LICHENOGRAPHIA THOMSONIANA: NORTH AMERICAN LICHENOLOGY
IN HONOR OF JOHN W. THOMSON.
EDS: M. G. GLENN, R. C. HARRIS, R. DIRIG & M. S. COLE.
MYCOTAXON LTD., ITHACA, NY. 1998.

LICHENS OF GRANITIC PEAKS IN THE BITTERROOT RANGE, MONTANA AND IDAHO, USA

Bruce McCune

Department of Botany and Plant Pathology, Oregon State University, Corvallis, OR 97331-2902

ABSTRACT. Lichens on the high peaks and ridges of the Bitterroot Range are of particular interest because the Bitterroot Range lies near the eastern edge of the peninsula of oceanic influence into western Montana. The crest of the Bitterroot Range lies at the top of the huge Idaho Batholith, the largest mass of granite within the relatively maritime region of western Montana. A total of 218 species of lichenized fungi were found, distributed among 80 genera. *Lecidea syncarpa*, new to North America, is a common species in the Rocky Mountains. A species close to *Diplotomma alboatrum* is described in detail. It occurs on vertical rock surfaces and beneath sheltered overhangs. A key is given for sterile white crusts on soil or moss in the alpine. *Lecanora swartzii,* new to North America, also occurs beneath overhanging rocks.

INTRODUCTION

Only a handful of lichen studies have been published for alpine areas of the northern Rocky Mountains in Montana, Idaho, and adjoining British Columbia and Alberta. Imshaug's "Part I" describing alpine macrolichens of the western states (Imshaug 1957) gave high hopes for a "Part II" which never arrived. Recent lichen floras (Goward and McCune 1994, McCune and Goward 1995) included alpine macrolichens, but the crustose alpine lichens have been included only in floristic works for a few areas (e.g. DeBolt and McCune 1993, Eversman 1995). A comparison of the list in this paper with the few papers including alpine lichens from the Cascade Range (e.g. Douglas 1974, Ryan 1985) will show that the alpine areas of the Rockies and the Cascades have many differences. The most useful comprehensive keys for alpine crusts in the northern Rockies remain, therefore, Thomson (1979), Bird (1970), and McCune (1997).

The species list presented in this paper probably represents less than half of the total alpine lichen flora of the northern Rockies. I base this guess on the combination of our ignorance and inclusion of only granitic rocks in this study. The present paper includes a list of species, ecological notes, extended descriptions of selected species, a key to whitish sterile crustose species, and a briefly annotated checklist.

STUDY AREA

The high peaks and ridges of the Bitterroot Range lie near the eastern edge of the peninsula of oceanic influence into western Montana (McCune 1984). The crest of the Bitterroot Range lies at the top of the huge Idaho Batholith, the largest mass of granite within the relatively maritime region of western Montana. Most of the other high ranges in western Montana are primarily of sedimentary rock, with notable exceptions in the Anaconda Range and the Beartooth Plateau. Most of the granites in the Idaho Batholith are granodiorite and quartz monzonite (Ross 1963).

Climatic data are unavailable for the high mountains of the Bitterroot Range. Summers are warm yet short and often have prolonged dry periods. During the rest of the year precipitation is frequent, though often in small amounts. Snowfields often persist well into July although wind exposed ridges and peaks are relatively snow free through the winter.

All collecting sites reported here are on peaks and ridges over 2000 m in elevation. This study includes the highest peak in the Bitterroot Range, Trapper Peak, at 3080 m. The major collecting sites (Table 1, Figure 1) are all non forested. They range from broken subalpine forests to true alpine communities with no trees even in spots with adequate soil. Many of the sites had krummholz or scattered small trees around the edges. All of the sites are extremely rocky and many have almost no soil development.

Table 1. Primary collecting sites at elevations over 2000 m, in order of increasing elevation (States: MT=Montana, ID=Idaho).

Site	Elev., m	State	County	Lat.	Long.
Bear Cr. Overlook	2165	MT	Ravalli	46°23'	114°17'
Skookum Butte	2195	MT	Missoula	46°39.5'	114°23'
Castle Rock	2350	MT	Ravalli	45°53'	114°27'
Big - Sweathouse divide	2500	MT	Ravalli	46°28'	114°14'
Grave Peak	2520	ID	Idaho	46°23.5'	114°44'
Ingomar Peak	2590	MT	Ravalli	46°13'	114°25'
Salmon Mt	2624	ID	Idaho	45°37'	114°50'
Lolo Peak	2750	MT	Lolo	46°40'	114°15'
Little St. Joseph Peak	2753	MT	Ravalli	46°36'	114°13'
Canyon Peak	2755	MT	Ravalli	46°15'	114°21'
Sweeney Peak	2780	MT	Ravalli	46°39'	114°13'
St. Mary's Peak	2845	MT	Ravalli	46°31'	114°14'
El Capitan	3043	MT	Ravalli	46°01'	114°24'
Trapper Peak	3080	MT	Ravalli	45°53.5'	114°18'

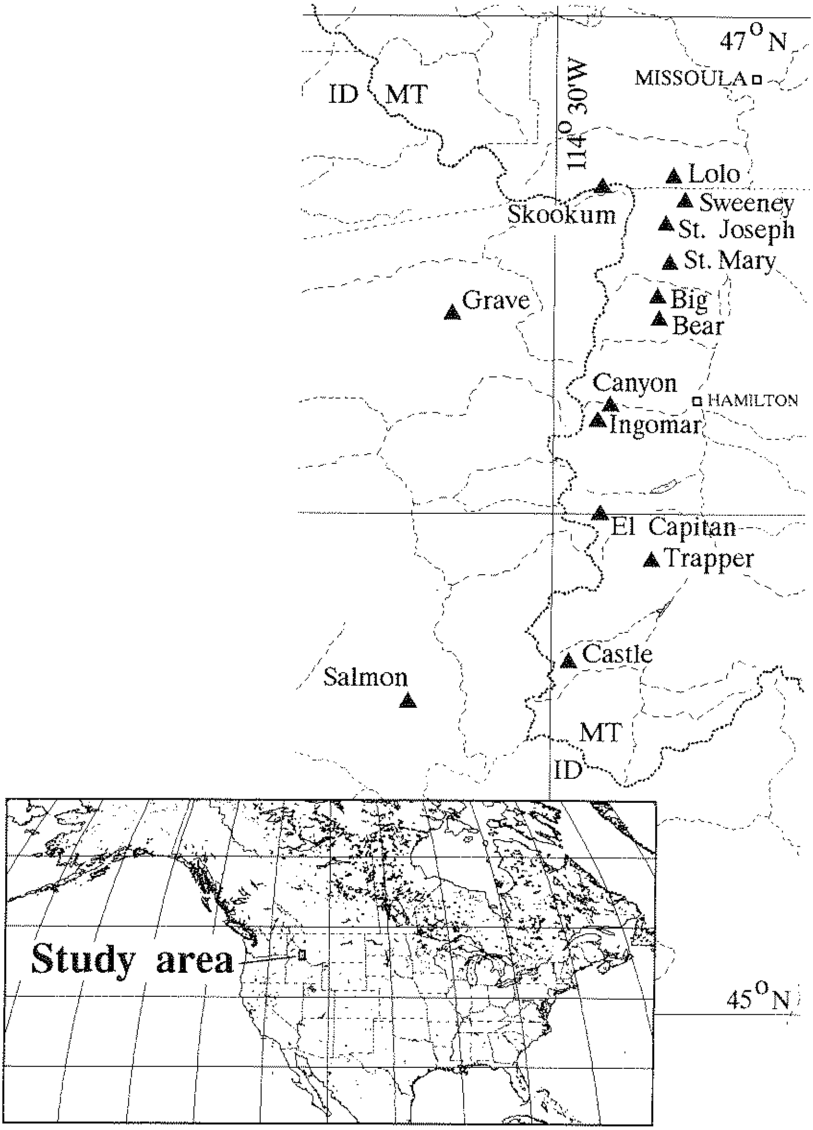

Figure 1. Major collecting sites (triangles) and location of study area. Small squares are towns. The Montana-Idaho border is shown by a dotted line.

METHODS

Each site was visited on only one day, with the exception of St. Mary's Peak which was visited twice. Collecting effort was fairly uniform across the sites, except for less time spent at Bear Creek overlook. Vouchers were collected for most species at most sites, but some common species were simply recorded without collecting. Approximately 1000 collections were made. Vouchers are primarily in the author's herbarium and OSC, with smaller numbers in WIS. Nomenclature mainly follows Esslinger and Egan (1995).

RESULTS AND DISCUSSION

Biodiversity

A total of 218 species in 80 genera were found. This total is much smaller than that of the alpine lichens of the Rocky Mountains because calcareous substrates are not represented in this study. The list given below is, however, fairly typical of siliceous alpine sites in the Rocky Mountains.

A few species are conspicuous by their absence. *Evernia divaricata* and *Dactylina madreporiformis* are common on the high granitic areas of the Beartooth Plateau in southern Montana and northwestern Wyoming, but these species are apparently absent from the Bitterroot Range. *Dactylina arctica* is common in the Canadian Rockies but still has not been found in the Rocky Mountains in the U.S. *Umbilicaria proboscidea* is another species common in the Canadian Rockies but apparently absent in the Bitterroot Range. *Cornicularia normoerica* is fairly frequent in the Cascade Range of Oregon and Washington, but is very rare in Montana, where it is not known south of Glacier Park (DeBolt and McCune 1993; McCune and Goward 1995).

Given the elevation range included in this study (2000-3080 m), one might expect a number of species to be restricted to one end or the other of this range. Certainly the low elevation sites include more species requiring woody substrates. A few species occurred only at the highest sites, for example, *Dactylina ramulosa*, *Sporastatia polyspora*, and the possibly undescribed black-fruited *Caloplaca*.

Alpine Habitats in the Bitterroots

Extensive alpine fellfields occur in only a few areas, one of the largest being on Lolo Peak. Alpine communities in the Bitterroot Range are mostly small, local, and poorly developed. This derives from several factors: elevation, topography, and snow, as described below. Elevations are rather low (compared to the Beartooth Plateau) for developing alpine communities at this latitude. Most of the sites had peripheral small trees. The peaks and ridges are steep and very rocky, with little soil development, greatly restricting the potential for terricolous lichen development. Snowpacks are deep in many microsites, excluding all but a few lichens tolerant of prolonged burial by snow.

Combining these factors results in many alpine lichens being restricted to a very narrow habitat on many of the peaks: cliff ledges and short slopes near the crest of peaks on the northwest side. This is the intersection of the most favorable areas on two independent gradients: the temperature gradient, with alpine lichens favoring cooler northerly aspects, and the wind/snowpack gradient, with lichens favoring the windswept western faces. Thus the best alpine lichen development in the Bitterroot Range is usually near the crest of northwestern slopes, combining cool temperatures and low snow accumulation. Because of the steep topography, the terricolous alpine lichen communities are often restricted to cliff ledges just off the NW side of the summits.

Communities Beneath Overhangs

Lichens beneath sheltered overhangs and cliff faces often formed complex mixtures of interesting species. Some of these species are in the *Lecanora rupicola* group. Examination of this group in light of Leuckert and Poelt (1989) has refined our understanding of this group. *L. swartzii* (Ach.) Ach., new to North America, is quite distinct morphologically from the rest of the group, having almost stalked areoles and apothecia. It was found at four locations (Castle Rock, Ingomar Peak, Little St. Joseph Peak, and Skookum Butte, in all cases beneath overhangs. *L. rupicola* sens. str. turns out to be essentially absent from the northern Rockies, most of the previous reports actually being *L. bicincta*. West of the Cascade crest the pattern reverses and *L. rupicola* is much more common than *L. bicincta* but occasionally (Siskiyou Mountains) they co-ocur. All three taxa in Europe have two or more subspecies differing in chemistry (Leuckert and Poelt 1989), but I found it difficult to assign the North American specimens to subspecies based on spot tests.

Lecanora swartzii is a component of the distinctive community that grows beneath overhanging rocks. Other species restricted to this habitat are *Lecanora pringlei, Fuscidea praeruptorum*, and the *Diplotomma* species discussed below. Curiously, the two *Lecanora* species and the *Fuscidea* have very similar growth forms, being stalked areolate to almost fruticose. *L. argopholis*, when growing in this habitat, also assumes this growth form. Surely these are extremely stable habitats where longevity can be obtained by adopting a growth form that allows thickening in place rather than rapid lateral expansion.

Lecidea syncarpa Zahlbr. Verh. Zool.-Bot. Ges. Wien. 68:10. 1918.
Syn.: *Lecidea gneissicola* Zahlbr. Ann. Mycol. 17:235. 1919.
Lecidea saxosa R. A. Anderson (nomen nudum)

Lecidea syncarpa is a fairly common species in the Rocky Mountains. This taxon was tentatively described as a new taxon, "*L. saxosa*", by Roger Anderson (1964) but this description was never formally published. In correspondence Dr. Anderson mentioned that he had found this to be synonymous with the European *L. syncarpa*. This fact is noted in Hertel (1995). This species is apparently poorly known and rare even in Europe. The following description is based on notes sent to me by Dr. Anderson, along with my own observations on variability.

Thallus to 15 cm diam., rimose areolate to areolate or subsquamulose, brown, pale brown, or yellowish brown, less often greenish tinged; **areoles** to 2-3 mm diam., usually contiguous, occasionally somewhat dispersed, sometimes whitish or blackish edged; **prothallus** black or nearly so (occasionally whitish in spots), often conspicuous between the areoles or at the thallus margin, but occasionally not apparent.

Apothecia lecideine, black or somewhat whitish pruinose, to 3 mm diam., usually sessile to slightly elevated above the areoles; **disc** initially concave or flat, later convex; **margin** thin to somewhat thick, usually persistent except in strongly convex apothecia; **exciple** bluish green or olivaceous at the edge, pale or hyaline within or greyish-cloudy from crystals of norstictic acid, forming K+ rusty crystals; **hymenium** 45-55(60) μm high, I+ blue-green, the asci I+ red brown; **epihymenium** blue green or olivaceous; **subhymenium** hyaline or nearly so; **hypothecium** brownish or pale brown; **ascospores** 8-13 x 3-5(7) μm, simple, 8/ascus; **conidia** not seen.

Chemistry: Cortex I+ blue, K+ red, P+ yellow, C-; Medulla I+ blue or purple, K-, P-, C-. Contains norstictic acid (TLC).

Taxonomy: This member of the *Lecidea atrobrunnea* group is easily recognized its typically pale brownish, K+ red thallus and I+ blue medulla. For a description of the European material see Hertel (1970).

Distribution: Rocky Mountains in North America from western Montana south to Colorado and Utah; also in Europe (Austria, Spain).

Ecology: The substrate is typically siliceous rock, but occasionally this species is found on calcareous rock. It is usually in the subalpine to alpine zones in exposed to somewhat sheltered sites, but extends down into cool steppe communities (e.g. the Idaho location below).

Representative Specimens Seen: USA. COLORADO: Clear Creek County, N-facing slope between Squaw Mt. and Chief Mt., 39°41'N 105°30'W, 3440 m, *Anderson 5426, Lich. Western N. Amer. No. 38*; Summit County, North Star Mtn. near Blue Lake Reservoir, T8S R78W S3, 3600-3900 m, *Anderson 9160*. IDAHO: Custer County: Lost River Range, above Bear Creek, 43°49'N

113°28'W, 2200 m, *McCune 19734*; Fremont County, E of Henrys Lake, 44°38'N 111°18'W, 2100-2700 m, *Anderson 10246*. MONTANA: Gallatin County: Madison Range, ridge above Beaver Creek, 45°10'N 111°22'W, 2835 m, *McCune 15757*; Ravalli County: Bitterroot Range, summit of El Capitan, 46°01'N 114°24'W, 3043 m, *McCune 13067*. WYOMING: Park County: Beartooth Plateau, 44°59'N 109°26'W, 3150 m, *McCune 19894*. (all specimens in herb. McCune).

Additional Locations: Roger Anderson provided me with location data for the following additional states and counties, but I have not seen the specimens. COLORADO: Boulder, Garfield, Grand, Hinsdale, Larimer, Mesa, Ouray, Pitkin, San Juan, and San Miguel Counties. UTAH: Duchesne County (Uinta Mts.). WYOMING: Carbon County (Snowy Range Pass).

Diplotomma sp.

Thallus indistinct, becomming verruculose to bullate, the verrucules or areoles typically 0.1 to 1.0 mm diam., dull olive brownish but in one case grayish pruinose.

Apothecia lecideine, 0.3-0.7(1.0) mm diam.; **disc** initially flat but soon convex to hemispherical, black, often lightly but distinctly pruinose; **exciple** soon disappearing as the disk becomes convex, brown in section, the edge about 50 μm thick; **hymenium** ca. 125 μm high, not inspersed with oil drops; **epihymenium** brown, with superficial hyaline to yellowish granules; **hypothecium** brown; **ascospores** 16-19 x 7-10 μm, submuriform to muriform, with about 4 transverse walls and 1-2 longitudinal partitions, greyish to brown, 8/ascus; **conidia** not seen.

Chemistry: No lichen substances known; spot tests negative except hymenium, hypothecium, and exciple amyloid (I+ blue).

Taxonomy: Only two saxicolous *Diplotomma* species are known from the Rocky Mountains. *D. alboatrum* has muriform spores while the norstictic-deficient chemotype of *D. venustum* (= *D. epipolium*) has 3-septate spores. The species reported here is in the *D. alboatrum* group. That species typically occurs on calcareous rock, has a whitish thallus, and often a pseudothalline margin. The Montana material is close to descriptions of *D. ambiguum*. *Diplotomma ambiguum* was recently synonymized under *D. alboatrum* (as *Buellia alboatrum* in Nordin 1996). Nordin considered *D. ambiguum* to be an epruinose form occurring on siliceous coastal rocks in Scandanavia. Because of the complex taxonomic history and extremely variable morphology of *D. alboatrum*, a satisfactory disposition of the material from Montana must await the North American revision of this group by Anders Nordin.

The specimens are sometimes confused by associated *Amandinea punctata*. This species and the *Diplotomma* are sometimes intricately intermixed. The *Amandinea* has a thinner and usually more prominent exciple (about 20 μm thick), lacks the superficial granules on the epihymenium, and has two-celled spores. Both the *Amandinea* and *Diplotomma* can grow on a similar thallus, so

Lecidea tessellata
Lecidella elaeochroma Mt
Lecidella patavina Mt
Lecidella stigmatea Mt
Lecidella wulfenii Mt
Lecidoma demissum Mt
Lepraria cacuminum
Lepraria neglecta
Leprocaulon subalbicans
Leptochidium albociliatum
Leptogium lichenoides
Leptogium subaridum (Salmon Mt., Idaho; extremely isidiate, forming a compact tuft over *Grimmia;* medulla similar to that of *L. magnussonii*) Id
Letharia columbiana Mt
Letharia vulpina Mt
Lobaria linita (rare, Grave Peak only; see McCune 1984) Id
Massalongia carnosa Mt
Megaspora verrucosa Mt
Melanelia disjuncta
Melanelia elegantula Mt
Melanelia infumata Mt
Melanelia panniformis Mt
Melanelia sorediosa Mt
Melanelia stygia Mt
Melanelia subelegantula Mt
Melanelia subolivacea Mt
Melanelia tominii Mt
Miriquidica garovaglii Id
Miriquidica griseoatra Mt
Miriquidica leucophaea Mt
Mycobilimbia fusca Mt
Nodobryoria abbreviata
Nodobryoria subdivergens Mt
Ochrolechia androgyna Mt
Ochrolechia inaequatula
Ochrolechia upsaliensis Mt
Ophioparma lapponicum
Pannaria pezizoides Id
Pannaria praetermissa Id
Parmelia omphalodes ssp. *pinnatifida* Mt
Parmelia omphalodes Mt
Parmelia saxatilis
Parmeliopsis ambigua Mt
Peltigera aphthosa
Peltigera canina
Peltigera collina Mt
Peltigera didactyla Mt
Peltigera kristinssonii Mt
Peltigera lepidophora Mt
Peltigera leucophlebia
Peltigera malacea
Peltigera ponojensis
Peltigera rufescens Mt
Peltigera venosa Mt
Phaeophyscia sciastra Mt
Phaeorrhiza nimbosa Mt
Physcia dubia
Physcia phaea Mt
Physconia enteroxantha Mt
Physconia muscigena
Physconia perisidiosa Mt
Placynthiella oligotropha Sometimes dominant on soil on solifluction lobes but also common on many other microsites. Mt
Placynthiella uliginosa
Platismatia glauca Mt
Polychidium muscicola Id
Polysporina simplex
Porpidia glaucophaea auct. (see Gowan 1989)
Porpidia crustulata Mt
Protoparmelia badia
Pseudephebe minuscula
Pseudephebe pubescens Mt
Psora nipponica Mt
Psoroma hypnorum
Pyrrhospora elabens Mt
Rhizocarpon disporum Mt
Rhizocarpon eupetraeum Mt
Rhizocarpon geminatum Mt
Rhizocarpon geographicum
Rhizocarpon grande

Rhizocarpon hochstetteri Mt
Rhizocarpon macrosporum Mt
Rhizocarpon polycarpum Id
Rhizocarpon pusillum Mt
Rhizocarpon riparium
Rhizocarpon superficiale Mt
Rhizoplaca melanophthalma Mt
Rimularia insularis Mt
Rinodina archaea Mt
Rinodina mniaraea Id
Rinodina turfacea Mt
Solorina crocea
Sporastatia polyspora
Sporastatia testudinea
Staurothele areolata Mt
Stereocaulon alpinum Mt
Tephromela aglaea Mt
Tephromela armeniaca
Thamnolia subuliformis
Trapeliopsis granulosa Mt
Umbilicaria angulata Id
Umbilicaria decussata Mt
Umbilicaria deusta
Umbilicaria havaasii Mt
Umbilicaria hyperborea
Umbilicaria krascheninnikovii
Umbilicaria lambii Mt
Umbilicaria phaea Mt
Umbilicaria torrefacta Mt
Umbilicaria vellea
Umbilicaria virginis
Verrucaria sp. Mt
Xanthoparmelia coloradoensis
Xanthoparmelia lineola Mt
Xanthoria candelaria Mt
Xanthoria elegans Mt
Xanthoria sorediata Mt

Key to Sterile White Alpine Crusts on Soil or Moss

Species included were found in or near the study area. Bracketed species were not found in the study area but are likely to be found there or nearby in the future. In many cases these species occur on soil or moss over rock. The *Lepraria* species are poorly known in North America and will require considerable revision.

1a Thallus minutely fruticose
  2a Thallus corticate, C+ red, K-, P-. Thallus warty sometimes becoming coralloid, usually with spiny extensions
   [*Ochrolechia frigida*]
  2b Thallus ecorticate, C-, K+ yellow or deep yellow, P+ yellow or orange
    3a Thallus P+ deep yellow turning orange (thamnolic acid and atranorin); phyllocladia poorly developed and blending onto pseudopodetia; widespread, common in many open habitats
     Leprocaulon subalbicans
    3b Thallus P+ pale yellow or P- (atranorin and rangiformic acid); phyllocladia and pseudopodetia well developed and differentiated (typically the thallus is so well developed that it would not be keyed here); uncommon
     [*Leprocaulon gracilescens*]

1b Thallus crustose
4a Thallus P+ yellow, deep yellow, orange-red, or pale orange
5a Thallus P+ yellow or P+ deep orange, K+ yellow, C-
6a Thallus P+ yellow (alectorialic acid); thallus smooth, superficially appearing corticate but actually not
Lepraria neglecta

6b Thallus P+ deep yellow turning deep orange (thamnolic acid + atranorin); thallus fuzzy, obviously ecorticate
Leprocaulon subalbicans (see above)

5b Thallus P+ pale orange, K-, C+ red (gyrophoric acid + unknown substance); thallus warty, grading to fine granules but not forming discrete soralia
Ochrolechia inaequatula

[The P reaction of *O. inaequatula* is unlike the rich oranges from stictic, norstictic, and thamnolic acids; instead it is a dull, pale orange, but nevertheless a distinct reaction.]

4b Thallus P+ pale yellowish or P-
7a Thallus C+ red, KC+ red, K-
8a Soredia not in discrete soralia but rather with a warty thallus grading into small granules; thallus P+ pale orange
Ochrolechia inaequatula (see above)

8b Soredia in discrete soralia or the soralia fusing into a continuous, finely sorediate crust; thallus P- (gyrophoric acid only)
Ochrolechia androgyna

7b Thallus C-, KC- or KC+ yellow, K- or K+ yellow
9a Thallus K+ yellow, containing atranorin
10a Thallus margin indistinctly to distinctly lobed; thallus containing rangiformic acid plus traces of other fatty acids
[***Lepraria borealis***]

10b Thallus margin diffuse or obscurely lobed; thallus containing porphyrillic and fatty acids, usually roccellic acid); both powdery and granular forms are known; cortex lacking; very common in exposed alpine and subalpine sites; widespread
Lepraria cacuminum

9b Thallus K-, atranorin lacking, forming large, corticate warts, never forming a powdery or finely granular thallus; widespread and common
Ochrolechia upsaliensis

[Although not usually sterile, juvenile, sterile colonies of *Ochrolechia upsaliensis* are occasionally found; these are KC-, C- or C+ yellow]

ACKNOWLEDGMENTS

I thank John Thomson, who contributed greatly to this work by countless hours spent teaching me crustose lichens. Most of the field work and much of the lab work was done while I was a student at the University of Wisconsin. During that time I was a regular pest at Dr. Thomson's office; nevertheless he almost always would put down whatever he was doing to help me through the maze of scattered literature and difficult characters. Many other lichenologists, too numerous to mention, have also contributed by helping with difficult specimens. But in particular I thank John Sheard for advice and comments on *Buellia, Diplotomma, Rinodina*, and related genera and, posthumously, Roger Anderson for sharing his information on *Lecidea syncarpa*. Thanks to Trevor Goward, Katie Glew, and Bruce Ryan, for reviewing the manuscript. For great company during the field work I thank Patricia Muir, Jeff Kooris, Elaine Johnson, Homer and Virginia McCune, and Jack Mefford.

LITERATURE CITED

Anderson, R. A. 1964. The genus *Lecidea* (lichenized fungi) in Rocky Mountain National Park, Colorado. Ph.D. Thesis, University of Colorado, Boulder.

Bird, C. D. 1970. Keys to the lichens of west-central Canada. Photocopies distributed by Department of Biology, University of Calgary. 171 pp.

Brodo, I. M. and V. Alstrup. 1981. The lichen *Bryoria subdivergens* (Dahl) Brodo and Hawksworth in Greenland and North America. Bryologist 84:229-235.

DeBolt, A. and B. McCune. 1993. Lichens of Glacier National Park, Montana. Bryologist 96:192-204.

Douglas, G. W. 1974. Lichens of the North Cascades Range, Washington. Bryologist 77:582-592.

Esslinger, T. L. and R. S. Egan. 1995. A sixth checklist of the lichen-forming, lichenicolous, and allied fungi of the continental United States and Canada. Bryologist 98:467-549.

Eversman, S. 1995. Lichens of alpine meadows on the Beartooth Plateau, Montana and Wyoming, U.S.A. Arctic and Alpine Research 27:400-406.

Gowan, S. P. 1989. The lichen genus *Porpidia* (Porpidiaceae) in North America. Bryologist 92:25-59.

Goward, T. and B. McCune. 1994. The Lichens of British Columbia, Part 1. Crown Publications, Victoria, BC. 181 pp.

Hertel, H. 1970. Beiträge zur Kenntnis der Flechtenfamilie Lecideaceae III. Herzogia 2:37-62.

Hertel, H. 1995. Schlüssel für die Arten der Flechtenfamilie Lecideaceae in Europa. Bibliotheca Lichenologica 58:137-180.

Imshaug, H. A. 1951. The lichen-forming species of the genus *Buellia* occurring in the United States and Canada. Ph.D. Diss., University of Michigan, 217 pp.

Imshaug, H. A. 1957. Alpine lichens of western United States and adjacent Canada. I. The macrolichens. Bryologist 60:177-272.

Leuckert, C. and J. Poelt. 1989. Studien über die *Lecanora rupicola*-Gruppe in Europa (Lecanoraceae). Nova Hedwigia 49:121-167.

McCune, B. 1984. Lichens with oceanic affinities in the Bitterroot Mountains of Montana and Idaho. Bryologist 87:44-50.

McCune, B. 1997. Key to the lichen genera of the Pacific Northwest. 70 pp., privately published.

McCune, B. and T. Goward. 1995. Macrolichens of the Northern Rocky Mountains. Mad River Press, Arcata, California.

Noble, W. J. 1982. The Lichens of the Coastal Douglas-Fir Dry Subzone. PhD Thesis, Univ. British Columbia, 942 pp.

Nordin, A. 1996. *Buellia* species (Physciaceae) with pluriseptate spores in Norden. Symbolae Botanicae Upsalienses 31:327-354.

Ross, C. P. 1963. Modal Composition of the Idaho Batholith. U.S. Geological Survey Professional Paper 475-C.

Ryan, B. D. 1985. Lichens of Chowder Ridge, Mt. Baker, Washington. Northwest Science 59:279-293.

Thomson, J. W. 1979. Lichens of the Alaskan arctic slope. University of Toronto Press. 314 pp.