1. Thallus sterile, thick areolate to verrucose, often dispersed. 2

2. Thallus cortex or medulla K+ yellow, P+ orange (stictic acid) and either C+ red (gyrophoric acid) or C; cephalodia usually with Stigonema. .....Amygdalaria subdissentiens

2. Thallus cortex and sometimes medulla K, P, C+ red (gyrophoric acid), or C and KC+ pinkorange (confluentic acid). 3

3. Thallus bullate areolate, eroding into granular soredia at least in part; cephalodia large, hemispherical, pink, containing Gloeocapsa; medulla C+ red, or rarely C. .....Amygdalaria panaeola

3. Thallus esorediate, usually with flat areoles, becoming rimoseareolate, but sometimes with rounded areoles; cephalodia brown, disklike to rounded, containing Stigonema; medulla C+ red. .....Amygdalaria pelobotryon

Thallus to 6 cm diam., often smaller and coalescing, ± crustose at the center with radiating, closely contiguous, apparently pleated, convex marginal lobes, glaucousgraywhite, sometimes becoming darker, more verruculose and ± cracked and areolate towards the center; lobes 0.51 mm wide, wider at margins, matt, densely whitepruinose, sorediate. Soralia scattered, coalescing to form erose patches, mainly laminal; soredia white or concolorous, granular, ± farinose. Thallus P, K± yellow, KC, UV+ dull orange or UV, containing atranorin, chloratranorin, diploicin and a xanthone. On calcareous (or siliceous?) rocks and walls in mainly dry, often ± sheltered, nutrientenriched habitats, also on bird perch rocks in the xeric supralittoral. Southwestern. ..... Diploicia canescens

Cortex C+ red or pink (erythrin and lecanoric acid); roccellic acid absent. Medulla white, at least close to the substrate consisting of loose hyphae. Thallus less than 1 mm thick, nonlobate, not soft, tightly attached, usually whitegreen or creamy white, glabrous or only moderately pruinose, not strongly cretaceous, appearing well developed and "healthy". Individuals growing together in a mosaic pattern usually forming large uniform societies. Free prothallus thin, whitebrown to dark brown. Cortical hyphae anticlinally arranged. Thallus sorediate. 2

2. Meduula C. Thallus to 0.5 mm thick, whitegreen, seldom whiteyellow, smooth and pruinose, more or less areolate or even bullate. Medulla often dirty white. Cortex 1050 um thick. Unknown substance B absent. On rock. ..... Dirina paradoxa f. sorediata

2. Medulla C+ pink or red. Thallus to 1 mm thick, areolaterimose, nonlobate, creamy white or whitegray. Medulla white. Cortex 3565 um thick. Unknown substance B present. Soralia slightly pruinose, often globose or capitate. On rock. ..... Dirina catalinaria f. sorediata

Sorediate, pustulate, or isidiatepustulate; soredia coarsegranular or finefarinose, sometimes at tips of isidia. 6

6. Soralia developed at tips of thick erect isidial growths, craterform. Hypothecium lensshaped. ..... Dirinaria confusa v. saxicola

6. Soralia developed on thallus surface (not elevated on isidia), globose capitate or forming craterform verrucae. Upper cortex C. Lower side with well developed cortex. Thallus generally coriaceaous. Medulla white (to yellowish, but not red). With divaricatic acid. Soralia globose capitate, soredia finefarinose. Hypothecium more than 120 um thick at center. 8

8. Lobes to 0.5 mm wide, discrete, adglutinated to substrate, tips bluish; thallus soft, fragile, nonplicate. On rock. ..... Dirinaria frostii

8. Lobes 0.51(2) mm wide; thallus coriaceous. Discs black. Divaricatic acid. Lobes subdichotomously, dichotomously or irregularly divided, confluent form the peripheral region of thallus, often convex; tips generally flabellate; thallus generally longitunally rugoseplicate.
Substrate? ..... Dirinaria applanata

Haematomma

After Culberson (1963), Brodo & Culberson (1986), and others

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1. Thallus P+ orange, K+ yellow, (thamnolic acid). Thallus sorediate, pustulatesorediate, or isidioid. Prothallus absent. Usually on bark or wood. ..... Loxospora

1. Thallus P, K+ yellow or K, without thamnolic acid. Thallus with fine soredia. Prothallus often present. 3

3. Thallus soft, leprose or farinose, often widespreading, composed of fine soredia, whitish to pinkish gray, K+ yellow, P+ pale yellowish; with atranorin, porphyrilic acid and zeorin, usually delimited by a white, cottony prothallus. (if thallus pale yellowgreen or yellow=gray, with usnic acid, = var. ochroleucum). Pycnidia sometimes pressent, immersed but upper part scarlet (K+ magenta); conidia 1220 x 0.50.7 um, curvedfiliform. On rock (acid or slightly calcareous), on relatively dry, vertical surfaces, rarely on bark. ..... Haematomma ochroleucum var. porphyrium

3. Thallus at least in younger parts, with delimited soralia; margins usually esorediate; thallus, medulla and soralia P, K, KC, UV+ white (perlatolic acid); prothallus smooth, bluegray. Thallus pale gray and rather scabrid, with scattered areoles on a smooth bluegray prothallus; soralia numerous, efflorescent, discrete, 0.21 mm diam., or often confluent, whitish to bluish gray; soredia 3080(100) um diam.; external hyphae often bluegray, N+ red. Usuall on bark, rarely on shaded acid rocks (vertical surfaces). ..... (Mycoblastus caesium)

1. Thallus of puverulent spherical granules (ca. 0.1 mm diam.), without marginal lobes; when well developed producing a thick, areolate crust; color greenish yellow or dull orangeyellow, brownish to grayish yellow. On limestone cliffs and other dry, shaded, calcareous rocks, often overgrowing mosses, occasionally on mortar of shaded walls. ..... Leproplaca chrysodeta
1. Thallus ± plane, or rarely of convex granules, ± orbicular, with a pulverulent surface, when well developed delimited by ± distinct, radiating, flat to slightly convex, noncorticate marginal lobes; color yellow; medulla white, often exposed in places. On damp limestone cliffs and limestone walls. (Caloplaca citrina, which is partly corticate, rather bright yellow or orange, and sometimes fertile, will also key out here; it grows on smooth, illuminated ± calcareous or basic surfaces). ..... Leproplaca xantholyta

1. Thallus sorediate, pustulatesorediate, or isidioid; apothecia absent or rare. Thallus at least in younger parts, with delimited soralia; margins usually esorediate; prothallus absent or, if present, then not white and cottony; soredia often granular or subisidiate, or arising from pustules, or fine and completely covering thallus. Usually on bark, rarely on rock. (If thallus P or P+ yellow, without thamnolic acid, see Haematomma). 2

2. Thallus isidioid. Substrate? Queen Charlotte Islands, British Columbia. ..... Loxospora sp. Brodo ined.
2. Thallus verrucose, pustulate; pustules often forming erect plates or columns by the disintegration of the pustule summits, leaving the vertical portions of the walls intact, but sometimes breaking down into coarse granular soredia. With elatinic acid as a rare accessory. Primarily in the eastern United States. Substrate? ..... Loxospora pustulata

Thallus ± endolthic, on pure limestone or dolomite. Thallus inconspicuous, when partly superficial appearing as a pale orange stain, greenish gray in herbarium, sometimes scurfy, effuse, not delimited. Moist areas, high elevation. .....Sagiolechia protuberans

3A1 On rock;
Thallus well developed, yellow to red, K+ red or purple; nonlobed; isidiate or sorediate;
C. citrina Group

1. Thallus densely isidiate. [Check thallus color; it may be grayish instead of yellow to red!]. 2
1. Thallus sorediate, yellow to orange. (If areoles 0.5 mm diam., flat, not lobed, and soredia on most of the margins, growing in Utah, see C. sp. 94 of Wetmore). 4

2. Growing in Texas. .....C. subnitida
2. Growing in Baja California or Arizona. 3

3. Isidia granular globose. Thallus with small lobes. Baja California. ..... C. sp. 29 (Wetmore)
3. Isidia cylindrical. Thallus areolate. Arizona. ..... C. sp. 30 (Wetmore)

4a. Thallus tan at margin, becoming dark gray in center; soredia dark gray. On noncalcareous rock, Michigan. ..... Caloplaca sp. 4 (Harris)
4a. Thallus yellow or orange, K+. 4

4. Thallus orange to brownish orange, areolate; areoles contiguous or ± scattered, to 0.3 mm wide, often elongateirregular and somewhat sparingly branched, very closely adpressed, flat to ± convex; prothallus sometimes present, pale, occasionally fimbriate. Soralia few and scattered to numerous and ± continuous, ± punctate or irregular in shape; soredia smallgranular. On ± basic to acidic, ± deeply shaded rocks, chiefly on cliffs. ..... C. obliterans
4. Thallus mostly greenish yellow to yelloworange (to occasionally bright orange in C. citrina). 5

5. Prothallus mostly present and prominent yellow; areoles ± convex, incised at base; granules often present, coarse; soredia 3646.8 um diam., concolorous with thallus. Growing in mesic supralittoral or upper supralittoral fringe zone on the seashore. Thallus 13 cm across, sometimes coalescing, consisting of scattered to clustered areoles, crenate lobes or squamules, verruculose, coarsely granular or sorediate, occasionally slightly cracked to crackedareolate; areoles 0.050.4 mm wide; lobes 0.20.6 mm long, 0.10.4 mm thick, convex and mostly incised at base. Soralia usually common, discrete to continuous, first

appearing at edge of areoles or lobes. On acidic, calcareous or ultramafic rocks, occasionally on driftwood, usually on sunexposed, horizontal or somewhat sloping surface, occasioanlly on vertical or more protedcted parts, Southern Alaska to northern California. [= Caloplaca sp. 3 of Ryan, 1988). ..... C. flavogranulosa Arup.

5. Prothallus very rare, scanty, gray; areoles slightly convexto plane, not incised; granules absent; soredia 24.434.4 um diam., concolorous with thallus or lighter and often more intense than thallus. Growing inland, or occasionally in xeric supralittoral on the seashore. Thallus becoming completely sorediate or a somewhat areolate crust, yellowish green to yellow or yelloworange or bright orange; of very small, subsquamulose areoles or minutely scattered or continuously granular or + immeresed in substrate and inconspicuous, diffuse. Soredia diffuse, not in discrete soralia, thin to thick, when thick browkne up into irregular coarse areoles, usually yellow but soemtimes orange, yellowish gray in shade, farinose. Chem.: emodin, paritein, xanthorin, fallacinal. Often on calcareous substrates (limestone, mortar, etc.), usually in sunny situations, at times overgrowing mosses and dead plants; occasionally on acidic or ultramafic rocks. Widespread throughout much of N. America, at least in the north and west, S to S. Carolina in the east. (if thallus completely sorediate, also see Leproplaca) .....C. citrina

II. ON ROCK.

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1. Thallus lobed or radiatingplicate at margin. Thallus sometimes K+ red (norstictic acid). Spores and spermatia various. 2

1. Thallus immersed or crustose, at most areolate to verrucose or subsquamulose, without distinctly swollen areoles. Thallus K or K+ yellow, but not K+ red (norstictic acid lacking). 3

2. Lobes very distinct, elongated, very narrow (mostly to ca. 0.5 mm or less), graybrown; soredia or isidioid granules often present. Thallus with pseudoparenchymatous true cortex. .....(Hyperphyscia)

2. Lobes indistinct or short; thallus radiateplicate at margin, rimose to areolate in center, greenish yellow, white, or graybrown, without soredia or granules. Usually fertile. .....Dimelaena

Thallus lobed at margin. Cortical cells very small (1 um), indistinct. Medulla opaque. Upper surface of areoles pale yellow. Lobes 1.0 mm long. Thallus 0.51 cm across. Cortex 3550 um. Lobes contiguous, 1 mm long, 0.50.75 mm wide, plane or slightly convex, matt, smooth, ca. 0.2 mm thick; central areoles contiguous, anuglar, separated by thin cracks, 0.30.4 mm thick, the fertile ones ± slightly verrucose, broadly attached; lower surface pale. Medulla opaque. On granitic rock, Texas. ..... Acarospora texana
Thallus areolatesquamulose, not lobed. 2

2. Cortical cell lumina 34 um diam. Thallus areolate, apparently indeterminate (margin not observed); areoles squamulelike, usually distinctly peltate, contiguous to imbricate, confluent, 13 mm broad, 0.71.5 mm thick, on the whole plane or slightly convex though very uneven and ± verruculose from numerous pycnidia; upper surface somewhat dark greenish yellow, matt; margins often free, especially in the ± panniform areoles; lower surface pale. Upper cortex very uneven in thickness (varying from specimen to specimen). Upper cortex 70100 um thick. Hymenium (110)120135 um. Medulla filled with granules. Pycnospores narrowly ellipsoid, 22.5 x 0.81 um. Upper surface epruinose. On granitic or volcanic rocks. California, Colorado. ..... Acarospora evoluta
2. Not as above. Upper surface of thallus epruinose. 3

3. Areoles peltate, often large, thick or thin. (if thallus pruinose, see A. chrysops). Areoles dispersed, very large, 12(3) mm wide, 0.40.5 mm thick (to 0.7 mm thick at center), very irregular in shape, the fre margin thinner, ± depressed toward the rock; attached by a usually rootlike umbilicus 0.20.3 mm long. Upper side epruinose, with simple or crossing cracks which often do not reach the edge, parly with dense punctiform impressions in connection with the cracks, probably indicating pycnidia or apothecial initials. Thallus K, C, P. Cortex 5070 um; cells ca. 3 um diam. On hard, probably siliceous, rock. Arizona. ..... Acarospora radicata
3. Areoles not peltate, small, mostly thin., dispersed to contiguous, not imbricate. (If thallus pruinose, see A. rimulosa, A. albida and A. subalbida). Areoles contiguous. Upper surface dark greenish yellow, uniformly colored. Areoles 0.40.7(1) mm across, 0.30.6 mm thick, plane or subconcave, broadly attached. Cortex 3550 um thick, with distinct epinecral layer; cells 2.53 um. Upper surface epruinose. Similar to A. chrysops but areoles contiguous, small, thin. Pycnospores ellipsoid, 2 x 0.6 um. On

volcanic rock. Mexico. (including v. invadens Magn., from Kansas, Texas and Mexico, with areoles thick, intense citrine yellow, contgiuous or often subdispersed, invading other lichens, surface smooth, subconmvex. ..... Acarospora subcontigua

1. Isidia present (do not confuse with verruculose pycnidia), Isidia terete, simple, 0.1 mm diam., subglobose, often crowded centrally; soredia absent. Thallus forming ± orbicular and often confluent patches, to 6 cm diam.; marginal lobes closely attached, flattened, simple or irregularly branched, usually richly divided and markedly crenulate, discrete, separated by narrow cracks, with rounded or subcrenulate ends; surface creamy or whitish to pale olivebrown, matt, erpuinose; centrally cracked or indistinctly areolate, pittedpunctate with minute pocklike depressions resulting from abrasion of isidia. Cephalodia sessile, scattered, flattenedd orbicular or depressed convex, 0.85.0 mm diam., radially folded and wrinkled or cracked, yellowish brown or pinkish, matt. Pycnidia immersed, forming minute swellings with punctiform brownish ostioles; pycnospores filiform, slihgly curved, 2129 x 0.5 mm. Cortex K+ yellowish, C+ rose; medulla K+ yellow (faint), C+ rose, P. On rocks, rarely on sandy soil. ..... Placopsis cribellans

1. Isidia absent; soredia present or absent. Thallus center distinctly rimoseareolate, ± smooth, not verrucose or rugoseverruculose. 2

2. Thallus effuse, indeterminate, without any trace of marginal effiguration, thin (up to 0.2 mm thick); areoles contiguous or dispersed; ..... Placopsis effusa

2. Thallus effigurate, lobate, determinate. Soredia often present, scattered over the center and granulose; soralia rounded or radially elongate, eroded or plane, often irregularly confluent. Thallus forming rosettes which become confluent into large patches to 8 cm diam.; marginal lobes closely to ± loosely attached, contiguous, separated by cracks to 0.1 mm wide, to 2.5 mm long (or extending to center of thallus), 1.6 mm broad; apices uneven, rounded or crenulate, sometimes with a narrow, olivebrownish peripheral zone; thallus center becoming areolate; areoles irregularly angular, 0.62 mm across, ± swollen or plane; surface cream or ivory colored or glaucous, often olivebrownish tinged, smooth, matt, not pruinose; cephalodia single in center of small thalli, scattered in older thalli, discrete, 13(8) mm diam., orbicular, radiately folded and cracked, yellow brown or reddish brown, matt. Cortex Kor K+ yellowish, C+ rose; medulla K, C+ red, KC+ red, P+ red or P. Thallus containing gyrophoric acid. Pycnidia immersed in slight swellings, ostioles brownblack, 0.1 mm diam; pycnospores filiform, straight or curved, 1527 x 0.5 mm. Rather variable. On rocks (siliceous), occasionally on mosses or sandy soil, arctic to temperate, south to the White Mountains in the east and to California in the west; very common, at least in montane areas on the west side of the

Cascades. ..... Placopsis gelida

Thallus ± yellow (uv+++ yellow, with rhizocarpic acid).

1. Medulla I or at most faintly bluish. 2

2. Medulla white to yellowish white, K+ red (norstictic) or K+ yellow (stictic). Thallus often fairly large, on black hypothallus, contiguous but usually separated by strips of hypothallus, or sometimes dispersed (ssp. boreale); areoles usually 0.51.5 mm diam. (to 2.5 mm in ssp. splendidum; to 36 mm according to Thomson), slightly concave to convex, angular, yellowish white to pure yellow (ssp. superficiale and boreale), or greenish yellow to brownish yellow (ssp. splendidum), matt or glossy to scabrous; surface coarsely verrucose at least when old (ssp. superficiale) or smooth (other ssp.); marginal areoles sometimes subradiate; areole margins sometimes slightly crenate. On exposed rocks, usually very hard, acidic. Arcticalpine, south to New Hampshire in the east and Colorado and California in the west. The K+ red strain was recognized by Thomson as R. crystalligerum. .....Rhizocarpon superficiale
2. Medulla (in N. American species) K. Thallus often smaller 3

Thallus margins not effigurate. Thallus parasitic, exclusively on Sporostatia spp., forming roundish islands to 1 cm broad; prothallus indistinct; areoles close together, 0.20.6 mm broad, flat to convex, angular or roundedangular, whitish yellow to usually bright yellow, matt, smooth to slightly farinose. Prothallus developed only where parts of the thallus margin touch the rock. Thallus C (without gyrophoric), P+ yellow (psoromic acid). On hard, noncalacareous rock in exposed places, alpine. Alaska, Yukon. Perhaps a synonym of R. effiguratum. ..... Rhizocarpon pusillum

6a Medulla K, P+ yellow (psoromic), C or sometimes C+ rose (traces of gyrophoric). Thallus often large and widespreading, to more than 10 cm diam.; black hypothallus well developed; areoles to 1.5(3) mm diam., to 1.5 mm thick, bright yellowgreen, matt, usually crowded together, sometimes contiguous to widely scattered, usually secondarily cracked, round to angular or irregular, flat to moderately convex, smooth to rarely minutely scabrid, usually greenish yellow to whitish yellow. Morphology quite variable. On siliceous rocks in exposed situations (e.g., boulder fields), especially places with persistent snow cover, on level to sloping surfaces. Pacific NW, and New England. ..... Rhizocarpon alpicola

7b Thallus to 5 cm wide but often smaller and sparsely developed, on black hypothallus, dispersed; areoles to 1 mm, angular to rounded, usually slightly convex, whitish yellow to grayish yellow and often with a whitish pruina, rarely bluish green, matt. Usually K+, P+, sometimes with accessory psoromic or gyrophoric acids, rarely K. Mainly on basic rocks, arctic. ..... Rhizocarpon inarense

Hypothallus (in N. American spp.) indistinct or completely lacking. Hypothecium brown, K. Areoles 0.31.2 mm wide. Predominantly species of dry, temperate to warm climates. 2

2a At least young thalli parasitic on Aspicilia or Lecidea. Medulla K, P (unknown fatty acids), or rarely K+ yellow, P+ orange (stictic), rarely C+ rose (gyrophoric acid). Hypothallus indistinct. Thallus to 2 cm diam., or sometimes much larger; areoles to 0.31(1.2) mm diam., greenish yellow, matt, contiguous, flat to strongly convex, smooth, roundish to angular with irregularly crenate margins. Highly variable. On acidic to moderately basic basalts. California. ..... Rhizocarpon viridiatrum

2b Not parasitic. Hypothallus distinct or not. Medulla K+ red, P. On basalt, especially in dry, lowland sagebrushdominated areas, at least in the Pacific NW. ..... Rhizocarpon cookeanum

Medulla I+ blue.

3a Areoles scattered on a dark prothallus. Medulla I+ blue, P. Areoles 0.10.4 mm diam. Parasitic on Tremolecia atrata. ..... Rhizocarpon parvum
3b Areoles contiguous to crowded. Prothallus absent or only slightly developed at thallus margin. 4

4a Thallus of small (usually 0.20.5 cm diam.) dispersed groups of small (0.30.7 mm), usually strongly convex, bright yellow areoles. Prothallus lacking. Medulla I+ blue, P+ yellow (psoromic acid) or P. On slightly calcareous or often heavymetal containing siliceous rock in places where there is little competion, especially on windswept ridges, arcticalpine. ..... Rhizocarpon norvegicum
4b Thallus continuous; larger or parasitic. P+ yellow (psoromic acid). 5

5b Medulla usually I+ blueviolet. Thallus margins often effigurate. Thallus not parasitic, or parasitic on lobate yellow Acarospora spp., usually ca. 12 cm diam.; areoles at margin usually elongate and radiate, commonly surrounded by blakc prothallus; areoles 0.30.8 mm diam., flat to strongly convex. Thallus usually C+ rose (gyrophoric acid). On steep, exposed slopes of very hard rock, alpine. California, Colorado, Montana, Wyoming. ..... Rhizocarpon effiguratum

6b Medulla usually K+ red (norstictic). Paraphyses clavate. Spores occasionally multicellular. 7

7a Medulla I+ intense blueviolet or sometimes I in part. Thallus ± large and extensive, on distinct black hypothallus, scattered or grouped; areoles to 1.5 mm diam., angular or rounded, slightly or very convex, whitish yellow or sometimes yellow or orange yellow, farinose to smooth. Medulla rarely K, P+ yellow (psoromic acid) or K, P (bourgeanic acid). Thallus highly variable. An acidic or often slightly basic rocks, mostly on steep surfaces, arcticalpine, Alsaska, NW Territories, Maine. ..... Rhizocarpon eupetraeoides

4. Hypothallus thin, black or lacking; areoles green or yellow; thallus small (ca. 0.52 cm). Areoles contiguous to dispersed or usually clustered in groups, to 0.7 mm, irregularly angular, ± convex, bright yellow to greenish yellow, matt or glossy. Medulla K, P, I (according to Thomson, and according to Poelt) or sometimes P+ yellow, with psoromic acid (according to Purvis, et

al.). On calcareous rocks (according to Thomson) or on exposed siliceous rocks (slightly calcareous or at least mineralrich), when young sometimes parasitic on thalli of a wide variety of crustose lichens (e.g., Bellmerea), arcticalpine, in open plant communities on windswept sites.
Alaska. ..... Rhizocarponintermediellum

4. Hypothallus often thick, whitish or grayish; areoles whitish yellow; thallus usually large. Areoles to ca. 1.5 mm daim., often divided. It is doubtful whether the following division into taxa is warranted. 5

5. Thallus P, very thin, whitish to whitish yellow. Prothallus grayish. Medulla K. ..... Rhizocarpon atroflavescens ssp. atroflavescens

5. Thallus P+ yellow or P, thickish, whitish yellow, often pruinose. Prothallus whitish. On calcareous rocks, alpine. ..... Rhizocarpon atroflavescens ssp. pulverulentum (Schaerer) Runem.

6. Areoles mostly rounded, rarely angular. On siliceous rocks. 7

6. Areoles mostly angular. 8

7. Medulla K+ yellow, P+ reddish orange (stictic, often in low concentration). Areoles usually contiguous. Thallus to 4 cm diam., or merging to form extensive cover; hypothallus + distinct, black; areoles to 1.2(1.5) mm diam., bright yellow to greenish yellow, matt, mostly distinctly convex. In the open on upper surfaces of rock outcrops and boulders that are often impregnated with dust, often on rocks with considerable iron content. Arctic, and (according to Fink) "Throughout northern United States, and southward in the mountains". Common at least in parts of the western U.S., south to northern California. ..... Rhizocarpon lecanorinum

7. Medulla K, P+ yellow (psoromic). Areoles often dispersed. Thallus pale yellow, mostly small. On slightly calcareous or mineralrich shales in competitionpoor pioneer vegetation in places exposed to the wind. Alpine. ..... Rhizocarpon ferax

9. Areoles 0.51.2 mm wide, thin, light yellow or grayish or greenish yellow, not pruinose, angular to orbicular, contiguous to scattered; hypothallus often visible between the areoles, not prinose. Four chemotypes: 1) barbatic acid, 2) psoromic acid, 3) stictic acid, 4) no medullary substances. On open, often dustimpregnated acidic boulders, lowlands in arcticboreal areas,

alpine in temperate areas. 10
9. Areoles usually 12 mm wide, thickish, bright yellow, usually faintly to distinctly pruinose, mainly angular and contiguous; hypothallus usually visible only at the periphery, ± pruinose. Areoles flat to very convex. Medulla K, P+ yellow (psoromic acid), rarely P. On ± calciferous rocks, montane in arcticboreal areas. ..... Rhizocarpon sublucidum (= R. saananse according to Timdal, 1988)

10. Thallus ± greyish or greenish, usually rather large. Medulla K+ yellow, P+ red (stictic acid) or P (barbatic), rarely P+ (psoromic). Areoles thickish, not subdivided or barely so, to ca. 1.5 mm diam. On large, dustimpregnatedboulders and outcrops. ..... Rhizocarpon sphaerosporum (= R. macrosporum according to Timdal, 1988)
10. Thallus pale to bright yellow, usually small. Medulla P+ yellow (psoromic) or P, rarely P+ brownish red (stictic). ..... Rhizocarpon macrosporum s. str.

Thallus to 15 cm diam.; hypothallus usually well developed, black; areoles 0.21.8(2.5) mm wide, bright yellow green or more rarely greenish, grayish, or orangeyellow, matt or shiny, usually contiguous, ± angular, flat to convex or rarely slightly concave, usually smooth. Medulla I+ blue. Medulla P or P± orangeyellow, K, c or C± red, containing either psoromic or barbatic acids, sometimes also ± gyrophoric acid. Extremely common and variable; still poorly understood.

1. Thallus grayish green to greenish yellow (to bright yellow?), smooth, matt; areoles nearly continuous, angular or irregular, subdivided or not, flat; black hypothallus at margins, sometimes between areoles. Medulla P+ yellow (psoromic acid) or P. On acid rocks, arcticalpine, south to New York, New Hampshire, South Dakota, Arizona and California. R. riparium s. lato. (Lumped by Purvis, et al. under R. geographicum). 2
1. Thallus usually large, bright yellow or ± greenish yellow, rarely grayish yellow, smooth, matt or glossy; areoles contiguous or dispersed, ± angular, flat to convex, strongly subdivided or not; black hypothallus present and sometimes conspicuous. Medulla K, P+ yellow (psoromic acid). On acid or calcareous rocks. Arcticalpine, south to New Hampshire, New York, Minnesota, Colorado, and California. None of the infraspecific taxa described below (other than by implication the typical one) are listed by Egan, but several probably do occur in N. America. R. geographicum ± s. str. 3

2. Areoles strongly subdivided. Medulla K, P+ yellow (psoromic acid) or seldom P; C. ..... Rhizocarpon riparium ssp. riparium

2. Areoles not strongly subdivided, flat, angular. Medulla K, P (barbatic acid) or P+ yellow (psoromic acid), rarely C+ rose (gyrophoric acid). ..... Rhizocarpon riparium ssp. lindsayanum

3. Areoles 0.40.9 mm diam., angular, flat to convex, thick. On exposed outcrops and boulders, and in snowfields. ..... Rhizocarpon geographicum ssp. diabasicum (Rsnen) Poelt & Vezda in Hawksworth, James & Coppins

Areoles strongly subdivided. 5

Apothecia angular. Areoles not strongly subdivided. 6

5. Areoles yellow to greenish, 0.40.9 mm diam., closely pakced. ..... Rhizocarpon geographicum ssp. prospectans (Rsnen) D. Hawksw. & Sowter

5. Areoles whitish yellow, 0.41 mm diam., close together or often dispersed on black hypothallus. ..... Rhizocarpon geographicum ssp. arcticum (Runem.) Hertel

6. Areoles about as thick as wide, usually bright yellow, + shiny. On boulders and outcrops above tree limit, arcticalpine. ..... Rhizocarpon geographicum ssp. frigidum (Rsnen) Hertel

6. Areoles usually much wider than thick. Areoles ca. 0.40.8 mm diam., often somewhat subdivided. Arcticalpine to temperate and montane. ..... Rhizocarpon geographicum ssp. geographicum

Thallus with cephalodia. Thallus with pink to brown tones (reddish brown, light orange, gryaish reddish orange or yellowish pink to dark reddish gray), rimosearoelate, continuous, sometimes smooth at edges; prothallus bansent or black and conspicuous. Cephalodia cushion or diskshaped, greenish brown when wet and black or dark brown when dry, containing Stigonema. Medulla K+ yellow, P+ orange, C, I, containing stictic acid and almost always menegazzic acid in varying concnetrations. On siliceous rocks, close to shore on bluffs, and in alpine zone, British Columbia; Alaska. ..... Rhizocarpon hensseniae

1. With Isidia. 2
Without isidia; with soredia (or apparently so). Medulla never C+ red or KC+ red. 5

2. Isidia small (always less than 1 mm tall). Thallus C+ orange or red, UV+ dark red (xanthones, with or without gyrophoric acid). Thallus K, P, C+ orange, UV+ dark red, containing only xanthones (arthothelin and granulosin, in N. American material; thiophanic acid in British material). Isidia pale yellow, with a soft surface, to 0.6 mm tall; On tops of calcareous, schistose boulders. ..... Pertusaria flavocorallina Coppins & Muhr
2. Isidia large (generally more than 1 mm tall. Thallus C or C+ red (gyrophoric acid), UV, without xanthones. Isidia frequent, columnar or coralloid, but never sorediate, predominantly associated with fruit bodies. 3

3. Isidia mainly coralloid, fruit bodies absent or present, borne laterally on isidia or on nonisidial portions of the thallus; thallus gray, verrucae large (1.4(±0.6) mm wide), medulla K+ yellow becoming redbrown, P+ yellow becoming orangered (fumarprotocetraric acid), and KC± red (gyrophoric acid); substrate? ..... Pertusaria oculata
3. Isidia mainly columnar, fruit bodies always present, rarely borne other than terminally on isidia; thallus graywhite; verrucae small, ... 4

4. Thallus gray; medulla with all chemical tests negative; verrucae at times lateral on isidia;
substrate? ..... Pertusaria panyrga
4. Thallus white; medulla with at least one spot test positive; verrucae always terminal on isidia. Medulla P+ yellow becoming orangered, K+ yellow becoming redbrown (fumarprotocetraric acid). Substrate?..... Pertusaria dactylina

5. Medulla with at least one spot test positive; thallus variously colored. 6
5. Medulla with all chemical tests negative (or spot tests uncertain); thallus always gray (?). Producing no lichen substances; restricted to the (eastern) arctic. ..... Pertusaria pruinifera

6. Medulla K+ yellow becoming red, P+ yellow becoming yelloworange (norstictic acid), C, KC; saxicolous; disjunct between the Appalachian Mountains and the northwestern arctic coast; known only sterile. .....Pertusaria excludens

6. Medulla K or K+ yellowish then redbrown or violet, without norstictic acid, KC+ or KC. 7

7. Medulla KC. Thallus margin characteristically zoned; medulla K, C, P+ orangered, contains fumarprotocetraric and succinprotocetraric acids; Widespread throughout eastern temperate North America. .....Pertusaria multipunctoides

7. Medulla KC+ rose or violet. Medulla K or K+ yellow becoming redbrown, P or P+ yellow becoming orangered (± protocetraric acid), C, but always KC+ instantly roseviolet fading to wine red (picrolichenic acid), UV; widespread throughout eastern and western temperate North America. ..... (Pertusaria amara)

sorediate or finely isidiate (isidia sometimes disintegrating into soredia);

1. Thallus isidiate. Medulla C; cortex C+ red. Isidia coarse, 0.10.3 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, coralloidbranched 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. Without variolaric acid. On rocks (often sandstones) in mostly hardwood forests, 7601500 m, Applachian and Ozark regions. [Note: O. turneri, a European species apparently incorrectly reported from British Columbia, has a completely C thallus, containing variolaric acid]. ..... Ochrolechia yasudae Vainio
1. Sorediate, without isidia. 2

2. Thallus and soralia P, C+ red. Thallus thickish, coherent, wartyfissured, irregularly breaking up into granular to almost isidiatesorediate surfaces. ..... (see Ochrolechia androgyna"v. saxosum")
2. Thallus and soredia C. Rare, western Canada. ..... ("Ochrolechia sorediosa" morph of O. szatalansis)

Lepraria s. lato (including Leproloma)

I. Thallus P+ yellow, orange, or red

1. Thallus coarsely granular, with few if any projecting hyphae, pale gray, on sunny (to shaded), mossy, acid rocks or stony ground, usually on horizontal to gently sloping surfaces. 2
1. Thallus powdery; in shade, often on steep or overhanging surfaces (protected from sun and precipitation). 3

2. Thallus C+ reddish orange or C, KC+ reddish orange, P+ yellow, K+ yellow or K, containing alectorialic acid, ± atranorin. Thallus granular, firm, delimited, somewhat effigurate and growing in irregular rosettes, but without distinct lobes; granules convexglobular, ca. 0.10.2 mm diam., usually without projecting hyphae, ± separated in center but clustered at the margins; bluish to whitish gray; medulla grayish white, rarely exposed. On moss cushions or acidic rock, and on stony ground, in open, sunny locations, Arctic/alpine. (If containing porphyrilic acid and fatty acids, see Leproloma cacuminum; various other whitish or grayish sterile granular lichens are also common, but are apparently not named at present). ..... L. neglecta (Nyl.) Lettau
2. Thallus P+ orange red, K± yellow, KC± yellow. With fumarprotocetraric acid, usually + atranorin (and zeorin?not mentioned by Laundon). Thallus a mass of convex granules 0.050.2 mm diam., usually without projecting hyphae (i.e., not appearing powdery), pale gray, delimited, the granules often lighter and clustered towards the margin, sometime giving a zonate appearance, with alternating zones of dark and light greenish or bluish gray, firm (or soft?), not clearly lobed but often growing in irregular rosettes; medulla grayish white, rarely exposed. On moss cushions, lichens and cyanobacteria, or directly on rock, often on gently sloping and somewhat sunny habitats. Northeastern, and elsewhere. Resembles L. neglecta but differs chemically. ..... L. caesioalba (B. de Lesd.) Laundon (syn. L. zonata)

5. Thallus P+ yellow, KC, with porphyrilic acid and fatty acids. Thallus crustoseleprose, forming a thick, nonareolate crust of powdery to nonpowdery spherical granules to 0.4 mm diam., yellowish white to gray; surface not corticate, or eroded to leave a leprose membrane, the margin absent, diffuse, undelimited

to delimited, without lobes; medulla white; underside with a weft of loosely entangled hyphae forming the early development of a hypothallus, whitish gray. On especially acid, mossy rocks, also acid bark, soil, and other lichens.
Temperatearctic. ..... Leproloma cacuminum (Massal.) Laundon
5. Thallus P+ orange or red. 6
6. Thallus P+ redbrown, K+ yellow. Granules connected by cottony membrane, whitish. On soil, moss or rock, arctic/alpine. Not treated by Laundon,
1992. .....L. arctica
6. Thallus P+ orange or orange red. 7

7. Thallus with pannaric acid or its derivatives. 8
7. Thalllus without pannaric acid or its derivatives, often K+ yellow (atranorin). 9

8. Thallus P+ reddish orange, K, C, containing pannaric acid 6methyl ester, ± pannaric acid, rarely atranorin. Thallus forming irregular rosettes and obscurely lobed, or irregularly delimited small crusts, powdery, whitish to pale yellowish or greenish gray; surface not corticate, a mass of powdery, convex granules, which are sometimes eroded to leave a leprose margin; medulla white, exposed in places on most specimens; underside a weft of loosely entangled hyphae forming the early development of a hypothallus, whitish grya to brownish. On stone and bark, in shaded situations, espcially on nutrientrich Fraxinus and Ulmus in sheltere parks and woodlands, on bare surfaces, and bryophytes, also commonly on soil. Resembling a poorly developed morph of Leproloma membranaceum, but lobes indistinct and differing chemically. ..... Leproloma vouaxii
8. With pannaric and roccellic acids, P+ reddish orange, K+ yellow (atranorin) or K, C. Thallus soft, well delimited, forming irregular rosettes, usually rather distinctly lobed at the margin, forming small, shelflike membranous outgrowths, yellowish white; apices of lobes rounded, ± flat; surface not corticate, of numerous powdery convex granules, the margin either flat or raised, 117 mm wide, older lobes often disintegrate to poweery convex granules to 0.5 mm diame, especially at the center of the thallus, or eroded to leave a leprose membrane; medulla whitish; underside a continuous, welldeveloped weft of branched hyphae forming a hypothallus, whitish gray to brownish. Young specimens with rounded powdery squamules with a rolled edge at the margin, recalling Normandina. Apothecia very rare, to 2 mm diam., the sorediate thalline exciple 0.5 mm thick. Usually on shaded, steep, mossy, acidic rock faces or walls, on the surface

and over mosses, occasionally on mosses on shaded tree trunks, especially Quercus. .....Leproloma membranaceum

9. Thallus KC+ reddish orange, K+ yellow or K, P+ orange, with protocetraric and alectorialic acids. Thallus of a mass of powdery spherical granules to 0.2 mm diam., with projecting hyphae, when well developed forming a thick powdery crust, bright whitish gray with a greenish or yellowish tinge, diffuse, without marginal lobes; medulla white. On bricks, mortar and mosses of brick walls in slight shade, rock crevices and tree trunks. ..... L. eburnea Laundon9. Thallus KC, without alectorialic acid, K± yellow, P+ orange. With protocetraric or fumarprotocetraric acid, stictic acid, or thamnolic acid. 10

10. Thallus granular (rarely powdery), often zonate, with alternating zones of dark and light greenish or bluish gray. Soft or firm, usually not clearly lobed. Directly on rock, often on gently sloping and somewhat sunny habitats. K± yellow, with fumarprotocetraric acid, + or atranorin. Northeastern (and elsewhere?). ..... (see L. caesioalba)
10. Thallus powdery, not zonate. 11

11. Thallus K, P+ orangered, with protocetraric or fumarprotocetraric acid, and rangiformic or roccellic acids as uncommon accessories. Thallus froming an uneven noncortciate membrane on which occur powdery convex granules to 0.4 mm diam., with projecting hyphae, when well developed producing an extensive, thickish, powdery, folded crust, delimited, with the margins almost lobelike; color white to pale gray, sometimes with a bluish gray tinge. On bare rock and over mosses and lichens on shaded limestone, often dominant, also on siliceous coastal rocks. ..... L. nivalis Laundon
11. Thallus K+ yellow, P+ orange, with stictic or thamnolic acid. 12

12. Thallus with atranorin, stictic ± constictic acid, and zeorin. Thallus of a mass of powdery convex granules of variable shape and size, to 0.5 mm diam., with projecting hyphae which sometimes form a weft on the surface, or the granules becoming eroded to leave a leprose membrane; usually forming a thick powdery crust, bright greenish gray to whitish gray, the latter color especially when eroded; usually diffuse, without marginal lobes but in eroded specimens the medulla often develops into

delimited sublobes; medulla white. On shaded bark and on shaded acidic and calcareous rock, directly on the surface and especially over mosses; also on shaded earth. ..... L. lobificans Nyl. (L. sp. of Brodo, Long Island, also keys out here)

12. Thallus with thamnolic acid, often dull green. ..... L. umbricola Tonsb.

ADD:

Thallus KC+ red, with fumarpotocetraric acid and zeorin, + or alectorialic acid, + or atranorin, soft and powdery or firm and granular, zonate. Directly on rock, in shaded to somewhat sunny habitats, northeastern. ..... L. zonata sensu ? (lumped by Laundon under L. caesioalba)

II. Thallus P (at most P+ pale yellowish)

1. Thallus bright greenish yellow or orangish yellow. .....
(see Chrysothrix if K, Leproplaca if K+ purple)
1. Thallus not bright yellow, at most pale yellow. 2

2. Thallus coarsely granular, often zonate, K± yellow, C. With either rangiformic or roccellic acids, ± atranorin [If containing porphyrilic acid, see Leproloma cacuminum]. Often growing on rather sunny, mossy, acidic rocks. ..... (see L. caesioalba)
2. Thallus finely granular or powdery soft or firm, not zonate growing in shade. 3

3. Thallus C+ red, K, P, KC+ yellow; thick, pale green with white prothallus, fine, soft. On dry overhangs, Western Washington. .....L. sp.
3. Thallus C. 4

4. Thallus ± yellow, KC+ yellow (usnic acid). 5. Without pannaric acid. K+ yellow (atranorin), KC+ yellow (usnic acid). Friable in consistency. With fatty acids (roccellic, hydroxyrocellic) and pulveracic acid. Not treated by Laundon, 1992. .....L. farinosa
4. Thallus ± white, gray, green, bluish, or creamy, without usnic acid. 5

5. Thallus poorly delimited, not lobed. 6
5. Thallus well delimited, ± lobed. 8

6 With porphyrlic acid and fatty acids, K+ yellow (atranorin), without triterpenes. ..... (see Leproloma cacuminum)
6. Without porphyrilic acid and fatty acids, with triterpenes, with or without atranorin. 7

7 Thallus UV+ white, with divaricatic acid, zeorin, K± yellow (atranorin). Thallus leprose, a mass of powdery spherical granules to 0.1 mm diam., with projecting hyphae, when well developed forming a thick (sometimes loosely attached?), frequently areolate, powdery crust, dull greenish gray, usually with a bluish tinge, diffuse, without marginal lobes; medulla ± undifferentiated. On acid, shaded bark, and on acid, shaded walls and rocks, especially on bare surfaces but also over mosses. .....L. incana
7. Thallus UV, with unidentified triterpene, K. Thallus leprose,

of a mass of powdery irregular granules, to 0.1 mm diam., but often much smaller, with numerous projecting hyphae which tend to form a weft over the surface, when well developed forming a thick powdery crust, verdigris green, but becoming dull greenish gray in herbarium; forming ± irregularly orbicular patches in the early stages, without marginal lobes. On rock and over mosses in limestone caves and clefts, and on limestonecliffs shaded by trees, confined to damp, heavily shaded habitats, in deeper shade than Leproplaca chrysodeta with which it often grows. ..... L. lesdainii (Hue) R. C. Harris

8. Thallus K+ yellow (atranorin); with roccellic and lepraric acids. Thallus pale green to fairly vivid green, rather thick; granules ± fine, piled on top of each other. Algae Trentepohlia. Not treated by Laundon, 1992. .....L. latebrarum
8. Thallus K, without atranorin. 9

9. Thallus UV+ white, with divaricatic acid. Thallus thick, soft. On shaded calcareous substrates. .....L. crassissima (Hue) Lettau
9. Thallus UV (?), obscurely lobed, powdery, whitish to pale yellowish or greenish gray, containing pannaric acid 6methyl ester, ± pannaric acid, rarely atranorin. ..... (see Leproloma vouaxii)