Weber) also on Selaginella, mosses, or plant remains, and rare in the Rocky Mountains. Arctic-boreal to temperate, Washington to California, west to Nevada and Ohio. Common at least on concrete. (If thallus present, = var. urilocularis (Elenk.) Zahlbr.). In Ontario there is a taxon that seems to key out here but has a fairly well developed thallus and very tiny (ca. 0.2-0.3 mm diam. apothecia). C. aurella (Hoffm.) Zahlbr.

8. Thallus gray, granular-squamulose. Squamules to ca. 1 mm long and wide as well as high, ± constricted at the base, gray to dark lead-gray; older ones in thallus center producing erect isidia-like structures, which become granular-sorediate. Apothecia lecanorine, sunken into the surface of the squamules, ca. 1 mm wide, the older ones wavy in outline; thalloid margin thick, at least at first strongly incurved, yellow above, gray on the outside; definite proper margin usually present. Spores 13-18(-20) x 4.5-6 µm. On rock deposits in dry warm limestone walls. C. plumbea Poelt & Vezda

8. Thallus immersed, flat, or only a gray "prothallus" developed. 9

9. With flat, almost areolate, grey "prothallus". Apothecia dispersed or rarely 2-3 grouped, then angular, 0.1-0.3(-0.4) mm wide; discs convex, yellow then yellowish red, matt to slightly nitid; margin distinct, entire, thin. Hypothecium 80-100 µm. Epithecium distinctly granulose. Hymenium 45-55 µm. Asci ventricose-clavate, 40-50 x 12-18 µm. Spores oblong, ovoid, or slightly curved, 11-18 x 4.5-6 µm, often with oil drops. Paraphyses scarcely branched, 3 µm thick, hardly swollen at the tips (to 3.5-4 µm), free. On bark (Fraxinus, Quercus) and dry wood. According to Weber, the reports of C. antennaria Räsänen from N. America (Colorado and New Mexico) are based on C. deflexa. C. deflexa (Nyl.) Zahlbr.

9. Thallus immersed, without grey prothallus. 10

10. On rock, cement, mortar, etc., or vegetable matter.
(see C. dispersa and C. aurella, above)

10. On bark or wood. Apothecia round, ca. 0.2-0.7 mm wide, plane or becoming convex, yolk yellow (at most slightly reddish tinged when old), rather rough and dull; margin entire to subcrenate, 50-100 μ m wide. Hypothecium 30-40 μ m thick. Epithecium yellow, granulate, opaque; hymenium 50-60 μ m; asci ventricose-clavate, 45-55 x 15-20 μ m. Spores straight to slightly curved, simple or rarely appearing 1-septate, (9-)14-20 x 5-6 μ m. Paraphyses septate; tips clavate, 4-4.5 μ m thick. Differs from C. aurella in the thick paraphyses with swollen cells, and the thin hypothecium. [C. antennaria Räsänen]

II. Spores 16-32/ascus

1. Apothecial margins and usually thallus \pm yellow. Discs usually yellow (brown only when old). 2

1. Thallus not yellow. [No such species reported for N. America]

2. Thallus absent or consisting only of minute scattered granules, which for the most part are apothecial margins or precursors of apothecia. 3

2. Thallus well-developed, warty-granular to lobed-squamulose. 4

3. On acid rocks in fissures and holes, particularly on the seacoast.

Apothecia numerous, \pm scattered, 0.2-0.7 mm wide, plane; margin entire to subcrenate; hymenium 50-60 μ m; epithecium lemon yellow; paraphyses slightly capitate; asci broadly clavate; spores 32-36 per ascus, ellipsoid, often poorly formed, with one or sometimes both ends pointed, filled with oil drops which sometimes coalesce to give the appearance of 2-celled spores, straight or slightly curved, 9-15 x 4-6 μ m. Thallus lacking or of minute dispersed granules, yolk yellow. Canada and Arizona. C. athallina (Wedd.) Du Rietz

3. On bark of broad-leaved trees or shrubs, sometimes on wood or humus.

Apothecia scattered or in small groups, 0.2-0.4 mm wide; discs convex to subglobose, matt to subshining; margin entire, thin to disappearing; epithecium yolk-colored, granulose; hymenium 60-65 μ m; paraphyses simple, capitate, partly septate, 1.5-2 μ m, the tips 2.5-3 μ m; asci broadly clavate; spores numerous, oblong or ovoid, slightly curved, 9-12 x 4-5 μ m. Thallus powdery granulose, of minute dispersed granules or lacking, yolk colored. Arctic-boreal. C. lutella (Vainio) Räsänen

4. Thallus squamulose-lobed. 5

4. Thallus granular-areolate or of coherent granules; not flat lobed. 6

5. On siliceous rock. Thallus well developed. New Mexico, known only from the type. [= C. vitellina according to Weber]. C. citrina B. de Lesd.

5. On soil, moss, or humus. Thallus dispersed to granulose-verrucose, of rounded granules, occasionally glomerate, matt, lemon yellow to yolk yellow, becoming subsorediate; margins becoming effigurate-crenate. Apothecia to 1.5 mm diam.; discs flat, granulose, darker than the margin; margin flexuose to crenulate, very golden pulverulent; epithecium yellow; hymenium 60-120 μ m; spores 16-32 per ascus, 6.5-15 x 5-6 μ m. Arctic-alpine, south to Colorado. According to Weber, "C. placodizans H. Magn. non (Nyl.) H. Magn.", and also C. placodizans (Nyl.) H. Magn. do not occur in N. America. "C. placodizans (Nyl.) H. Magn."

6. Thallus ± coralloid, 1-3 mm thick, ± continuous, uniform or coarsely cracked, of contiguous, coarse, rounded granules, becoming erect, simple or branched, bright golden yellow. Apothecia 0.8-1.5 mm diam.; margin granulose; hymenium 65-75 µm; spores 10-12.5 x 4.5-5.5 µm. On rock (rarely wood). Arctic; California.
C. coralliza (Nyl.) H. Magn.

6. Thallus not coralloid. 7

7. Thallus finely granulose or soorediate. (see Group III).

7. Thallus coarsely granular-squamulose or verrucose-areolate. 8

8. Apothecia rare. Thallus usually ca. 1-3 cm wide, often breaking into cushions, composed of thick, granular-warty aggregations (presumably areolate in v. areolata, which I haven't seen a description of), yellow to very weakly reddish tinted yellow, consisting of subunits 0.1-0.3 mm across. Apothecia ca. 0.5-1 mm diam.; hymenium 65-75 µm; spores 9-15 x 4.5-5.5 µm. Over mosses, plant remains and soil, in fissures and depressions of rock, also on old wood on manured sites. [Description based on species as a whole]. C. kuusamoensis Räsänen v. areolata Hakul.

8. Apothecia usually abundant. Thallus granules to 0.2 mm broad but frequently flattened and forming masses to 5 mm broad, in groups, lemon yellow to yolk yellow, mustard yellow to brown yellow, ± olive-greenish in shade, matt. Apothecia usually common, often crowded, to 1.5 mm diam., sessile, plane to subconvex; margins entire or becoming granular-soorediate, flexuose, crenulate, or disappearing; hymenium 60-90 µm; epithecium granulose, yellow, olivaceous or brownish; paraphyses simple, non-capitate, non-septate, 2-3 µm broad; asci saccate; spores 12-30 per ascus, oblong to ellipsoid, slightly curved, apices rounded, 9-15 x 4.5-6.5 µm. Ch.: calycin and pulvinic dilactone. Pycnidia frequent, 80-100 µm; pycnosporos 2.5-3 x 1-1.5 µm, bacilliform. On acidic or ultramafic rock, less often bark, wood, soil, decaying plants, iron or stained glass, nitrophilous, widely distributed in N. America, very common. In the Rocky Mountains it occurs primarily at high altitudes on igneous rocks, but the species also occurs in Pacific coastal regions. [If growing on wood = var. assericola Räsänen]. C. vitellina (Hoffm.) Müll. Arg.

III. Thallus \pm sorediate or granular, usually sterile.

1. Thallus usually ca. 1-3 cm wide, often breaking into cushions, composed of thick, granular-warty aggregations (presumably areolate in v. areolata, which I haven't seen a description of), yellow to very weakly reddish tinted yellow, consisting of subunits 0.1-0.3 mm across. Apothecia rare, ca. 0.5-1 mm diam.; hymenium 65-75 μ m; spores 12 or more per ascus, 9-15 x 4.5-5.5 μ m. Over mosses, plant remains and soil, in fissures and depressions of rock, also on old wood on manured sites. C. kuusamoensis Räsänen v. areolata Hakul.

1. Thallus at least partly powdery-sorediate or finely granular. 2

2. On rock. Thallus of scattered to aggregated, roundish to elongate, 0.1-0.4 mm wide, unevenly pitted granules, yolk yellow, matt, sometimes forming thick, rimose patches, with 1-2 mm wide groups of areoles. [If thallus \pm squamulose, see C. vitellina]. (C. dispersa)

2. On other substrates. 3

3. On bark or wood (if occasional tiny lobes present, see Candelaria concolor var. effusa, which has simple, elliptical spores). 4

3. On moss. Granules coarse, entirely corticate. In sagebrush areas, Pacific NW. (This may be C. kuusamoensis). C. cf. terrigena

4. Granules 0.02-0.15 mm, mostly ecorticate. Thallus consisting of scattered small areoles and verrucae, breaking into fine soredia; soredia often making up most or even all of thallus. Spores 32 per ascus; otherwise similar to C. reflexa. On bark. Great Lakes area, SE Canada, probably elsewhere. C. efflorescens R. C. Harris & W. R. Buck

4. Granules coarser, entirely or mostly corticate. 5

5. Granules forming a thin to thick, continuous, uniform crust, (0.1-)0.3-0.6 mm, entirely corticate, lemon yellow to yolk yellow, farinose-leprose or minutely granular or dissolving into soredia, often widely dispersed. Apothecia rare, adnate between granules, to 0.8 mm diam., plane to slightly convex; margin thin and entire to becoming leprose, concolorous with thallus; epithecium granulose, yellow to orange yellow; hymenium 65-75 μ m; paraphyses slender, only partially slightly capitate, lax, rarely branched; asci saccate; spores mostly 16 per ascus, 9-15 x 4-5 μ m. Ch.: calycin and pulvinic dilactone. On humus or bases of broad-leaved shrubs, or old wood, arctic-boreal to temperate. C. xanthostigma (Ach.) Lettau

5. Granules dispersed, yolk yellow. Apothecia common but dispersed, to 0.4 mm broad, convex to subglobose; spores numerous, 9-12 x 4-5 μ m. On

bark, or sometimes wood or humus. Arctic-boreal. (see C. lutella)

Literature

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