

**KEYS TO NORTH AMERICAN LOBATE OR  
FRUTICOSE SPECIES OF LECANORA SENSU LATO**

Rev. 8/22/93

I am working on a simpler, more artificial key to these taxa, but at present it's a mess.

**Key to Families and Genera of  
Lobate, Umbilicate, and Dwarf Fruticose Taxa of  
Lecanoraceae sensu Zahlbruckner in North America**

After Ryan & Nash, 1994b  
(submitted to Nova Hedwigia for publication)

1. Thallus (usually) with isidioid soralia towards center, brown or gray-brown; lobes very narrow (under 0.5 mm wide), thin (ca. 100-200  $\mu$ m), plane and closely appressed, appearing cellular throughout inside; hyphae thin-walled (walls thinner than lumina). Apothecia unknown. Spermatia bacilliform, 5-7  $\mu$ m long. Chem.: no substances, or traces of unknown substances. On dry, steep or overhanging silicates at low to moderate elevations. [Note: various Hyperphyscia spp. (Physciaceae) will also key out here; they generally have a prosoplectenchymatous medulla and some lack soredia, but some are extremely difficult to separate from true L. demissa] . . . . . INCERTAE SEDIS: "Lecanora" demissa

1. Thallus without isidia or soredia, or if soralia present then thallus distinctly yellowish (Lecanora subg. Placodium sect. Endochloris Poelt), very thick and inflated-squamulose (Lecanora cavicola) or otherwise different (various taxa not known from North America); lobes broader and thicker; thallus not appearing cellular inside; hyphae thick- or thin-walled. Apothecia often present. Spermatia filiform to bacilliform. Chem.: usnic acid present or not. Mostly on exposed rocks, sometimes on soil, mosses, or rarely wood, low to high elevations. . . . . 2

2. Asci narrow-clavate to cylindrical; tips I- or I+ weak bluish; spores more or less broadly ellipsoid; paraphyses often branched and anastomosing, sometimes moniliform; tips N+ green or N-; apothecia immersed to sessile; discs red-brown to black; thallus gray to yellow- or red-brown (Chem., in N. American species: without usnic acids; usually with norstictic acid), thick, lobate to fruticose; medullary hyphae thin-walled; spermatia short, bacilliform, under 10  $\mu$ m long. [Note: fruticose, terricolous taxa in Aspicilia Massal. s. l. (including "Agrestia Thoms."), not treated further in this document, will also key out here--see key to Aspicilia and similar genera] . . . . . "ASPICILIACEAE": Lobothallia

2. Asci usually clavate (to subcylindrical in Squamarina and Solenopsora); tips at least partly I+ strong blue; spores usually ellipsoid to oblong; paraphyses variable, but never moniliform; tips N+ red or N-; apothecia usually adnate to sessile; discs yellowish to red-brown or greenish to black; thallus usually green-yellow (often whitened by pruina) or occasionally brown or orange-brown (Chem.: often with usnic acids; with or without norstictic acid); thallus thin to thick, areolate to rosulate, lobate or dwarf-fruticose; medullary hyphae usually thick-walled (walls thicker than lumina); spermatia usually

filiform and over 10 um long (except in Solenopsora, Omphalora, and some species of Rhizoplaca s. l. and Lecanora subg. Placodium sect. Dactylon Poelt). . . . . 3

3. Ascus tips appearing entirely I+ blue, without non-amyloid axial mass ("axial body"), but sometimes with small "ocular chamber"; apothecial discs yellow- to red-brown. Layers of thallus well delimited, evenly thickened; upper cortex false (but sometimes with few dead algal cells). On soil or rock. "SQUAMARINACEAE". . . . . 4

3. Ascus tips I+ blue but with non-amyloid axial mass; apothecial discs yellow- to red-brown or greenish to black. Layers of thallus well-delimited or not, evenly or unevenly thickened; cortex true (without dead algal cells) or false (with dead algal cells). . . . . 5

4. Spores mostly oblong, sometimes slightly curved, usually 1(-3)-septate (but sometimes, in undescribed taxa tentatively assigned here, simple or at least apparently so); asci with a uniformly deeply amyloid tholus; apothecia small, usually biatorine, often more or less immersed. Thalli thick, moderately rigid, squamulose to lobate, brownish, greenish or whitish (Chem.: without usnic acid; usually with various other lichen substances in cortex); upper cortex thin (mostly to ca. 30 um), false but with few or no empty algal cells, with calcium oxalate or not; medulla relatively thin and loose, composed of rather thin-walled but sometimes swollen hyphae; spermatophores endobasidial; spermatia bacilliform, under 10 um long. Often in coastal areas with Mediterranean climates (California and Baja California). [Note: some species of Lecania will also key out here; they differ primarily in having exobasidial spermatophores and a very narrow non-amyloid region in the tholus, and can often be distinguished from Solenopsora only with artificial keys treating both genera together]. . . . . Solenopsora s. lato

4. Spores ellipsoid, straight, simple; asci with a long, narrowly cylindric amyloid tube in the tholus; apothecia large, lecanorine to biatorine, adnate to sessile. Thalli thin or thick, very rigid, rosulate or squamulose, yellowish (Chem: usually usnic acids in cortex); upper cortex usually very thick (30-100 um or more), false, with empty algal cells (often difficult to see because of large amounts of calcium oxalate crystals); medulla thick, dense and chalky, composed of thick-walled, often gelatinized and agglutinated hyphae; spermatophores exobasidial; spermatia filiform, over 10 um long. Generally in inland areas, desert to arctic or alpine. . . . . Squamarina s. str.

5. Apothecia zeorine (with proper and thalloid margin); excipulum cupulate (composed of both an outer tissue of anticlinal hyphae extending around sides of hymenium, and an inner layer distinctly differentiated from hypothecium), thallus large umbilicate, over 5 cm diameter; spermatophores "type VI" sensu Vobis (1980); spermatia under 10 um long. High mountains of southwestern U.S. . . . . PARMELIACEAE: Omphalora arizonica

5. Apothecia usually lecanorine (with thalloid margin only), or occasionally biatorine or appearing lecideoid; excipulum usually annular (with single tissue of periclinal hyphae, developing only around sides of hymenium and not strongly differentiated from hypothecium) (apparent exceptions include Rhizoplaca spp., L. opiniconensis and L. bipruinosa s. l.); thallus crustose to lobate or small umbilicate (usually 1-3 cm diam.), or sometimes fruticose; spermatophores usually "type III"; spermatia often much longer than 10 um. . . . . 6

6. Thallus bullate-areolate to dwarf fruticose (an artificial grouping; several rare taxa of very uncertain affinities ("Biatora" caulophylla from California, and several rare undescribed species from Colorado) will also key out here; I do not have an adequate key for them at present). . . . . 7
6. Thallus areolate to lobate, umbilicate (or, in vagrant terricolous forms of Rhizoplaca, globose to tubular or irregularly shaped). LECANORACEAE SENSU HAFELLNER. . . . . 9
7. Asci with broad axial mass. Thallus papillate to dwarf-fruticose, not differentiated into layers; inside composed throughout of areas of dense, strongly conglutinated hyphae and hyphal bundles, alternating with areas of looser tissue containing algae; surface strongly pale-spotted, brownish (Chem.: usually usnic acids, with or without unknowns). Apothecia mostly terminal; discs pruinose. On rocks at the coast. . . . . INCERTAE SEDIS: Cladidium bolanderi
7. Asci with narrow axial mass. Thallus clearly differentiated into cortex, algal layer and medulla, without dense areas inside (except occasionally narrow cords of hyphae); surface at most weakly pale-spotted, distinctly yellowish (Chem.: usually usnic acids or xanthonenes). Apothecia mostly laminal to marginal; discs pruinose or not. On rock or soil, inland or coastal. . . . . 8
8. Apothecia, if present, usually appearing lecideoid; margins darkened or not evident; discs dark brown to green or black; thallus usually yellow-brown to green-black (Chem.: without cortical substances, or with atranorin; medulla without triterpenes, usually with psoromic acid, alectorialic acid, or both; hyphal walls (at least in L. pringlei (Tuck.) Lamb) containing lichenan; lobes often inflated and strongly plicate-foveolate and rugose towards tips. Growing firmly attached to non-calcareous rock, in alpine (to high montane) habitats. Lecanora cavicola Creveld (with soredia; not yet reported from N. America but known from a tiny fragment mixed with "Lecidea brandegei" from Colorado) also keys out here. I have not yet decided if "Lecidea brandegei" (which occurs in the Rockies and tends to be  $\pm$  squamulose) is distinct from L. pringlei, (which occurs mainly in the Sierras and Cascades and tends to be distinctly subfruticose) at the species level. . . . . INCERTAE SEDIS: "Lecanora pringlei group" sensu lato
8. Apothecia, if present, clearly lecanorine or zeorine, but occasionally appearing biatorine; margins usually pale and distinct at least when young; disks yellow- to red-brown or green-yellow to black; thallus usually green-yellow (Chem.: cortex containing usnic acid or related substances; medullary chemistry various, but lacking alectorialic acid; hyphal walls, so far as known, lacking lichenan); lobes sometimes enlarged and plicate or rugose, but tips not inflated or foveolate. Growing on rock or soil, in various habitats, often at lower elevations. . . . . 9
9. Thallus UV+ orange, C+ orange (xanthonenes), growing on rock or rarely on soil, in coastal areas. . . . . (see Lecanora subg. Placodium sect. Endochloris: L. phryganitis Tuck.)
9. Thallus UV+ orange, usually C- (always without xanthonenes; rarely C+ yellow or red), growing on soil or rock, mostly in inland areas. . . . . 10

10. Growing on soil (rarely on rock). . . . . 11
10. Growing on rock (rarely on moss or soil over rock). . . . . (Note: various subfruticose taxa or modifications of various saxicolous members of Lecanora (especially the L. crustacea/L. opiniconensis group in subg. Placodium) and Rhizoplaca may key out here; they can be identified using couplets 12-14 below)
11. Growing free (unattached), forming compressed-globular masses. . . . . (See Rhizoplaca: R. haydenii (Tuck.) Follm. and undescribed vagrant taxa in that genus)
11. Growing firmly attached, forming mats or cushions. . . . . (See Lecanora subg. Placodium sect. Dactylon Poelt)
12. Thallus usually umbilicate; underside attached only in a relatively narrow central area, or thallus variously shaped and growing free on soil; margins of thallus not distinctly radiating; both cortices usually well-defined and with lower one often thicker than upper one (except in some forms growing free on soil); medulla usually loose; apothecia often substipitate; margin often strongly raised, with double algal layer (one next to hymenium, separated by medulla from one next to outer edge), and a well differentiated cortex on lower side. . . . . 13
12. Thallus not clearly umbilicate; underside of at least central areoles firmly attached to substrate (usually rock) over a broad area (or sometimes on one side or at several small areas); margins of thallus usually radiating (at most somewhat ascending) and lower (and sometimes upper) cortex thin or absent; medulla dense or loose; apothecia usually adnate to sessile; margin usually only slightly raised, with single algal layer or scattered clumps of algae, with or without a well differentiated lower cortex. . . . . 14
13. Thallus C+ orange, UV+ orange (xanthonenes), without usnic acids; apothecia large, usually completely covering thallus. On rock in coastal areas in the Arctic, very nitrophilous. . . . .  
. . . . . Arctopeltis thuleana
13. Thallus C- or C+ yellow, UV- (without xanthonenes), with usnic acids; apothecia small or medium-sized, usually not completely covering thallus. On soil or rock, usually in inland areas of temperate regions, extending to the poles, moderately nitrophilous. . . . .  
Rhizoplaca s.l.
14. Thallus brown (chem: acetone-insoluble brown pigment), crustose to more or less effigurate, the areoles often subpeltate; cortex false; apothecia lecanorine to biatorine; discs brown; excipulum sometimes with outer layer of roundish cells; axial mass of asci often rather wide; spermatia sometimes pleurogenously formed, bacilliform to filiform. On rock. . . . . (Protoparmelia)
14. Thallus greenish, yellowish, or whitish (chem: usually various yellow pigments), or if brown then clearly rosulate or lobate, and excipulum without outer layer of roundish cells; other characters various, but axial mass of asci always narrow and spermatia always acrogenously formed. On rock or sometimes other substrates. . . . . 15
15. Thallus white to bright yellow (Chem.: atranorin, often with epanorin, without usnic acid; usually with zeorin); apothecia of the L. frustulosa type sensu Eigler (1969); discs red-brown to black, epruinose; apothecial cortex continuous with that of thallus; thallus verrucose, only rarely

becoming weakly lobed (rosulate); true cortex present; medulla loose, without hyphal bundles. On rock. . . . . (Lecanora argopholis (Ach.) Ach., not treated further in this document)

15. Thallus dull green-yellow to gray-green or bluish green (sometimes whitened by pruina), or various shades of brown (Chem.: usually usnic acids or xanthones; without epanorin; rarely if ever with atranorin; with or without zeorin); apothecia of other types; discs yellow- to red-brown or yellow-green to black, pruinose or not; apothecial cortex continuous with that of thallus or disappearing below; thallus squamulose to lobate or fruticose; cortex true or false; medulla solid or loose, with or without hyphal bundles. . . . . 16

16. Thallus squamulose, typically forming small (to 1-2 cm diameter) convex mounds; cortex evenly thick, usually interspersed with grayish granules (insoluble in K); containing usnic acid; medulla thick, dense, stiff. On rock. Does not belong in Squamarina, and may be a distinct genus. . . . . "Squamarina sect. Petroplaca"

16. Thallus rosulate to lobate or minute fruticose, or if squamulose then usually forming larger, more flattened masses, or cortex either thinner or unevenly thickened; containing usnic acid or related compounds, xanthones, or occasionally no acetone-soluble substances; medulla various, often thin or loose. On rock or other substrates. An artificial, heterogeneous taxon. . . . . Lecanora subg. Placodium

**Key to Major Groups and Taxonomically Isolated Taxa  
of Lecanora subg. Placodium in North America**

After Ryan & Nash, 1994a  
(submitted for publication in Nova Hedwigia)

1. Thallus on soil or among mosses; lobes short, thick, more or less plane, or somewhat elongated, ascending, convex to terete; surface more or less yellow-green when fresh, in some species turning yellowish brown in herbarium; cortex with usnic acids; medulla usually with zeorin and unknowns; spermatia filiform and curved or baciliform and straight. In arctic or alpine areas. . . . . Group 1. Lecanora sect. Dactylon

1. Thallus on rock, only occasionally extending onto other substrates; lobes prostrate, strongly to weakly adherent, more or less flattened (except in sect. Endochloris: L. phryganitis); color and cortical and medullary chemistry various; spermatia filiform, curved. In desert to alpine sites. . . . . 2

2. Cortex C+ orange, UV+ orange, with xanthones, with or without usnic acid or related substances (placodiolic, pseudoplacodiolic, or isousnic acids); cortex not interspersed with gray calcium oxalate granules; on or near the seashore, often very nitrophilous. . . . . 3

2. Cortex C-, UV-, most species with usnic acid (or related substances), without xanthones; cortex with or without oxalate granules; mostly in inland areas and only moderately nitrophilous if at all (note: specimens similar to L. contractula, but lacking xanthones, will also key out here). . . . . 5

3. Thallus yellow or yellowish green, rosulate or dwarf fruticose, usually 1-2 mm or more thick; cortex with usnic acid in addition to xanthones; surface often rough-warty-granular or eroding, sometimes with soredia or blastidia; lobes coarse, ca. 1 mm wide; medulla C+ orange, UV+ orange, with xanthones (arthothelin, thiophanic acid and others) and zeorin; discs orangish, with thick yellow pruina; spores more or less oblong-ellipsoid; spermatia 10-15 µm long. Restricted to southwestern N. America. . . . . Group 2. Lecanora sect. Endochloris

3. Thallus more or less yellow-brown, squamulose to lobate; cortex with xanthones, without usnic acid; surface more or less smooth (not eroding, without soredia or blastidia); lobes narrow to broad; medulla C+ orange, UV+ orange (with arthothelin or other xanthones) or C-, UV- (without xanthones), without zeorin; discs more or less dark, brown to blackish, at most weakly whitish pruinose; spores ellipsoid; spermatia mostly 20-35 µm long. Circum-boreal-arctic. . . . .  
... 4

4. Thallus rosulate, 1 to many cm diam.; marginal lobes elongated and usually radiating, thin and small to very thick and large; cortex well developed on both thallus and apothecia, and often unevenly thickened, forming bundles dividing the algal layer. . . . .  
... Group 3. Lecanora sect. Arctoxanthae

4. Thallus of scattered squamules, to 0.5 cm diam., crenate-incised to weakly lobate at margins; cortex poorly developed except on apothecia. (note: specimens with umbilicate thalli mostly covered by large apothecia are Arctopeltis thuleana). . . . .  
... Group 4. Incertae sedis: Lecanora contractula

5. Upper cortex densely inspersioned with gray granules insoluble in K (calcium oxalate), without dead algal cells, moderately and more or less uniformly thick, without definite conical hyphal bundles; thalli usually densely and completely pruinose, forming patches to 3 cm diam.; cortex containing only usnic acid; medulla containing only fatty acids (except in L. albula, which also contains zeorin and unidentified triterpenes). . . . . 6

5. Upper cortex at most weakly inspersioned with gray granules, with or without dead algal cells, evenly thin or thick, or unevenly thickened and forming conical hyphal bundles; thallus mostly not pruinose or only partly pruinose, forming patches to 4-5 cm or more diam. in some species; cortex with or without usnic acid; medulla frequently with other secondary products. . . . . 7

6. Apothecia of the L. polytropa type sensu Eigler (1969), with margins similar to the discs; medulla containing zeorin, unidentified triterpenes, and rangiformic acid; alpine areas. . . . . (see Group 7c. Lecanora sect. Petrasterion, incertae sedis: L. albula)

6. Apothecia of a different type, with margins similar to thallus; medulla usually containing roccellic acid (or rarely no lichen substances), without triterpenes and rangiformic acid. Occurring mostly at low to moderate elevations. . . . . Group 5. Lecanora sect. Pruiniferae s. l. (one species in North America: L. valesiaca)

7. Medulla solid, dense; cortex usually evenly thickened and lacking distinct hyphal bundles, with or without dead algal cells; thallus areolate-squamulose to rosulate, less often distinctly lobate; lobes concave to plane or convex, usually not sinuous or plicate; discs pruinose or not. . . . . 8

7. Medulla mostly loose to almost hollow; cortex usually unevenly thickened with distinct hyphal bundles, with few or no dead algal cells (except in L. laatokkaensis group, which typically has immersed to adnate apothecia borne laminally on central areoles); thallus areolate-squamulose to lobate or subfoliose; lobes flattened to concave or undulate, or convex and often becoming sinuous and more or less plicate; discs epruinose. . . . . Group 6. Lecanora sect. Placodium

8. Thallus composed of thick (ca. 0.5-1 mm), tightly adnate squamules, usually forming small (1-2 cm diam.), often thick (1-2 mm) mounds; cortex thick (50-75  $\mu$ m), containing dead algae; medulla chalky (densely inspersioned with gray granules). . . . . ("Squamarina" sect. Petroplaca)

8. Thallus composed of thin or thick, loosely or tightly adnate areoles or squamules, often becoming rosulate or lobate, often forming rosettes to 3-4 cm. or more diam., usually not mound-forming; cortex relatively thin (mostly under 50  $\mu$ m); medulla not chalky (more weakly inspersioned). . . . . Lecanora sect. Petrasterion s. l.

# 1. Lecanora subg. Placodium sect. Dactylon Poelt

After Ryan, 1989a

1. Apothecia sessile on the areoles, the discs persistently yellow to yellow-brown, epruinose and somewhat waxy-looking, the margins thin, strongly crenate, soon crowded back; thallus epruinose, turning yellowish brown to orangish in herbarium, the lobes mostly terete, short and wide, or transformed into more-or-less erect, thick papillae, pale edged; hypothallus not evident; paraphyses 1-1.5  $\mu$ m thick; spores 9-13 x 5-7  $\mu$ m, often pointed at one or both ends; cortex with usnic acid; medulla with triterpenes and unknowns LGP-1, 2 and 3; Greenland to Alaska. .... **L. geophila (Th. Fr.) Poelt** (Syn. L. pachythallina Lynge, L. superfluens Magnusson) .....2

1. Apothecia developing between the areoles, the discs at first mostly brown with yellow pruina, then blackening, the margins persistent, thick; thallus rough or pruinose, pale yellow to yellowish white when fresh, turning pink in herbarium, the lobes flattened above, short and wide, arranged in a single plane. ....3

2. Thalli to 1-2 cm wide; lobes often transversely broadened, mostly undivided; thallus center without papillae; apothecia common. .... "L. superfluens" form

2. Thalli to 4 cm wide; lobes narrow, often divided; thallus center often with large, constricted papillae; apothecia rare. .... "L. pachythallina" form

3. Lobes ca. 1.5-2 mm wide, strongly black-edged; hypothallus well developed, blackish; apothecia to 3-4 mm diam.; hymenium ca. 100  $\mu$ m high; spores 11-15(-19) x 6-8(-9)  $\mu$ m, often pointed at one or both ends; spermatia 11-17(-20)  $\mu$ m long, more-or-less curved; cortex with usnic and isousnic acids; medulla with triterpenes and trace of unknown LGP-1; Greenland to Northeastern Canada. .... **L. maxima Lynge**

3. Lobes 0.5-1 mm wide, pale-edged; hypothallus not evident; apothecia to 2 mm diam.; hymenium ca. 80  $\mu$ m high; spores 10-12 x 6-8  $\mu$ m, rounded at ends; spermatia 8-10  $\mu$ m long, straight; cortex with usnic acid; medulla without zeorin, with unknowns LGP-1 and LBM-1; alpine, central Mexico. .... **L. beamanii Ryan**

**2. Lecanora subg. Placodium sect. Endochloris Poelt emend. Ryan & Poelt**

After Ryan, 1989b

1. Thallus dwarf fruticose (rarely poorly developed and appearing somewhat crustose, but not marginally lobed) ..... L. PHRYGANITIS Tuck.

1. Thallus crustose, marginally lobed ..... 2

2. Thallus forming thick mounds, rather uniformly pale yellowish green; hypothallus well-developed; medulla and hypothecium of mostly anticlinal hyphae; cortex Pd-; thallus containing LPN-1 and LPN-2 and other unknowns (UV+ white substances, in addition to usnic acid, zeorin and xanthonenes); central California ..... L. PINGUIS Tuck.

2. Thallus forming rather thin, more or less flat rosettes, usually grayish yellow or greenish yellow (more strongly yellow in herbarium); hypothallus thin or absent; medulla and lower hypothecium of more or less randomly oriented hyphae; cortex Pd+ yellow; thallus without LPN-1 and 2; Baja California Norte to southern California. ....3

3. Thallus without distinct pustules or soredia-like granules, greenish yellow with more or less concolorous lobe tips; Baja California (Sur and Norte) ..... L. PACHYSOMA Ryan & Poelt

3. Thallus usually with pustules or soredia-like granules, grayish yellow to slightly brownish (often much paler at margin); Baja California (Norte) to southern California .... L. XANTHOSORA Ryan & Poelt

Bruce D. Ryan

**3. Lecanora subg. Placodium sect. Arctoxanthae Ryan, sect. nov.**

After Poelt, 1958, and Ryan, in prep.

1. Thallus extensive, usually 3-5 cm or more across; lobes usually coarse and clearly elongated, mostly 2-5 mm or more long, divided towards tips into ca. 0.5-1 mm wide branches, thick (0.5-1 mm); cortex ca. 100-200  $\mu$ m thick, very uneven, with xanthones (usually arthothelin); medulla C-, UV- (without xanthones); apothecia 2-3 mm or more diam.; discs pruinose or not; Alaska to northern Canada and Greenland. Common. .... 1. L. STRAMINEA

1. Thallus small to medium-sized (to 3 cm diam.); lobes very small and narrow (to 2-3 mm long and 0.5 mm wide), thin (to 0.5 mm); cortex to 50  $\mu$ m thick, only moderately uneven; medulla C+, UV+ (xanthones); apothecia small (to 1 mm), discs epruinose. Thallus contiguous, rosulate, to 2-3 cm diam., areolate-verrucose in center, with distinctly elongated and radiating marginal lobes; cortex of thallus and apothecia well delimited; Eastern Canada, and Alaska. Rare, possibly extinct. .... L. MICROBOLA

Bruce D. Ryan

**4. Lecanora: incertae sedis: Lecanora contractula Nyl.**

Mostly after Poelt, 1983

Thallus of scattered squamules, to 0.5 cm diam., crenate-incised to weakly lobate at the margins; cortex poorly developed except on apothecia; Alaska, northern Canada, Greenland, and Eurasia (specimens with umbilicate thalli mostly covered by large apothecia are Arctopeltis thuleana Poelt). ..... L. contractula

Lecanora contractula shares many features in common with the L. perconcinna-L. microbola group, features which differentiate them from L. straminea (small dimensions of thallus and apothecia and their tissues, absence or poor development of maculae and the corresponding cortical bundles of the thallus, and a more dense medulla). However, we are excluding L. contractula from sect. Arctoxanthae for several reasons: Lecanora contractula has a different thallus form (small, weakly lobed squamules) and color (pale, often whitish), and a poorly developed thallus cortex. Poelt (1983) treated L. contractula as a member of subg. Lecanora, close to L. behringii Nyl., and he reported material that resembled L. contractula but lacked the C+ reaction of xanthonenes. Xanthonenes have been reported from several groups in subg. Lecanora, and there are specimens of uncertain identity, from arctic coastal rocks (e.g., Almquist, s.n., Alaska: St. Lawrence Island (S!)), that have apothecia like those of L. contractula and contain xanthonenes, but that lack any apparent thallus. Although such xanthone-containing purely crustose forms could have evolved towards (or "devolved" from) umbilicate thalli (Arctopeltis thuleana Poelt), or lobate thalli (L. straminea), the alternative hypothesis, that these umbilicate or lobate taxa originated from separate groups of non-xanthone containing taxa, seems more likely, as many coastal lichens contain xanthonenes (e.g., Buellia, Lecidella, and Pertusaria). The systematic significance of differences in the kinds of xanthonenes found in L. contractula versus the various other xanthone-containing taxa is uncertain. According to Elix & Crook (1992), the earlier reports on the chemistry of L. contractula, by Santesson (1969) and Sundholm (1979) are incorrect, and the species contains 5-chloro-6-O-methyl-norlichexanthone, 2,5-dichloro-6-O-methyl-norlichexanthone (major) and 5-chlorolichexanthone (based on Santesson 11819, UPS).

Bruce D. Ryan

**5. Lecanora subg. Placodium sect. Pruiniferae Jatta**

Only one species reported from N. America: **Lecanora valesiaca (Müll. Arg.) Stizenb.**

After Ryan, 1990

Thalli usually densely and completely pruinose, to 3 cm diam.; cortex densely interspersed with gray granules (insoluble in K), without dead algal cells, moderately and more or less uniformly thick, without definite conical hyphal bundles. Lobes usually well developed, with raised/thickened margins, and discs usually yellowish brown, but sometimes thallus reduced or discs greenish to blue-black. Widespread in North America (mostly prairies and foothills of southwestern and north-central U. S.). ..... L. valesiaca

Bruce D. Ryan

6. Lecanora subg. Placodium sect. Placodium ("Pers.") Mann emend. Poelt

After Ryan & Nash, 1993a,b and unpublished

1. Thallus areolate to weakly lobate. Apothecia immersed to semi-immersed at least when young. Cortex poorly developed, often composed partly of dead algal cells. Containing zeorin, without leucotylin. Thallus and discs epruinose. Cortex with usnic acid only. L. laatokkaensis group. .... 2

1. Thallus distinctly lobate. Apothecia (in N. American species) adnate to sessile even when young. Cortex well developed, without dead algal cells. Chemistry and other characters various. .... 3

2. Apothecia pale, yellowish. Lobe margins pale. Distinct black hypothallus absent. Southwestern U.S. .... Lecanora mazatzalensis Ryan & Nash

2. Apothecia deep or dark brown. Lobe margins black. Distinct black hypothallus present. Widely scattered in the West. .... L. laatokkaensis (Räsänen) Poelt

3. Lobes usually  $\pm$  elongated and often  $\pm$  swollen and sinuous-plicate; margins not raised or thickened; pruina, if present, on upper surface, not primarily on margins. Upper cortex without distinct conical bundles of hyphae. Leucotylin absent. L. garovaglii group. (Note: "L. chiricahuae Ryan & Nash ined.", a rare taxon from SE Arizona, with elongated but flattened lobes, containing zeorin and having faintly pruinose pinkish disks, will also key out here). .... 4

3. Lobes mostly shorter, not swollen or sinuous-plicate; margins often raised or thickened; pruina, if present, often primarily on the margins. Upper cortex usually with distinct conical bundles of hyphae (giving a jagged appearance to the algal layer, visible in section even under a hand lens). Leucotylin usually present. Presently a hopeless mess. Some of the more distinctive variants (taxonomic rank uncertain but presently treated as varieties) are v. brunneola Mereschk., with brown thallus containing isousnic instead of usnic acid, v. dubyi (Müll. Arg.) Poelt sensu lato, with coarse, thick, often loosely attached lobes, and v. "diomedensis Ryan ined.", with thallus to 5-10 mm thick and discs appearing almost white when wet, on the coast of Alaska. Other variants include ones with white-margined squamulose thalli, ones with distinctly bluish thalli, and chemical variations including a few populations lacking leucotylin. .... L. muralis group ("L. muralis sensu [very] lato")

4. Upper surface of thallus greenish yellow (often tinged with olive or gray), often pale-spotted near lobe tips; lobes usually strongly inflated and sinuous-plicate; apothecial discs matt, yellowish to brownish or becoming blue-black. Medulla with triterpenes, usually P-, but rarely P+. Western North America, Eurasia, and South America. ....  
... L. GAROVAGLII S. L. (including L. cascadenis Magn. non auct., syn. L. nevadensis, with discs blue-black in sunny habitats, yellowish in shaded habitats)

4. Upper surface of thallus yellow to blue-green or various shades of brown, often shiny, not pale-spotted; lobes mostly only weakly inflated and sinuous-plicate; apothecial discs usually shiny, often tinted with red or orange (except in shade), never blue-black. Medulla without triterpenes, often Pd+ orange or yellow (pannarin or psoromic acid).

Bruce D. Ryan

Western North America. . . . . 5

5. Thallus surface yellow to blue-green, shiny; cortex with usnic acid; medulla with rangiformic acid; mostly at high elevations in the Sierra Nevada mountains of California. . . . .

L. SIERRAE

5. Thallus surface various shades of brown (usually orangish or reddish, but yellowish in shade), shiny or matt; cortex without usnic acid; medulla with fatty acids of the protolichesterinic group; mostly at low to moderate elevations, especially in the Columbia Plateau of the Pacific Northwest. . . . . L. PSEUDOMELLEA

7. Lecanora subg. Placodium sect. Petrasterion Poelt,

Bruce D. Ryan

**Key to Major Groups of  
Lecanora sect. Petrasterion s. l. in North America**

Mostly after Ryan, unpublished data

1. Cortex strongly differentiated from medulla, evenly to unevenly thickened, usually with few or no dead algal cells; hyphae densely packed, with large (ca. 3  $\mu$ m diam.), rounded lumina; apothecia sessile to immersed, the margins similar to the discs or to the thallus; cortex (in North American species) with usnic acid only (plus calcium oxalate in L. albula); medulla with fatty acids, plus or minus psoromic acid; without triterpenes (except in L. albula). . . . . 2

1. Cortex more or less weakly differentiated from medulla, evenly thickened and usually with numerous dead algal cells; hyphae usually loosely packed, with narrow (1-2  $\mu$ m) lumina; apothecia sessile, the margins similar to thallus, at least in structure; cortex with usnic, placodiolic, or isousnic acids, or no substances; medulla with or without fatty acids or psoromic acid; often with triterpenes. . . . . 4

2. Apothecia sessile, the margins similar to those of the L. polytropa group (subg. Lecanora), i.e., often narrow and similar to discs in color and lacking algae; discs epruinose and becoming convex and emarginate; thallus areolate-squamulose to rosulate (with lobes short and broad in N. American species); medulla with fatty acids of rangiformic group (plus occasionally psoromic acid in some species); excipular cell lumina mostly narrow (1-2  $\mu$ m) and elongated. In alpine areas. . . . . 3

2. Apothecia often immersed to adnate, the margins usually thalline and often rather broad and flattened, dissimilar to those of the L. polytropa group, i.e., different in color from disk, and containing abundant algae; discs pruinose and more or less plane and persistently margined; thallus rosulate to areolate-squamulose, the lobes often short and flat, frequently with thickened edges; medulla with fatty acids of murolic group and often psoromic acid; excipular cell lumina (tangential section) often large (3-5  $\mu$ m) and rounded. Lowland to montane, hot deserts to semi-desert scrub. . . . . 7A. Lecanora sect. Petrasterion subsect. Deserticola

3. Cortex interspersed only with yellowish granules (soluble in K); medulla without triterpenes. . . . 7B. Lecanora section Petrasterion subsect. Concolores: L. dispersoareolata

3. Cortex interspersed with grayish granules (insoluble in K) in addition to yellowish granules (soluble in K); medulla with zeorin and unidentified triterpenes. . . . . 7C. Lecanora sect. Petrasterion, incertae sedis: L. albula

4. Apothecia long remaining immersed, borne laminally, often several per areole; discs epruinose, brown; thallus areolate, the lobes at most weakly developed, more or less plane. . . (See Sect. 6. Placodium: L. laatokkaensis group)

4. Apothecia soon adnate or sessile, mostly borne submarginally, the discs pruinose or not; thallus areolate to squamulose, rosulate or lobate. . . . . 7D. Lecanora sect. Petrasterion subsect. Pseudocorticatae

Bruce D. Ryan

**7A. Lecanora subg. Placodium sect. Petrasterion subsect. Deserticola Ryan & Nash, subsect. nov.**

After Ryan, unpublished data;  
An extremely difficult group!

1. Upper surface usually yellowish to slightly orangish or brownish, either with at most a thin line of pruina inside the often blackened margin of the lobes, or densely pruinose throughout. Thallus areolate-squamulose, scattered or rosette-forming, at most rather shortly and weakly lobed at margin; lobes  $\pm$  concave to plane, with  $\pm$  thickened, usually strongly blackened and often granular margins. Excipulum uniform, with small, elongated cells and narrow lumina. Primarily in the Chihuahuan Desert or at higher elevations in the Sonoran Desert or southward; absent from coastal areas. .... 2

1. Upper surface usually with greenish or grayish overall color (when fresh), with  $\pm$  dense but spotty pruina scattered on the surface, or if yellowish and epruinose then growing on the seashore in Baja California. Thallus areolate in center, usually with distinct, short to long but usually distinctly radiating, marginal lobes; lobes or areoles often partly somewhat convex; margins plane to thickened and raised, sometimes weakly blackened especially towards lobe tips, but never strongly blackened and granular. Excipulum sometimes with outer layer of large cells with broad, rounded lumina. Primarily in the Sonoran Desert or at  $\pm$  low elevations southward. .... 4

2. Thallus surface densely pruinose throughout, forming rosettes with marginal lobes distinctly radiating and appressed, with thickened but not strongly blackened nor granular margins. Coahuila, Mexico and SW Texas. .... L. "coahuilae" Ryan & Nash ined.

2. Thallus surface epruinose or with thin line of pruina next to margin; scattered to rosette-forming, with marginal lobes often poorly developed, often with black, sometimes granular, margins. .... 3

3. Areoles small, thin,  $\pm$  scattered, not distinctly lobed, at most with thin, smooth black margins. Apothecia small. Central Mexico, possibly to southern Arizona. .... L. "flavopruinosa" Ryan & Nash ined.

3. Areoles larger, thicker, often contiguous and rosette-forming, and often  $\pm$  distinctly lobed, usually with thick, granular black margins. Apothecia larger. SW Colorado south to Texas, New Mexico and Arizona, Chihuahua and Sonora. .... L. "nashii" Ryan ined.

4. Thallus surface grayish or greenish tinged when fresh,  $\pm$  densely but spottily pruinose; marginal lobes usually distinct, often  $\pm$  elongated, often with raised margins. A very problematic taxon, probably needing to be further divided. Typically with coarse, elongated lobes, and with large, rounded outer excipulum cells, but extremely variable, with some forms approaching all of the other species in the section. Arizona to southern California, south to Baja California and central Mexico. .... L. bipruinosa  $\pm$  s. str.

4. Thallus surface often pale yellowish green when fresh, epruinose; marginal lobes short and indistinct, without raised margins. Excipulum cells uniformly small and narrow. Baja California. .... L. "baja-californicae" Ryan & Nash ined.

Bruce D. Ryan

Bruce D. Ryan

**7B. Lecanora subg. Placodium sect. Petrasterion subsect. Concolores Poelt**

Only one species reported from N. America (alpine areas of Colorado, apparently rare): L. dispersoareolata, most concisely characterized by the areolate-squamulose thallus, epruinose discs and oblong spores.

Apothecia sessile, often similar to those of the L. polytropa group (subg. Lecanora), the margins narrow and similar to discs in color and structure, the discs epruinose and becoming convex and emarginate; thallus pruinose or not, areolate-squamulose, without distinct lobes; medulla usually with fatty acids of rangiformic group and sometimes psoromic acid; excipulum cell lumina narrow (1-2 um) and elongated. .... L. dispersoareolata

Bruce D. Ryan

**7C. Lecanora subg. Placodium sect. Petrasterion, incertae sedis: L. albula (Nyl.) Hue**

Apothecia similar to those of the L. polytropa group (subg. Lecanora), the margins narrow and similar to discs in color and structure, the discs epruinose, becoming convex and emarginate; thallus areolate, not distinctly lobed; cortex interspersed with grayish granules; alpine; Colorado (rare) and Eurasia (Lecanora Sect. Petrasterion, incertae sedis)..... L. ALBULA (NYL.) HUE

A problematic taxon presently known only from alpine areas in Colorado, apparently rare. Characterized by the white, barely lobed thallus, epruinose discs with margins often similar in color and lacking algae, and ellipsoid spores. Difficult to distinguish from members of the L. polytropa group, with which it may have close affinities.

Bruce D. Ryan

**7D. Lecanora subg. Placodium sect. Petrasterion subsect. Pseudocorticatae Poelt**

Mostly after Ryan, unpublished data

A large and very difficult, heterogeneous and unnatural group. I have a number of potentially new species, and do not yet have a comprehensive key. A preliminary brief key to the main groups and taxonomically isolated species, and paragraphs discussing each, are presented below. Some of the species may belong in other sections or subsections.

1. Discs pruinose, or if epruinose then usually greenish or bluish black. .... 2
1. Discs epruinose, yellowish to reddish or brownish, not greenish or bluish, not black except occasionally from parasitism. .... 5
  2. Discs usually only faintly pruinose (high magnification good quality dissecting scope),  $\pm$  brown (never bluish, greenish or blackish). Thallus areolate-squamulose, usually scattered on other lichens; areoles small, thin, often black-edged; apothecial margins often thick and black. Common but inconspicuous, mainly in the Sierras and Cascades, with a few outliers in the central to northern Rockies that may not belong here. .... L. semitensis group
  2. Discs usually distinctly pruinose (hand lens or low power dissecting scope), or epruinose and then greenish to bluish black. Thallus areolate-squamulose to rosulate to lobulate; areoles usually larger, thicker, black-edged or not; apothecial margins usually thin and pale (except in L. nigromarginata). Common and conspicuous, mainly in the Rockies, with outliers in alpine areas of the Sierras and Cascades. L. novomexicana/L. weberi group. .... 3
4. Thallus areolate-squamulose to rosulate or lobate, usually greenish yellow except in shade; cortex more or less thick (30-70  $\mu$ m); apothecia sessile, often constricted at base, the discs yellowish and pruinose or epruinose and blue-black; medulla often with psoromic and/or lecanoric acids; cold desert to montane or alpine; widely distributed in mountains of western North America ..... L. NOVOMEXICANA MAGNUSSON (COMPLEX, including L. nigromarginata Magn., with short, broad, flat to concave lobes and strongly thickened, raised, black and granular margins, known with certainty only from central Cascades of Washington)
4. Thallus more or less squamulose-lobate, composed of densely imbricate, flat to more or less concave squamules when sterile, or of contiguous areoles when fertile, more or less grayish tinged; cortex very thin (10-15  $\mu$ m); apothecia adnate to broadly sessile, the discs orangish brown, pruinose; medulla with fatty acids only, or also with psoromic acid. Montane; widely distributed, eastern and western. .... L. WEBERI RYAN s. lato (including some undescribed taxa of uncertain status)
  4. Growing in Mexico or hot desert areas of the Southwest. Medulla P+ yellow, with psoromic acid. .... L. sonorae group
  4. Growing at higher latitudes or altitudes, in cooler areas. Medulla P+ or P-, but without psoromic acid. .... 5

Bruce D. Ryan

5. Thallus when fresh distinctly yellowish, orangish, reddish, or brownish, or grayish green, without usnic acid, usually with isousnic acid or no acetone-soluble pigments, sometimes with placodiolic acid, usually with fatty acids, sometimes with phenolic medullary substances, never with terpenoids or psoromic or lecanoric acids. Thallus forming rosettes, with distinct, elongated marginal lobes. Endemic to California west of the Sierras (except for populations in the Tehachapi mountains). ..... L. mellea group

5. Thallus when fresh usually pale to moderate greenish yellow, sometimes yellowish or orangish towards the lobe tips, with usnic or placodiolic acid, usually without isousnic acid, often with fatty acids, sometimes with phenolic medullary substances (including psoromic or lecanoric acids), sometimes with terpenoids. Widespread, always east of the Sierras or outside of California (if growing in California west of the Sierras, and thallus areolate-squamulose, see the L. semitensis complex). ..... 6

6. Thallus without placodiolic acid. Thallus areolate-squamulose, without distinct marginal lobes. Arizona (San Francisco Peaks). ..... L. "geiseriae" Ryan in herb.

6. Thallus with placodiolic acid. Thallus areolate-squamulose to subfruticose, or rosulate with distinct marginal lobes. .... 7

7. Thallus scattered and areolate-squamulose to subfruticose, or forming large, often thick and convex,  $\pm$  loosely attached mounds or rosettes, often with somewhat broad and short marginal lobes; surface often shiny-waxy, always epruinose, often turning orangish towards lobe tips. Discs uniform in color. Eastern N. America, Arctic, or mostly  $\pm$  sheltered, shaded or moist sites in the mountains of the West. .... L. crustacea complex

7. Thallus contiguous, forming  $\pm$  flat and closely appressed rosettes, with  $\pm$  narrow and elongated marginal lobes, or sometimes small (under 1 cm across) mounds; surface matt, often  $\pm$  pruinose, never turning orangish towards lobe tips. Discs usually (but not always) darker and redder when young and next to the margin. On exposed surfaces in arid areas of the temperate intermontane West, from SW Canada to SW United States. .... L. phaedrophthalma complex

L. novomexicana/L. weberi group. The first group of taxa includes L. novomexicana Magnusson s.l. and L. nigromarginata Magnusson, L. weberi Ryan, which we have compared and contrasted to species of Rhizoplaca (Ryan, 1989c; Ryan & Nash, 1991), and new taxa we are describing that have areolate, scarcely lobate thalli. These Lecanoras are similar to subsect. Deserticola in chemistry (usnic acid, and psoromic or fatty acids) and in apothecia (pruinose disks), but have a pseudocortex and a montane to alpine, temperate to boreal distribution. New data on L. nigromarginata, and on the distribution and variability of L. weberi, will be presented by us in a future article. Lecanora weberi appears to be much more widespread and variable than originally reported, and is now known from eastern Canada (Wong & Brodo, 1992), where it has been confused with L. chlorophaeodes Nyl. (a species of uncertain affinities, differing especially in having epruinose discs and containing triterpenes). An areolate, scarcely squamulose species with oblong spores, L. "chacoensis" Ryan & Nash ined., from New Mexico, and several taxa of uncertain status from the Pacific NW, also fit within this general group.

L. semitensis group: Another group consists of at least one complex of taxa which have an

Bruce D. Ryan

areolate-squamulose thallus, which is usually scattered among other lichens and perhaps partly parasitic on them. These taxa show some resemblances to L. nigromarginata and L. weberi, but frequently contain placodiolic acid (and occasionally isousnic acid), lack psoromic and lecanoric acids, and have consistently smaller areoles and apothecia, with brown discs that are often epruinose or only very lightly pruinose. This group is common in montane to subalpine areas of the Sierras and Cascades, and also occurs occasionally in the northern Rocky Mountains, but previously has been overlooked or misidentified. The main part of this group centers around L. semitensis (Tuck.) Zahlbr. (holotype, FH!), which contains fatty acids and lacks triterpenes, and typically has lightly pruinose apothecia. At least one apparently undescribed taxon that is superficially very similar to L. semitensis contains triterpenes, appears to be associated loosely with filamentous cyanobacteria, and may have closer affinities to the other groups.

L. sonorae group: One species, L. sonorae Ryan & Nash (Ryan & Nash, 1989) from siliceous rocks in Sonora and Oaxaca, Mexico, is similar to the L. novomexicana/L. weberi group in chemistry (usnic and psoromic acid), but differs in apothecial characteristics (orangish, epruinose discs) and distribution (warm-temperate to subtropical areas); it forms rosettes to 2 mm diam., with short, broad lobes (ca. 3-5 mm long and 2-3 mm wide), with surface greenish yellow, epruinose, often strongly rimulose toward center. It, and two undescribed species with epruinose discs (L. "pueblae" Ryan & Nash ined. from limestone in Puebla, Mexico, similar to L. sonorae but with thinner, longer lobes, smooth surface and shinier, often more reddish brown discs, and L. "kofae" Ryan & Nash ined. from calcarium-exposed siliceous rocks in southwest Arizona, with  $\pm$  densely pruinose thallus mostly to 5 mm across, without psoromic acid, and with orangish epruinose discs), may have closer affinities to subsect. Deserticola.

Another group of taxa share with each other the following main features: 1) lobes distinctly differentiated, more or less divided and often overgrowing each other; 2) apothecial discs mostly yellow, orange or brown, and epruinose (with associated characters of the paraphyses and epihymenium); 3) frequent presence of placodiolic or isousnic acids in the cortex, and triterpenes and various unknowns in the medulla (without psoromic or lecanoric acids); and 4) distribution in temperate to boreal or arctic areas, most often at low to moderate elevations. This second group is represented in N. America by several species complexes summarized below.

1) The L. mellea complex, endemic to California, is characterized by rosulate thalli containing fatty acids and various sporadically occurring phenolic substances, but not terpenes. It centers around L. mellea W. Weber (holotype, COLO!) which typically has isousnic acid or an acetone-insoluble brown pigment as the only cortical substance, but is quite variable in form, color, spores, and medullary chemistry. Thalli containing rangiformic acid vary from being rather thick, coarsely lobed, and yellowish brown to orangish brown (as in the type) to rather thin, finely lobed and grayish green, in various combinations. Thalli containing the constipatic acid group but are also quite diverse, but most often are thin, finely lobed, and pale yellowish. While much of the variability can be explained by environmental modification, there also appear to be genetic components. A second taxon, Lecanora collatolica Thomson & Nash (holotype, WIS!; isotypes, ASU!), typically has darker apothecial disks, broader spores and a more yellowish thallus (containing placodiolic acid as the main substance). This taxon is still known with certainty only from the type collection, but many specimens are intermediate between it and

Bruce D. Ryan

typical L. mellea, in appearance, chemistry, and spore shape; we hypothesize that the distinctive characters of the rare species L. collatolica are gradually being lost through introgressive hybridization with the much more common L. mellea (rangiformic acid chemotype). This complex appears to have a somewhat different cortical structure from that of other members of the Pseudocorticatae, and does not seem to have close affinities with any other members of the subsection.

2) The members of the L. crustacea complex, known especially from arctic to boreal areas, but spreading southward at higher elevations, have greenish yellow squamulose to pulvinate or rosulate thalli that are often divided into secondary areoles, and contain placodiolic acid, various mostly unidentified phenolic substances, and triterpenes, fatty acids, or both. This complex can often be recognized by the frequently olivaceous tinge of the thallus, which often turns orangish towards the lobe tips. These taxa also share a very peculiar and unexplained tendency for almost constant association (in both Asia and North America) with the squamulose morphotypes of Rhizoplaca chrysoleuca sensu lato, which have been named as R. subdiscrepans (Nyl.) R. Sant., a very problematic taxon, but one which is well distinguished from the L. crustacea complex by its pruinose discs, matt upper surface with a more grayish green color (without yellowish and orangish tints), looser medulla, and somewhat different chemistry (presence of pseudoplacodiolic rather than placodiolic acid in eastern North American material, and usual absence of triterpenes or unknown substances). In North America the L. crustacea complex is represented by two broadly treated species. The first, Lecanora crustacea (Savicz) Zahlbr. (syntypes, W!, UPS!), was described from Asia but is reported here for the first time from North America: ALASKA. Valley of the Okpilak River at Okpilak Lake near Mt. Nicholson, Thomson 9516, WIS!; Demarcation Point Quad: Jago River floodplain and McCall Creek fan, 670 m, on granite boulder, Murray 8539, ALA!). Lecanora opiniconensis Brodo (holotype, CANL!), was described from eastern Canada, but (treated in a broad sense) it also extends as far west as Arizona (e.g., Nash 22523, ASU!) and the Northwest Territories (e.g., Scotter 2257, WIS!). Lecanora opiniconensis is similar in many ways to L. crustacea, but typically has a more rosulate thallus and narrower spores than L. crustacea and contains triterpenes and unknowns LOP-1 and LOP-2 (Brodo, 1986), which differ from the substances found in typical L. crustacea. However, both species as treated here are extremely variable in morphology, color, and chemistry. Although the material from North America is characteristic of fairly low elevations, a third species probably belonging to the L. crustacea complex, L. sherparum Poelt, is presently known only from very high elevations in the Himalayas. As discussed by Ryan and Nash (1993b), although Lumbsch, et al. (1991) placed L. opiniconensis in the Parmeliaceae on the basis of its apothecial ontogeny, this conclusion is controversial, and the problem requires further study.

3) The L. phaedrophthalma complex, characterized by rosulate, greenish yellow thalli frequently containing placodiolic acid in the cortex and always terpenes in the medulla, and by disks that tend to be darker next to the apothecial margin. This complex centers around L. phaedrophthalma Poelt (holotype, M!), originally described in 1958 from central Asia but very common and widespread in temperate intermontane areas of western N. America. In central Asia, L. phaedrophthalma is presently known to occur primarily on hard, calcium-poor silicates, on sloping to overhanging surfaces at high elevations (2700 to over 5000 m) (Poelt & Grube, 1993). In contrast, North American material occurs on a wider variety of substrates and slopes

Bruce D. Ryan

(including horizontal surfaces and the tops of rocks), at lower elevations (700-1900 m), mainly in the steppes of the Great Basin and foothills of the Rocky Mountains. Specimens from the Pacific Northwest, collected on volcanic rocks (often spreading onto mosses or pockets of soil) closely resemble the holotype of L. phaedrophthalma and form small, discrete, mound-shaped thalli that are usually epruinose, and the discs are often strongly convex and darkened. In the variant that was recognized in 1975 as Lecanora christoi W. Weber (holotype, COLO!), from calcium-enriched sandstone in the southwestern U.S., typically the thallus forms rather large, often coalescing, somewhat flattened rosettes with a frequently pruinose upper surface towards the center, and the discs are often rather pale and only moderately convex. However, these extremes are connected by intermediates, and both Asian and North American material is morphologically and chemically variable. So far we have seen no obvious correlations between chemistry and other characters in this complex. Lecanora phaedrophthalma appears to have affinities with various other species that are all endemic to central Asia.

Bruce D. Ryan

**Lecanora subg. Placodium s. l.: Names of Uncertain Application**

Parmularia brouardii B. de Lesd.,

Rev. Bryol. et Lichénol. n.s. 12: 58 (1942).

The type is lost; the taxon may belong in L. novomexicana complex, but the description is too vague for positive identification.

L. muralis var. brouardii (B. de Lesd.) Zahlbr.,

Cat. Lich. Univ. 5: 637 (1940).--Parmularia muralis var. brouardii B. de Lesd., Ann. Crypt. Exot. 5: 118 (1932).

The type is lost; the taxon is not the same as Parmularia brouardii, and does not belong under L. muralis, but the description too vague for positive identification.

Bruce D. Ryan

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Bruce D. Ryan

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