EAST SIDE LICHEN REPORT

FOR WASHINGTON AND OREGON

BY

DR BRUCE RYAN

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Intro

ECOLOGICAL ASSESSMENT OF LICHENS OF THE COLUMBIA BASIN OF OREGON AND WASHINGTON

INTRODUCTION

Only in a few areas of the Columbia Basin of Oregon and Washington, have the lichens been studied intensively from an ecological perspective. The only previously published attempt 'to group lichens of this region into associations is the study by Cooke (1955) in Spokane, Stevens, and Whitman Counties of Washington. Only a few other studies in this region, mainly those by Douglas and Bliss (1977) in the north Cascades of Washington, and by Rossman (1992), in the Lawrence Memorial Grassland in Wasco County, Oregon, provide enough detailed information to relate particular lichen species to particular vascular plant communities or habitat types. Although fairly specific habitat data is available from labels for a few other localities, the collections in those areas have mostly not been very thorough or systematic. While a few additional areas have been collected rather intensively, the collections were not done systematically and the habitat data is mostly vague or minimal. Only in a few cases is there a little bit of definite information on ecological factors relating directly to particular lichen taxa. In addition, many specimens have not yet been identified (at least to species) or have been misidentified (sometimes grossly so).

Therefore my attempts to group species and discuss their ecology in this. report are very preliminary, and should be regarded more as hypotheses to guide future studies than as definite conclusions. Mostly I have tried to arrange species according to physiognomic provinces and vascular plant communities, and made inferences about physical and biological factors from this, supplemented by additional information when it was available, from label data or the literature. This involves a lot of assumptions and extrapolations, that may or may not be valid. Although I have cited information from studies done in other parts of the country or world, I have mostly tried to emphasize what little information was available that related directly to the Oregon and Washington parts of the Columbia Basin. Due to time limitations, I have not been able to been as thorough as I might have liked, neither in searching herbaria and literature nor in analyzing and interpreting the information. However, I hope that this report will be a useful first contribution to what should eventually be a major study.'

The first part of this report lists major species and species of special concern, with general summaries of information about their distribution and ecology, and gives a broad outline of functional groups or habitat associations, and a discussion of the preferences of these species and groups for various successional stages.

The second part provides more detailed information and discussions about biogeography and ecology, and also includes the literature citations and some appendices.

METHODS

Intro

Label data used in this report are primarily from the following herbaria: Arizona State University (ASU); Oregon State University (OSC--including collections formerly in ORE); University of British Columbia (UBC), University of Washington (WTU); Washington State University (WSU); 'Western Washington University (WWB), and the private herbaria of John Davis, Linda Geiser, Roger Rosentreter (at Boise State University), and Bruce Ryan (on loan to ASU and WWB).' A partial printout of.a database from OSC, prepared by Sherry Pittam, was also used. For certain species of the genera Lecanora'and Rhizoolaca, data from additional herbaria were used.

Due to time limitations, recording of label data was not.comprehensive. In general, only the following information from the labels was recorded:. Collector, collection number, state, county, elevation, substrate, and ecological notes; specific locality data was recorded only in some cases (primarily where county or elevation were not given on the label). .At most of the herbaria, emphasis was placed on genera most likely to occur east of the Cascades (this may have resulted in some loss of information from'the larger herbaria, as more thorough searches in smaller herbaria showed that some genera expected to be strictly "west side", such as Lobaria, have occasionally been collected on the east side). Data for localities for which no county were given were usually not recorded, unless quickly recognized as being on the east side of the Cascades.

Especially in the larger herbaria, the focus was on macrolichens and selected crustose taxa that were expected to be more likely to be correctly identified. Only a few of the identifications were checked (primarily cases where checking could be done quickly). Determinations made by monographers or at least workers fairly likely to be competent in the particular group were generally accepted, and the name of the determiner was recorded in most such cases. Identifications that were especially likely to be dubious (especially in cases were the species concept has narrowed or changed considerably in recent years) were recorded, but in this report are given in quotation marks or with "s. lato" or other hedging.

A limited amount of data from taxonomic monographs or other literature was also used in this report. It should be noted that in the few cases where monographic studies have been made, specimens from herbaria other than those I visited often greatly increased the known distributions of the species within the Oregon-Washington part of the Columbia Basin, which suggests that more extensive herbarium searches in the future would be desirable.

ADDITIONS AND CORRECTIONS TO FAST SIDE CONTRACT REPORT

Nov. 21, 1994

MISCELLANEOUS

The tables were prepared rather hastily, and may not reflect the actual data as we.11 as I would have liked, but I just didn't have time and don't now either; You can use my data and make your own tables if you want, for your report, but I guess mine should be left the way they are for my report.

The changes include'all the ones suggested in the Peer Review (and minor changes indicated by Janet in the margins on the hard copy she read), plus a lot more that I simply did not catch or have time'to deal with before mailing the diskettes, because Janet had the only updated printouts of the documents. * = suggestions from Janet (marked on my printouts)

I did not get around to making a detailed table of contents and decimal outline for the document as a whole, nor for the longer documents (except for decimal outlines in the Ecological Groups documents, and other kinds of outlines in a few others).

Some pages will be blank (due to my use of forced page breaks), or have "widows" or "orphans" (one or two lines only) or other screw-ups. Sorry 'bout that.

I think somewhere I listed Thelomma "occidentale"; this may have been supposed to be T. occellatum (e.g., Union Co., O` R)

Quotation marks, s. lato, or cf. could be added to Xanthoria polycarpa" and a lot of others, but it probably does not matter that much.

My arrangement and abbreviation of the words in the names of the provinces is not consistent. To shorten the documents, use replace commands to abbreviate "Northeast" to "N.E.", "East" to "E", "and" to "&", etc. where I have.not done so. I also have not been consistent about giving "subprovinces" for OR, and did not give them for WA at all, because I did not get the detailed maps in time.

To shorten the documents, genera with only one species (at least in the Columbia Basin), such as Pseudotsuga menziesii, or Hydrothyria venosa, can be given without the specific epithet (use "replace"), at least after the first mention in a particular section; I have not been consistent about doing this.

Additions

I have not been consistent about using complete sentences, punctuation, and other details like that, but frankly at this point I don't have time.

Literature citations **to be inserted** or changed:

The following literature citations go in the text (I am not sure off hand where, but you'll see where they are needed as you read the report). One is on the destructive effects of lichens (e.g., Evernia prunastri) **on trees; there is an** empty "( )" **after reference to this, which needs to be filled with "Legaz, et al., 1988". The other is a reference to agricultural chemical effects on lichens; it is incorrectly cited as "Seaward** (1977)", **and it should be "Gilbert (1977) ". The reference to a geological map of** the Pacific **Northwest should be cited as** Bennison, **et al. (undated). I was not able to find a citation for "Rossman, 1977"; I presume it is just an earlier edition of "Rossman, 1992".**

INTRODUCTION

Minor corrections (use search/replace)

*"Cooke **(19)" 'should be "(1955) ". "Douglas and Bliss** (19)" **should be "(1977) ".**

***"data is" should be "'data are" "A limited amount of data . . . was" should be "A limited amount of data is".**

*"able **to been" should be able to "able to be".**

"WSU" **should be** "WS".

Additions

"EAST SIDE CONTRACT"
"RESULTS AND DISCUSSION PART ONE"
1. Biogeography

Title. of section should be simply "1. BIOGEOGRAPHY". The "PART ONE" is a left over from my initial attempt to divide the entire report into two parts. "EAST SIDE CONTRACT" should not be part of a-heading;

*Insert comments from Janet's peer review (collections in Columbia Gorge area; "excellent range conditions", etc.) as you see fit.

*OREGON. Baker Co.: "excellent range conditions" [*for cattle??]. Hood River Co.: *Nash and company collected on OR side of Columbia Gorge in Aug., 1994

"[Possibly interesting areas1 . Heading should be "AREAS OE KNOWN OR POTENTIAL INTERESt OR CONCERN" (in bold, all caps, without []).

"Contributions of Federal lands". Heading should be in ALL CAPS. Since the maps of land ownership arrived late, and at any rate I already spent too much time trying to guess at it from other maps, my discussion of this topic is brief, and does not reflect the data very well. See the "Localities" document for'an idea of what land ownership areas have been visited by collectors; see "Collecting Data" documents for an idea of which areas had rich or unusual floras.

"Co tribution of non-FS/BLM lands". Should be space between heading and previous paragraph.

Additions

"RESULTS AND DISCUSSION"
"PART 1"

Title of section should be "2. MAJOR SPECIES AND SPECIES OF SPECIAL CONCERN". Janet's reference to "RESULTS AND DISCUSSION PART 2" is based on my pencilled in change of 1 to 2; the "PART 1" is a left over from my initial attempt to divide the entire report into two parts.

***"Alstrup (19)" should be "Alstrup (1994) ".**

Habitat: This should say that "more detail . . . is presented in Sections 3 and 5" (rather than "in part 2".

Role(s): *Many lichens provide food or habitat for invertebrates and microbes, but few data are available as few studies have been done, especially in the Columbia Basin area; cite general review of this subject by Gerson & Seaward (1977). Actually, this whole discussion of role(s) could be integrated with the Functional Groups document, which could then be referred to here.

Sensitivity: In connection with air pollution, cite.Ryan & Rhoades (1992) after Peterson, et al. (1992); cite general review by Nash & Wirth (1988); and cite Ryan (1990) as the source of information on sensitivities of particular species. In connection with agricultural chemicals, cite Kauppi (1980). Mention effects of volcanic eruptions (e.g., burying by ash) and cite Harris, et al. (1987). The part of the text beginning with "Sensitivity of lichens to air pollution" should be a separate paragraph.

"Major Lichen Species . .."

Title of section should be in ALL CAPS

The " *" for "no specific information" is unnecessary; headings followed by that, or nothing, should simply be deleted.

"+ = Info. from Saxicolous by Zone document incorporated" at beginning, and "+" signs throughout, should be eliminated.

***Taxonomic/nomenclatural problems are dealt with mostly in Master Species List, but if you want you can put them here also. Although some high elevation "Acarospora chlorophana" may be Pleopsidium, this is not necessarily true of all such material. Likewise, although guesses could be made about, e.g., which Umbilicaria "vellea" collections are actually U. americana, there's already enough uncertainty involved in citing specimens under names that may be incorrect; basically the identifications**

Additions

of the majority of specimens and reports are suspect.

"--Habitat: Distribution: Role(s): Sensitivity:" at the beginning, without any information, should be deleted. Longer forms of these headings under some species names (e.g., Dermatocarpon spp. (vagrant forms) should be shortened.

There are some differences between what I called "major species" in this document and what I included as "major species" in some of the tables.

Distribution

The information on distribution of the major species is based on counties cited in the "Master Species List", without looking closely at collections from counties that include two provinces. This probably is not as critical for these major species as it is for the rarer ones. Distribution maps would have been more useful for getting a good idea of where the species occur, since the location and number of dots would'give more precise information.

Special concern major species

I did not indicate which of the major species are also of "special concern", but the following could be indicated as such with an asterisk (*) before the name (and an explanation of that at the beginning):

> Alectoria sarmentosa, fuscescens:emontii, **Brvoria** I
> Brvoria spp., Collema spp., Leptochidium albociliatum, Leptogium californicum/lichenoides, Peltigera aphthosa **complex,** Peltigera "canina", Peltigera rufescens **s. lato**

Typographical errors, **etc. (use** "replace" **when** possible)

*"shadead" **should be "shaded"**

"Rhizocapon" **should be** "Rhizocarpon".

*"Alstrup **(19)" or** "(199)" **should be "(1994)** ".

The information would be easier to follow if the topics (Habitat, etc.) were separate paragraphs, or their headings were in ALL CAPS or numbered (these last two types of changes can be done by "replace").

Space needs to be inserted between some of the species names and the previous paragraphs (which ones may vary depend on how the documents are printed), e.g., before "Peltigera spp.", "Vulpicida canadensis", and "Xanthoparmelia mexicana/plittii".

Additions

Maser, et al (1985) and Hayward & Rosentreter (1994) should be cited in connection with squirrel nests under Bryoria **spp.**

"Lumbsch (19)" should be "(1989)".

"Poelt", **under** Diploschistes muscorum, **should be** "Poelt **(1969)** ".

"Boykin, **unpublished" should be** "Boykin **(1989)** ".

"Richardson, Vanishing Lichens" should be "Richardson (19751".

Additions,

"Additional Species of Special Concern..."

Title should be in ALL CAPS.

Topics followed only by *'s or nothing should be eliminated, and other changes as suggested above should be made.

Again there are inconsistencies in what I considered special concern species'in the various, tables.

The information that was under a separate heading called "Rare Species" in the first rough draft I sent needs to be incorporated into this section instead, as indicated below. The following statement needs to be added to the introduction of the "Special Concern" subsection:

> None of the special concern species'had FWS Status or ODA Status as of 1991, unless noted otherwise. "G" ranks are from a a preliminary compilations by Pittam (1989, 1991). for North America north of Mexico; G1 and G2 are "rare and and endangered throughout" the species's range. Information on species on OHNP (Oregon Natural Heritage Program) lists comes from an unpublished list by John Christy and a book on rare and endangered plants of Oregon by Eastman (1990); I do not have access to that book at present, so I am unable to say what the lists mean, but John Christy or someone else with OHNP can explain them. John may also have an updated version of his list of rare'lichens of OR; which would provide much more information.

I have still not put in information on "Population trends" for most of 'the special concern species, because although we know that the habitat is threatened in many cases, and that there are other, direct threats, this is covered under "Sensitivity", because there are no real data on changes in populations of. lichen species, per se.

"Apparently Rare Throughout Their Range . .."

Although they are mentioned in the introduction to this group, Carbonea vitellinaria and Rimularia insularis (and other lichenicolous taxa not mentioned) are not given separate treatments, because their host species are common,' and the apparent rarity of the lichenicolous taxa is probably due to insufficient data.

To save time and space I am treating a some groups of species together below, when the general information is similar and no specific data are available.

Arthonia alebosa, Biatorella hemispherica, Caloplaca

Additions

tominii, romatochlamys muscorum v. octosporum, Texasporium sancti-jacobi--**Role(s): Soil binding and enhancement. Sensitivity: Habitat destruction (replacement of bunchgrass by annuals),; direct trampling and manuring by livestock; possibly agricultural chemicals or eutrophication.**

Vagrant taxa/modifications of Aspicilia **spp.,** Rhizoplaca melanophthalma **s. lato, etc. (same considerations for all or most fruticose spp.)--Role(s): Soil enhancement** in the **sense of contributing organic matter;** A. reptans **also binds the soil. Sensitivity: Habitat destruction (replacement of bunchgrass by annuals); direct trampling and manuring by livestock; possibly agricultural chemicals or eutrophication.**

Bryoria **spp., and** Tuckermannopsis pallidula**--Role(s):** Precipitation interception/nutrient **cycling. Sensitivity: Logging and fire; probably also air pollution.**

(: -• H a b i t a t : On bark or bryophytes over bark of mature hardwood trees. Distribution: E. Slope of Cascades, WA (Klickitat Co.).

Chromatochlamys muscorum v. octosporum--On **OHNP List 3.**

Euopsis granatina--Habitat: On rock. Distribution: E. Slope of Cascades, WA (Yakima Co.: Little Naches). **765 m.**

Gyalecta jenensis--**Habitat: On rock. Distribution: E. Slope of Cascades, WA (Boulder Cave, Yakima Co.). "A rare, inconspicuous lichen" (Howard,** 1950)

"Haematomma pàcı icum"--According to Egan (1987), **the identity of this** taxon **is "uncertain". Habitat: On** Pseudotsuga. **Distribution: E. Slope of Cascades, OR (Hood River' Co.). 120 .m.**

Hypogymnia ruaosa**--Delete (the one record is based on misidentification of** H. occidentalis).

Lecania dubitans--Habitat: On bark. Distribution: E. Slope of Cascades, WA (Klickitat Co.).

Melaspil proximella--Habitat: On root (wood) of Pseudotsuga. **Distribution: E. Slope of Cascades,.WA (Klickitat Co.: Falcon Valley).**

Phylliscum demangeonii**--Habitat: On rock. Distribution:** E.

Additions

Slope of Cascades, WA (Klickitat Co.).

"__enopsis melambola"--Delete. This now has a new name, which I don't remember offhand. The species isn't in the Master Species List, and therefore was probably from a locality that I decided was not east of the Cascades. In any case, it is an inconspicuous, difficult to recognize thing that could be quite common for all I know.

Stenocybe maior--Habitat: On wood. Distribution: E. Slope of Cascades, WA (Klickitat Co., Yakima Co.). 1500 m.

Texasporium sancti-jacobi--On OHNP List 3 (as of 1991; may have changed since then). Globally rare, rated by the INPS as a Priority 1 species. Based on 1991 survey results, the lichen was recommended as an addition ot the USFWS list of federal candidate species (DeBolt, 1992). Habitat: In Idao, the species grows on soil and organic matter, especially dead Sandberg's bluegrass [my rough draft says Poa secunda, but shouldn't this be P. sandbergii?] clumps, and in some cases, old rabbit pellets (McCune, 1992). Wyoming sagebrush, Thurber's needlegrass, and bluebunch wheatgrass are among the associated vascular plants. Three of the four populations: in Idaho are in sites where slickspot peppergrass (Lepidium papilliferum), a federal candidate (C2) plant, is also present. Sensitivity: Several factors may contribute to the geographic rarity of the species (McCune, 1992). First, it appears to be intolerant of saline and calcareous substrates, both widespread in the arid west. Secondly, it is intolerant of heavily disturbed sites. Grazing disrupts the biotic soil crust, promoting habitat conversion from sagebrush-bunchgrass communities to annual grasslands dominated by Bromus spp., especially B. tectorum. Lack of suitable microhbitats may also contriubte to the lichen's very restricted range.

V--Sensitivity: Elimination of habitat (replacement of old wooden fenceposts by new ones or ones made of materials not colonized by the species) is a threat.

"Thermu is velutina (Ach.) Fries"--I am not sure about these particular records, but I do know that'at least some of what Howard identified as this species is actually Pseudephebe pubescens. N.E. Mountains, WA (Ferry Co.: Boyds); E. Slope of Cascades, WA (Yakima Co.: Dewey Lake). On rock. 1470-4800 ft.

Species Characteristic of Dry Areas...

Although mentioned in the introduction, Ahtiana

Additions

sphaerosporella perhaps should be treated separately, because although it is easily identified it has.been collected only a few times in eastern WA/OR, and is likely to be rare or threatened in the region to the extent that its preferred host (Pinus albicaulis) is rare. However, A. sphaerosporella is widely distributed, and often locally, abundant, so I am not particularly concerned about it.

Acarospora schleicheri, Catapyrenium spp., Endocarpon pulvinatum, Squamarina lentigera Toninia spp., and soil inhabiting Xanthoparmelia spp. --Role(s): Soil binding and enhancement. Sensitivity: Habitat destruction (replacement of bunchgrass by annuals); direct trampling and manuring by livestock; possibly agricultural chemicals or eutrophication.

Collema spp.--Although the genus as a whole is probably more frequent to the west or east, the species identified so far are characteristic of dry areas. Habitat: On bark (C. nigrescens and others), soil (C. tenax and C. "xerica", etc.), or rock (various species). Distribution: Data were not recorded for most collections, which were not. identified to species; C. nigrescens occurs in E. Slope of Cascades, WA (Klickitat Co.); C. tenax occurs in E. Slope of Cascades/E. Plateaus & Hills, OR (Deschutes Co., Wasco Co.); C. "xerica" occurs in E. Plateaus & Hills, OR (Jefferson Co.).

S - - O n OHNP L i s t 3 . The species was abundant in one locality in Klamath Co.', OR, but aside from the fact that I collected a lot of it there, the area was later exposed to a severe forest fire, which may have finished off what I did not remove. However, I was the one who recommended the species be put on the rare list for OR. Fire, logging, and possibly overcollecting are potential threats.

Neofuscelia loxodes--Insert space between this and previous paragraph. On OHNP List 3.

Peltula euploca--On OHNP List 3.

"Species More or Less Common on West Side or in Northern Idaho"

In addition to the alpine species mentioned in the introduction to this group-but not treated separately, Lecanora pringlei should be mentioned, because it is on OHNP List 3 (thanks to my recommendation). However, like most other alpine lichens on rock, the species is widely distributed, and faces

Additions

little or no threat except perhaps from overcollecting (which is unlikely because the sites.are hard to get to, and it is difficult to collect much due to the kinds of rock surfaces the' species tends to grow on).

Caliciales--Sensitivity: Destruction of old-growth forest by logging or fire (including removal of leaning trees), is a major threat.

Nitrogen fixers: Role(s): Fixing nitrogen. Sensitivity: Probably most or all are sensitive. to air pollution, agricultural chemicals, and eutrophication. Ones on soil are sensitive to trampling, and ones requiring forests (especially old-growth) are sensitive to logging and fire.

v--Ranked "GSG4" by Pittam (1989, 1991). Role(s): Food/nest material for squirrels-or caribou.

Collema spp.--Delete from here (see comments on Collema under "Species Characteristic of Dry Areas", above).

Hydrothyria venosa--Listed as "G2G3" by Pittam (1989), but revised to "G1G2" (rarer) by Pittam (1991).

Lobaria U--Ranked "G1G2" by Pittam (1991).

Lobaria oregana--Ranked "G3" by Pittam (1991). Habitat: Fully mature conifer forests '(usually Pseudotsuga), above 240 m, mostly with coastal influence. Sensitivity: One of the most sensitive species to air pollution. Also potentially endangered by logging, because of its association with old-growth forests.

Additions

3. ECOLOGICAL GROUPS

Although I attempted to use the decimal system as recommended, because I was in a hurry, I did not do it consistently throughout, and there-are probably a few screw-ups, which can be corrected as you read through the documents.

This set of documents was the biggest pain of the bunch, and I spent so much time on these that I'm sick of looking at them.

For further additions and corrections to these documents, see changes made in Master- Species List, Collecting Data, and Locality Data.

Some of the changes listed here (based on my latest printout) may already be in the version I sent you after that printout'was made.

Originally I intended to put in much more data on distribution, climatic data., etc. for each vascular plant zone or community, from Franklin & Dyrness (1973) or other sources, but it would have taken a lot more time and.produced even more redundancy. Most of the climatic data can be extracted from the table on the next page.

Additions

Table 1. Elevation and climate of major vegetation zones of Franklin & Dyrness (1973).

HABITAT FEATURES	VEGETATION ZONE											
	Shrub-Steppes					Forests						
	ARTR	AGSP/FEID		ARRI	JUOC	PIPO	PICO	PSME	ABGR/ABCO		TSHE	ABLA
Elevation (m)	30 to 1000	30 to 120	450 to 775	450 to 1400	760 to 1400	600 to 2000	1200 to 1525	100 to 1350	1100 to 2000	1650 to 2000	800 to 1200	1300 to 1700
Av. Annual Precip. (mm)	190-389	200-250	360-600	280	200-312	355-760	350-700		632-1157		560-1700	
Av. Summer Precip. (mm)	24-43	23-44	75			41-94	56-66		43-115			
Av. Annual Temp. (°C)	8-12	12	9				6-8	5-6		6-8		3-8
Av. Summer Temp.	19-25	23-24	20			16-20	14-16		18			13-16
Av. Max. Summer Temp.	28-35	31-33	28		26-32	26-32	27-31	27-30		25-29		
Av. Winter Temp.	0 to -5	0	-2			-3 to -5	-3 to -4		-1 to -5			
Av. Min. Winter Temp.	-3 to -10	-3 to -4	-5			-8 to -11	-11		-5 to -10			
Av. Annual Snow (cm)	34-136	34	102	15	15	141-252	417		231-450			500

Additions

3.1. CORTICOLOUS/LIGNICOLOUS

" lace" type changes

*"Barkman (19__)" **should be " (1958)".**

Role(s):' Effects on host plants: Cite "Legaz, **et al. (1988)" as the source of the information about** Evernia prunastri.

***Sensitivity: Janet suggests that "kinds on other substrates" should be "lichens on other substrates".**

*"moreso" **should be "more so"**

*"[??--need **to check Douglas article]" should be deleted, because I have already eliminated the uncertainties.**

3.2, TERRICOLOUS/MUSCICOLOUS

The "soil types", information is pretty without knowing what properties these soils have (see Franklin & Dyrness, 1973, for that) and exactly which lichens are growing on which soils (no data).

Habitat: Lichens directly on soil or humus are usually abundant only in areas with harsh conditions not suitable for most few vascular plants, 'or low amounts of leaf or needle litter (e.g., many desert or'semi-desert areas, and alpine areas). Clearings in forests are also likely to support a better cover by lichens (especially **those that normally occur in open, non-forest areas).**

"Replace" type changes

*"abudant" **should be "abundant".**

*"microbiotic **plants" should be "microbiotic plants (including cyanobacteria, algae and bryophytes, as well as lichens)".**

***"Richardson (19) should be "(1975) ".**

"Rossman (1993)" **should be "(1992) ".**

"(in Barbour **and Billings)" should be deleted.**

3.3. SAXICOLOUS

"Replace" type changes:

*"Umbilicaria **ssp." should be "spp."**

Additions

*"desparate" **should be "desperate".**

*"Czehura, **19**)" **shduld be** "(1977)".

"Holborok" **should be** "Holbrook".

Aquatic communities--In the **main discussion on this, cite Gregory** (1976), **dealing with river channel capacity, and Rosentreter** (1984, 1991), **dealing with zonation, etc.**

Additions

4. SUCCESSIONAL STAGES

*"Rhoades, 19)" should be "(1988)".

Citations of the west side spotted owl documents need to be in accord with those in the revised Literature Citations document: "Report of the Scientific Analysis Team" should be "Thomas; et al. (1993) "; "Final Environmental Impact Statement" should be "Anonymous (1993) ".

Cite Essen (1983), Pike (1972), Pike, et al. (1972, 1975, 1977), and Söderström (1988).

5. KEY ECOLOGICAL GROUPS

Problems in treatment of information from some localities--This is a big pain, and I doubt I can detect and correct all the problems even if I could afford the time to make the attempt:

*"released" should be "realized".

"Miscellaneous" at end of document should be deleted.

6. KEY ENVIRONMENTAL FACTORS

*"quit diverse species" should be "quite diverse species".

7. FUNCTIONAL GROUPS

In introduction to the section, cite the general review of lichen functions by Slack (1988).

Nutrient cycling--cite Pike (1978).

Nitrogen fixation--cite Pike, et al. (1972) and Dension (1979).

Vertebrates--cite general review by Richardson & Young (1977). In part dealing with Caribou, also site Detrick (1985), Schroeder (1974), Servheen & Lyon (1989), and Stevenson (1979). In part dealing with flying squirrels, also cite Maser, et al. (1985).

Invertebrates--cite the general review by Gerson & Seaward (1977).

Soil enhancement--cite Harper & Marble (1988), Harper & Pendleton (1993), Brotherson & Rushforth (1983), Shields, et al. (1957), and Skujins & Klubek (1978), in connection with cryptogamic crusts.

Additions

Inhibition of wood destroying fungi--also cite Henningson & Lundström **(1973).**

10. AREAS OF UNKNOWN INFORMATION

*"Sigal & **Nash, 19** ;" **should be** "1983".

***"Ryan, 19**)" **should be** "(1989)".

*"Rhoades, **19**)" **should be** "1988".

"Miscelaneous" **at end of document should be deleted.**

Additions

12. TABLES AND MAPS

The left and right margins of many of the tables need to be decreased to the minima (0" for left, 0.5" for right), or the columns will be all messed up. See separate documents on this diskette for completed/corrected tables.

The numbering of the tables depends on whether you want them all together following this heading, or at the ends of the relevant documents (this is your choice, and numbering them is a simple enough thing for you to do after all the work I put in on this report).

13. LITERATURE REVIEW

"Esslinger (19 , 1973, 1977, 19)" should be "(1971, 1973, 1977, 1978)".

"Goward (19 19 19)" should be "(1985)" [the other Goward references I was thinking of are not directly relevant]

"Douglas and Bliss (19)" should be " (1977)"

"Rosentreter (1992, 199)" should be "(1984, 1986, 1990, 1991, 1992, 1993)" .

Under lichens of Washington, cite Foster (undated,. cited by Howard, 1950).

Under monographs/synoptic treatments, cite McCune (1987).

LITERATURE CITATIONS

See separate revised document.

EAST SIDE CONTRACT

RESULTS AND DISCUSSION PART ONE

1: Biogeography

[Possibly interestina areas1

WASHINGTON:

E. Slope of Cascades:

This province has been explored extensively for lichens, and the ecology of -lichens.-(especially ones on soil). in alpine areas the North Cascades part-has'been studied intensively;

Klickitat Co.: Columbia Gorge Area: Although this area was explored extensively,' by Suksdorf many years 'ago, and recently by Davis, their label data provide little or no informationon the ecology or abundance of-the species. The areas where Suksdorf collected (especially Bingen, Falcon Valley, and White Salmon River) -are of special interest because many 'lichens that occur only'rarely if'at all elsewhere in the WA/OR part of'the Columbia Basin were found there. Included'among these lichens- are several potentially important nitrogen-fixers (e.g., species of Lobaria, Neohroma, and Pseudocyphellaria), and others (e.g., 'members of the Caliciales), that are especially characteristic of old-growth forests and are also sensitive to disturbances (including air pollution, which may be 'a problem due to movement of air from-west side urban areas)., Suksdorf's sites need'to be revisited and studied carefully, to determine whether the species are still present,. specifically where and in what habitats they occur, and how abundant they are today. It is noteworthy that the collections by Davis in Klickitat Co. include only one nitrogen fixer (a Leptogium species), although he did find several members of the Caliciales at various sites in that county.

Okanogan Co.: Roser Lake area: This area is being proposed as a Research Natural Area, and has a rich and luxuriant lichen flora that'includes several possibly rare undescribed species, and large quantities of'the nitrogen-fixing and stabilizing species Solorina crocea (apparently uncommon elsewhere-in the Columbia Basin) and other potentially important taxa such as Brvoria spp. 'I have requested funding from-0kanogan'N.F;. to do a more thorough ecological study as a follow-up'to my preliminary floristic study there.

Yakima Co; : Mt. Adams area: The'only collections-are old ones by Suksdorf, many with very inadequate label data., A better knowledge of the lichen flora of this area 'will contribute to a fuller understanding of-alpine and subalpine communities in the province. 'Since the.east slope and accesses to the mountain are on the Yakima Reservation, permission will be needed to do studies there.

Biogeography

N.E. Mountains:

The entire province needs to be much more thoroughly examined 'for lichens. The collections so far have been few and very incomplete, giving the impression that many species occur in all the provinces of in the Columbia Basin except this one. While species restricted to drier communities or volcanic rocks may well be absent from the province, the diversity in this province (especially the eastern part) should still be quite high; since many other species that are common in northern Idaho or northward, including species characteristic of granitic rocks and especially ones on calcareous rocks '(which are uncommon in other provinces in WA and OR), and'species typical of Tsuaa heterophylla forests (absent elsewhere in the WA/OR part of the Columbia Basin) are likely to occur. Among the species that are known to be present are several-that have potentially very important ecological functions, are associated with mature-or old-growth forests, and are moderately to very sensitive to disturbance. Alectoria sarmentosa (an important food for caribou) and Brvoria spp. (important foods or nesting materials for northern flying squirrels) are known to be abundant in several areas; Lobaria pulmonaria (a potentially important nitrogen fixer) is known to be present, but nothing is known about its abundance or full distribution in the province.

Pend Oreille Co.: Colville National Forest. The areas most. likely to have especiallyunusual, important, or sensitive lichens are probably in this area, especially near the Kettle and Pend Oreille rivers, and sites at high elevations.

Stevens Co.: Cooke's site. 'This needs 'to be revisited, for reasons discussed.below.

Columbia Plateau:

Extensive collections have been made in this province, and detailed ecological studies were made by Cooke (1955) in the eastern part.

Spokane and Whitman Co.: Cooke's sites: These need to be revisited, to determine what changes in the lichen vegetation might have occurred. His voucher specimens need to be examined in the light of modern systematic concepts, 'and at least rough estimates of the relative abundance of the species in the communities he recognized should be made (e.g., it would be useful to know if the various parmelioid and cetrarioid taxa are all equally common, or are one or two species dominant).

Yakima Co. : Umotahnum Road Umotahnum Creek: This is apparently the only site-west of Idaho where Aspicilia "hispida" is presently known to occur.

Columbia Co., and **Asotin** Co.: Blue Mountains, Umatilla National Forest: This is the only major forested area in the SE fourth of WA, and floristic affinities with N.E. Mountains of OR, and probably also with northern Idaho, are likely. However, only a few collections have been made here.

OREGON.

The lichen flora of most parts of the Columbia Basin in OR is less well known than that of WA.

E . **Slope Cascades:**

Rather few collections, 'mostly with little or.no ecological data, have been made.in this province.

Hood River Co;: East slope of Mt. Hoo(Much more information-is needed on the lichen vegetation of this'area, since it is one of the few areas in the province where alpine and subalpine communities will be found. Columbia Gorse area: Even less is known about-the lichens'on the.OR side of the Gorge is known-than for the WA side, but the Same considerations 'are. applicable.'.

Deschutes Co./Lane Co.: Three Sisters: Imshaug's collections of crustose species from this area need to be examined; since this is another of the few alpine areas in the province. Ecological notes, and additional collections; including ones in subalpine and montane areas on.the "eastern'slopes, also need to be made.

Klamath Co.: Crater Lake,' and other pumice areas: The lichen communities in these areas, especially the ones actually growing on pumice (or soil or moss over pumice), are likely to be unusual. New collections, with ecological data, will supplement the limited knowledge available from the few, mostly rather old, collections.

E. Plateaus and Hills:

Gillian Co.: N of Condon: This area was described as having-*'excellent range condition". 2 mi W of Arlington: This area was described as "relict sagebrush habitat".

Harney Co.: Steens Mountain: The lichen vegetation on this very isolated high.ridge, with zones extending-into the alpine, could be very unusual.

Jefferson-co.:. 15 miles NW of Redmond: This area was described as "pristine", and.is the only known site of-the rare and.endangered lichen Texasporium sancti-jacobi in the WA/OR part of the Columbia. Basin:-

Klamath Co./Lake Co.: Gearhart Wilderness: Although extensive collections were made at sites around the'edges of this rather isolated high mountain area were made, the ecological data are minimal, and the higher elevation interior areas are likely to have interesting subalpine or alpine lichen vegetation. Pumice-areas: Lichens have apparently-not yet been collected in these areas; the lichen vegetation on pumice is likely to be unusual, as mentioned above. Although the corticolous lichens are unlikely to be unusual, collections in the Pinus contorta zone would be desirable.

Lake Co.: Warner Mountains: Collections have apparently been made only'in one area in the western foothills., The eastern

slopes are likely to have lichen communities with affinities to those in mountains of the Great Basin, and the higher elevation areas may also have interesting lichens.

Malheur Co.: N of Ontario: This area was described as "pristine".

Morrow Co.: E side of Boardman Bombing Ranae: This area was described as having @@excellent range condition".

N.E. Mountains:

Collections in this province are few, and with little or no ecological data; except to some extent in a few sagebrush areas around Baker City. The lichen vegetation is likely to be diverse, and to include some important and sensitive kinds; with affinities to communities in both the OR Cascades and the Rockies. The mountains include rock types and vascular plant communities not common elsewhere in eastern OR, and they are somewhat isolated, but probably act as a bridge for dispersal 'between the other major mountain ranges.

Baker Co.: Between Strawberry and Little Juniper Drainage: This was described as having @'excellent range conditions".

Crook Co. : Ochocho Mountains: The few collections are insufficient to allow conclusions about the distribution and ecology of lichens here. Maury Mountains: These include an isolated area with subalpine vegetation.

Crook Co., Grant Co., Harney Co., Umatilla Co., and Union co. : Blue Mountains: Knowledge of lichens in these mountains is . still very limited, but at least some localities are known to have species that are potentially important or of special concern (e.g., 'Caliciales and other potentially sensitive, old-growth associated species). Imshaug's crustose alpine lichens from Eagle Cap'also need to be examined, and other collections need to be made in this very isolated high elevation area.

Harney Co.', Lake Co., and Malheur Co., and others.: Desert scrub areas: Data from the a few collections are inadequate to allow conclusions about possibly unusual, features of the lichen vegetation'in these communities. Sasebrush shrub-steppe areas: More information on the relationshipsof lichens to different kinds of Artemisia communities and associated grasslands is n e e d e d ;

Wailowa Co.: Snake River (Hell's Canyon): Apparenly only one'verv limited collection has been made, but at least two species apparently unknown elsewhere in the region (Flavoparmelia caperata and Flavopunctelia flaventior) were found there.

Areas of endemism

Among the macrolichens, there appear to'be few species endemic to the WA/OR part of the Columbia Basin or particular areas within it Possible endemics include several poorly known taxa from E. Plateaus-t Hills, OR, with apparently unpublished

names, e.g., Collema "xerica" (Jefferson Co.), Physconia "americana" (Wasco Co.), Xanthoria "adscendens" (Lake Co.), and an unnamed fruticose Aspicilia (E. Plateaus. & Hills, OR: Klamath' Co.), and others that have'not yet been collected or correctly identified. Some other species may be.endemic to, or centered in,- the Columbia Basin region as a whole (e.g., Melanelia multispora) or to the Pacific Northwest in a broad sense including.northern California and the southwesternmost parts-of Canada (e.g., Esslinaeriana idahoensis, Tuckermannopsis subalpina).

Apparently endemic crustose species include Rhizocarpon cookeanum (to my knowledge known only from Palouse grasslands of Garfield and Whitman Co. in Columbia Plateau, WA, and adjacent parts of Idaho),, Lecidea pumicicola (so far identified only from pumice areas of south-central OR: Deschutes Co. and Klamath Co.). Other possible'endemic crustose lichens are poorly known species that were originally collected from the Columbia Basin, but rarely if ever collected or identified since, including some Lecidea spp. and others (mostly areas near the Columbia Gorge)', and some species with unpublished names, e.g.';. Buellia "glaucomarioidea" (Klickitat Co; WA); Rhizocaroon "sp. nov." (parasitic on Diploschistes in Jefferson Co., OR) , Rinodina "enteroxantha" (on soil in Okanogan' Co.; WA), Toninia sp. "to be. described by R. Anderson" (Wasco Co., OR).

The actual distributions of all of these species, and of the undoubtedly numerous others that remain to be found or determined, cannot be known until funding for field and herbarium taxonomical studies of lichens in the region is made available.

Areas of high diversity

Due to the sporadic-and often very limited or selective nature of lichen explorations in most parts of the Columbia Basin, 'it is presently very difficult if not impossible to say anything meaningful or specific about relative diversity, especially-.for taxonomically difficult genera, including most crustose lichens. About the most that can be said is that generally the National Forest lands have the highest diversity of lichens, mainly due to the high diversity of habitats. A" few more or less specific areas or localities can be pointed out as areas of real or potential "interest", for various reasons; these are listed and.discussed under a separate heading.

Areas- linking "hot spots"' of distribution

As described above, the Gearhart Wilderness and vicinity, Columbia, Gorge area, and-probably several other, less explored areas (N.E. Mountains, OR, N.E. Mountains, WA; alpine and subalpine areas along the Cascade Crest from Mt. Hood southward; Warner Mountains;' Steens Mountains), are of special interest because they (probably or definitely) include (at least in limited amounts in some areas) some lichen species that otherwise

occur almost exclusively on the west 'side or in other moist areas (e.g., northern Idaho or northern. California).

Apparent anomalies in distribution

Although the examples below are with reference to the very generalized'maps in Vitt, et al. (1988), numerous examples of the inadequacy of existing knowledge of lichen distribution in North America can also be found in the generalized maps of Hale (1979), the somewhat more precise (but not always correct)' dot maps in Thomson (1984), 'and even in the presumably most reliable dot maps in various monographs of particular taxa.

Apparent disjunctions: Some interesting apparent disjunct occurrences include the following: Arthonia patellulata in Klickitat Co., WA (map shows the species occurring only in west-central-Canada ; the species should be searched for in N.E. Mountains, WA), Cladonia scabriuscula in Spokane Co., WA (map shows this species extending into the United States only on the west side of the Cascades). However, most seemingly anomalous patterns are probably more apparent than real; due to insufficient collection or lack of proper identification, or to the generalized and incomplete nature of the distribution maps: (e.g., Vulpicida canadensis, which the map shows extending southward only in the northeastern part of the Columbia Basin. region, is widely distributed and is very common in at least some areas as far southwest as Klamath Co., OR.

Species supposedly rare or absent in eastern WA/OR: 'Some species that are indeed restricted to or common in moist areas to the west or east, as shown by the maps, e.g., Hypocenomyce scalaris, Lecidea atrobrunnea s. lato, Tuckennannopsis chlorophylla and Xanthoparmelia cumberlandia, also occur occasionally in a fair number of other, drier areas, and one (Hypogymnia imshaugii) is quite widespread and common throughout much of eastern WA and OR. Flavopunctelia flaventior, which Vitt, et al. show as extending into the United States only east of the Rockies also occurs in California, which makes the probably isolated occurrence of the species in Northeast' Mountains, OR (Wallowa Co.) less surprizing.

Species supposedly widespread and common in eastern WA/OR: On the other hand, some relatively distinctive species shown as occurring throughout the Columbia Basin or the Pacific Northwest are, in my experience, and based.on my herbarium notes and literature search, rarely if ever found in eastern WA/OR (Arctoparmelia centrifuga, Baeomyces rufus, Cladina mitis, Cladonia crispata, C. cervicornis ssp. verticillata, C. uncialis, Pannaria pezizoides, Ramalina dilacerata s. lato, Solorina saccata, and Souamarina lentigera s. lato, Xanthoparmelia chlorochroa s. lato). Others are found mostly close to the Cascade crest or Idaho, and occur apparently rather rarely in one or few moist areas (e.g., Calicium viride, Icmadophila ericetorum, Leptogium saturninum, Lobaria pulmonaria, Nephroma

parile, and probably many Cladonia species). Still others are restricted.to a few alpine areas (e.g. Cetraria islandica, which is apparently quite common on the east slopes of the North Cascades, Flavocetraria nivalis, and Sporastatia testudinea). Some species that I would have expected to be common throughout the drier areas of eastern WA and OR (as shown) are apparently uncommon there.(Psora decipiens, Toninia sedifolia). Several other species supposedly occurring-throughout the Pacific Northwest, but apparently rare in eastern WA and OR, probably have not often been correctly identified-(in fact, the photographs of Hypogymnia enteromoroha and Phaeophyscia orbicularis in Vitt, et al., 1988 are misidentifications'of. other species!). Amandinea punctata, Lecidella euphorea, and perhaps some species of the notoriously difficult to identify genus Usnea (e.g., U. hirta and U. lapponica) may well be more widespread and common, at least in moister areas of eastern WA/OR, than the few. specimens identified to species would suggest.'

Contributions of Federal lands.

Large areas of the Columbia Basin region-have not yet-been explored for lichens, due partly to their inaccessibility (distance from roads, or lack of parking areas when along roads).

Federal lands are potentially very important for lichens in the Columbia Basin region.

Forest' Service

In Oregon, the only east side National Forest areas that have been explored thoroughly for lichens by trained lichenologists are the Fremont National Forest (mainly the Bly District--Ryan), and to at least some extent the Wilamette (Pike, McCune, and others) Deschutes (Geiser--only a limited number of species identified, by me). Limited collections by a lichenologist (Roger Rosentreter) have been made in the Wallowa-Whitman National Forest. My own collections in the Winema National Forest are few and limited. Few if any areas in the Umatilla, Malheur, Ochoco, or Mount Hood National Forests have been examined for lichens.

In Washington, only a few areas have been explored for lichens (mostly sporadically by professional or amateur lichenologists) in the east side National Forests (Okanogan, Wenatchee, and Colville, and the southwestern part of Snogualmie). In preparing this report I did not record data from collections made in the Gifford Pinchot National Forest (although the east edge of the Forest is east of the Cascade summit, 'and has been explored for lichens by John Davis and others, it is within counties that I excluded as being "West Side"). Little if anything is known about the lichens of Kaniksu National Forest.

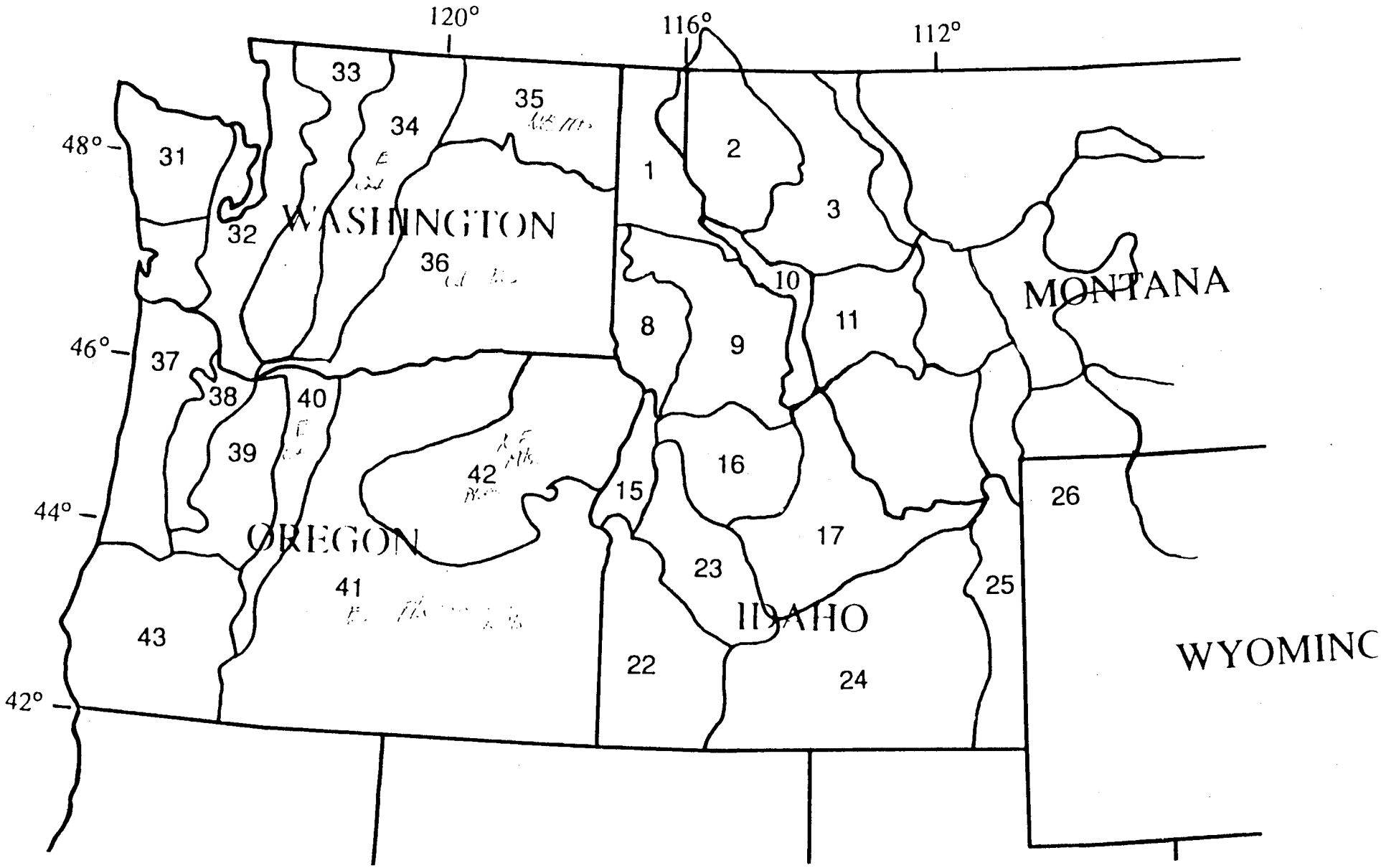
Bureau of Land Management

Although many of the collections from non-forested areas are probably from BLM land, determination of precisely which localities are under BLM jurisdiction or which districts are involved is not easily accomplished. One area of BLM land that has definitely been explored for lichens (by Kari Yanski, an amateur lichenologist) is that around Lakeview (Lake Co.), Oregon; however, I have not seen the label data from her collections.

Contribution of non-FS/BLM lands

Probably rather few non-federal lands have been explored for lichens, because cities or agricultural areas usually lack suitable lichen habitats, and access to private lands requires permission. Indian reservations, and Federal, but non FS/BLM, lands (e.g.; military areas, DOE lands, National Wildlife Refuges), also have not been explored much if at all. State lands (e.g., State-Parks) are potentially important areas for study, but are rather few; Horsethief Lake State Park and Lake Easton State Park (both in central Washington) are two that I have explored for lichens.

Physiographic Regions of the Pacific Northwest



Physiographic regions -- listing of Paradox database
9/15/94 Bruce McCune, Oregon State University

Region	Region name	States
1	Selkirk	ID,WN
2	Kootenai.	MT,ID
3	Flathead-Blackfoot	MT
4	East Front	MT
5.	Marias	MT
6	Northeast outlier mts	MT
7	Northeast Montana	MT
8	Columbia Plateau	ID
9	Clearwater	ID
10	Bitterroot Range	MT
11	Clark Fork Drainage	MT
12	Helena - Bozeman area-	MT
13	Eastern Outlier Mts	'MT
14	East Central Montana	MT
15	Seven Devils	ID
16	Salmon	ID
17	East-central Idaho	ID
18	Beaverhead	MT
19	Bozeman	MT
20	Beartooth	M T
21	Southeast Montana	MT
22	Boise	ID
23	Payette	ID
24	Snake River Plain	ID
25	Upper Snake	ID
26	Yellowstone Park	WY
27	Shoshone-Bighorn Valleys	WY
28	Bighorn Range	WY
31	Olympic Peninsula	WA
32	Puget lowlands	WA
33	W slope Cascades, Wash.	WA
34	E slope Cascades, Wash.	WA
35	NE Washington Mtns	WA
36	Columbia Basin	WA
37	Coast Range, Oregon	OR
38	Willamette Valley	OR
39	w slope Cascades	OR
40	E slope Cascades	OR
41	E plateaus-and hills	OR
42	NE Oregon Mts	OR
43	SW Oregon	OR
44	Columbia R Gorge	OR,WA
45	Klamath-Siskiyou	CA
46	Northeast CA volcanic	CA
47	Coast Ranges & foothills	CA.
48	Great Valley	CA

Table 1. Distribution of major corticolous/lignicolous lichen species by province.

LICHEN SPECIES	PROVINCE					
	34	35	3'6	40	41	42
Alectoria sarmentosa	+	+		+		
Brvoria abbreviata	+	+	+	+	+	
Brvoria' fremontii	+		+		+	+
Candelaria concolor			+		+	
Hypogymnia imshausii	+	+	+	+	+	+
Letharia columbiana	+		+	+	+	+
Letharia vulpina	+	+	+	+	+	+
Melanelia elesantula	+	+	+	+	+	+
Parmeliopsis ambigua	+	+	+	+	+	+
Parmeliopsis hyperopta	+	+	+	+	+	
Platismatia glauca	+	+	+	+	+	+
Tuckermannopsis merrillii	+	+	+	+	+	+
Tuckermannopsis platyphylla	+	+	+	+	+	
Vulpicida canadensis	+	+	+	+	+	+
Xanthoria "candelaria"	+	+	+	+	+	+
Xanthoria polycarpa	+	+	+	+	+	+

Table 2. Distribution of major terricolous/muscicolous lichen species by province.

LICHEN SPECIES	PROVINCE					
	34	35	36	40	41	42'
Cetraria aculeata	+	+				+
Cetraria ericetorum	+	+				
Cetraria islandica	+	+				
Cladonia cariosa	+	+	+	+	+?	+
C. fimbriata	+	+	+	+	+	+
Cladonia pvxidata	+	?	+	+	+	+
Dinloschistes muscorum	+	+	+	+	+	+
Lepraria nealecta	+		+	+	+	
Leptochidium albociliatum	+		+	+	+	
Leptogium spp.	+		+	+	+	+
Meaasoora verrucosa	+		+	+	+	
Ochrolechia upsaliensis	+	+	+	+	+	
Peltigera aphthosa	+	+	+	+		+
Peltiaera canina	+	+	+	+	+	+
Peltisera rufescens	+	?	+	+	+	?
Phvsconia spp.	+		+	+	+	+
Psora nipponica	+		+	+	+	+
Trapeliopsis sranulosa	+		+	+	+	

Table 3. Distribution of major saxicolous lichen species by province.

LICHEN SPECIES	PROVINCE					
	34	35	36	40	41	42
Acarospora "chlorophana"	+		+	+	+	+?
Caloolaca saxicola	+		+	?	+	+?
Dermatocaroon spp.	+		+	+	+	
Dimelaena oreina	+		+		+	
Dimelaena thvsanota		+	+		+	+?
Lecanora muralis	+		+	+	+	+?
L. ohaedrophthalma	+	+	++	+	++	+?
L. oseudomellea	+		+	+	+	+?
L. rupicola	+		+		+	
Lecidea tessellata	+		++	+	++	+?
Neofuscelia verruculifera	+		++	+	++	+?
Pseudephebe minuscula	++	+	+	+	+	+
P. nubescens	++	+	+	+	+	+
Rhizocarpon bolanderi	+		+	+	+	+
R. seosraohicum	+		+	+	+	+
Rhizoplaca chrvsoleuca	+		+	+	+	+
R. melanoohthalma	+		+	+	+	+
Umbilicaria hvoerborea	+	+	+	+	+	+
U. kraschennikovii	+	+	+	+	+	+
U. phaea	+	+	+	+	+	+
U. virainis	++		+		+	+
Xanthooarmelia mexicana/plittii		+			+	

Xanthoria eleaans	+	+	+	+

Veg Zones

Table 1. Elevation and climate of major vegetation zones of Franklin & Dyrness (1973).

HABITAT FEATURES	VEGETATION ZONE										
	Shrub-Steppes				Forests						
	ARTR	AGSP/FEID		ARRI	JUOC	PIPO	PICO	PSME	ABGR/ABCO	TSHE	ABLA
Elevation (m)	30 to 1000	30 to 120	450 to 775	450 to 1400	760 to 1400	600 to 2000	1200 to 1525	100 to 1350	1100 to 2000	1650 to 2000	800 to 1200	1300 to 1700
Av. Annual Precip. (mm)	190-389	200-250	360-600	280	200-312	355-760	350-700		632-1157		560-1700	
Av. Summer Precip. (mm)	24-43	23-44	75			41-94	56-66		43-115			
Av. Annual Temp. (°C)	8-12	12	9				6-8	5-6		6-8		3-8
Av. Summer Temp.	19-25	23-24	20			16-20	14-16		18			13-16
Av. Max. Summer Temp.	28-35	31-33	28		26-32	26-32	27-31	27-30		25-29		
Av. Winter Temp.	0 to -5	0	-2			-3 to -5	-3 to -4		-1 to -5			
Av. Min. Winter Temp.	-3 to -10	-3 to -4	-5			-8 to -11	-11		-5 to -10			
Av. Annual Snow (cm)	34-136	34	102	15	15	141-252	417		231-450			500

Major species

2a. RESULTS AND DISCUSSION

PART 1.

To avoid redundancy, some general comments can be made about the information presented. Where similar information is presumed to be applicable to entire genera or species groups, it is given only once. Genera or species groups in which the taxonomy is such that little or nothing can be said about individual species, are treated here as units; information on the component species of such groups, and on taxonomy (including authority names for species epithets, and synonyms) is given in the "master list" of species. presented as an appendix. The names of some species with major taxonomic problems (discussed in the appendix) are given here in quotation marks, for simplicity; the use of two species epithets connected by a slash refers-to situations where two species or complexes are difficult to separate from each other, or where for most practical purposes as far as known the same general considerations apply to both.'

Habitat: Generally only broad descriptions are given here; more detail (including subdivision'of major groupings, description of associations or communities, and discussion of environmental factors) is presented in'part 2.

Distribution: Generally only the distribution within what I have referred to as "the region" covered by this report' (Oregon/Washington part of the Columbia Basin)' is given here, and it is summarized according to major provinces. General summaries of worldwide or North American distributions, and more detail on distributions in Oregon and Washington, are given in a "master list" of species presented in an appendix. Many species appear to be widespread throughout the'region but absent from the Northeastern WA Mountains, which are distinctive in many ways, with closer affinities to the Rocky Mountains than to the Cascades and the plateau regions. However,' the apparent absence of species (especially crustose ones) is probably at least partly an artifact of the scarcity of collections from that area made or identified by lichenologists.

Role(s): Many lichens provide nourishment and/or habitat for animals, as well as for microfungi and bacteria; this is mentioned only in a few cases, where the species is definitely known to be used by particular vertebrate animals that occur within the region. Many if not all lichen species growing on rock are presumed to contribute to some extent to weathering of rock. Likewise most species growing on bare soil probably modify soil qualities, including moisture relationships. These functions are not listed here under the individual species. Lichens containing Nostoc (or perhaps other cyanobacteria) are presumed to be capable of nitrogen fixation; this is mentioned only briefly under those species in this list. Effects on wood-inhabiting fungi refer to water extracts of the lichens; the

cause of the inhibition is unknown, since acetone extracts (which remove the characteristic lichen acids much more effectively than water) had no significant effects (Lundström & Henningsson, 1973). The relative importance of the various contributions depends partly on the abundance of the lichen species within the ecosystem.

Sensitivity: Information on this comes almost entirely from either subjective inferences'or from literature studies made in other parts of the country or world; therefore it is at best a rough guide, and at this stage I have not attempted to present quantitative data for it. All lichens are obviously sensitive to complete'destruction of the habitat (e.g., by catastrophic floods or fire, or-covering of the habitat by asphalt or buildings) or at least their substrate (e.g., lichens on trees are sensitive to removal of those trees by logging; lichens on rocks are sensitive to removal of those rocks .for agriculture or construction; lichens on soil are generally sensitive to severe disturbance of the soil by agriculture, construction, etc., although some kinds of disturbance may be beneficial for some soil lichens). The effects of global warming are potentially another kind of disturbance, but no attempt is made here to predict the sensitivity of particular species. Sensitivity of lichens to air pollution involves many considerations, as discussed by innumerable authors; the broad, often vague categories of "sensitive, intermediate, and tolerant" used here, and the' sources of the information, are discussed by Peterson, et al. (1992). Information on sensitivity to agricultural chemicals is also given in general terms in this part of the report. Sensitivity to herbicides and pesticides, as given by Alstrup (19), refers to death ("sensitive") or visible damage ("somewhat less sensitive") from "high doses" (presumably 10 x the "normal" doses) of two herbicides ("Herbatox" and "Dantril") and two fungicides ("Tilt Turbo" and "Rival"), sprayed in liquid form with an atomizer.

Population trends:' In most cases this is unknown, at least for the Columbia Basin, and so is not mentioned in the lists below.

Major species

Major Lichen Species
In the Oregon-Washington Part of the Columbia Basin

These species are considered "major" for the east side of Oregon and Washington as a whole, because they are definitely known to be widely distributed and abundant in this area. Asterisk (*) = no specific information; see general comments above as applied to species on this substrate.

+ = Info. from Saxicolous by Zone document incorporated.

--Habitat: Distribution: Role(s): Sensitivity:

+Acarospora "chlorophana" complex--Habitat: On acidic rocks (mainly basalt and andesite, but also on granite and schist); on dry, more or less shaded, vertical or overhanging surfaces, especially rimrock cliffs, and often near the bottoms of large boulders and outcrops. On north-facing, or sometimes south-facing, surfaces. Sometimes in areas exposed to nutrient enrichment, but not where directly manured. In dry, open areas, sometimes near streams or rivers. At low to high elevations (100-2100 m). In shrub-steppes (Artemisia tridentata/Bromus tectorum), bunchgrass communities (Agropyron spicatum/Poa sandbersii), juniper-sage deserts (Juniperus occidentalis/Artemisia tridentata), yellow pine forests (Pinus ponderosa), montane forests (Abies concolor-Pinus), subalpine forests (Abies lasiocarpa zone), and alpine areas. Average annual precipitation ca. 25 cm. Distribution: All east side provinces of OR & WA, except apparently Northeastern WA Mountains. Very frequent, and often a dominant and very conspicuous taxon in its habitat. Sensitivity: Possibly sensitive to sulfur dioxide pollution. Population trends: Possible decrease (causes unknown) in at least one area (central Cascades of Washington) according to Rossman (1994, pers. comm.).

Acarospora spp. --Habitat: One species, A. schleicheri, occurs occasionally on soil or plant debris 'in open, arid habitats at moderate elevations (420-1525 m). The rest (at least.8 species) occur on various rocks in a variety of habitats from open lowland areas through forests to the alpine zone; of these species, only A. "fuscata" has been identified often in the region enough to have much idea of its ecology; it occurs on exposed rocks, mainly in open areas at moderate elevations. Distribution: Scattered very frequently throughout much of the Columbia Basin, but (except for A. "chlorophana") rarely obvious or high in cover. Sensitivity: After fire, cover of A. schleicheri was somewhat less;- frequency and cover of A. fuscata and A. striaata decreased (Boykin, unpublished).

+Alectoria imshaugii--Habitat: On bark or wood of conifers ;

Major species

(including Abies concolor, Pinus ponderosa, Pseudotsuga menziesii, and Tsuaa heteronhvlla). At moderate to higher elevations (780-2300 m). In yellow pine forests (Pinus ponderosa); montane forests (Abies concolor-Pinus, Abies-concolor). Distribution: Mountainous areas of all provinces in the region. Widely distributed, but (in my experience) rarely abundant.

+Alectoria sarmentosa ssp. sarmentosa--Habitat: On bark or wood (trunks and branches) of conifers (including Abies concolor, A. arandis, A. lasiocarpa, Larix occidentalis, Picea enaelmannii, Pinus contorta, Pseudotsuga menziesii, Tsuaa heterophvlla, and occasionally-Pinus'ponderosa)., sometimes primarily in the canopy, but. mainly ca.. 3-9 m above the ground,. but with smaller amounts towards the tops of trees (Edwards, et al., 1960). Mainly in montane forests-(including Abies srandis/Pachistima, Tsuaa heterophylla/Pachistima, Tsuaa heterophvlla-Pseudotsuaa-Abies amabilis, Abies concolor, Tsusa mertensiana-Pinus contorta-P. monticola-Abies lasiocarpa, and Abies lasiocarpa/Menziesia associations); sometimes in riparian areas.. At moderate to mainly higher elevations (500-2000 m) ft). A dominant species in some areas, by itself or with Brvoria spp. Distribution: Occasional at higher elevations of the East Slope of Cascades (OR & WA) and higher peaks in the Eastern Plateaus and Hills province (OR), and sometimes abundant; common in the Northeastern WA Mountains. Role(s): An important winter food for woodland caribou (Rangifer tarandus caribou) (Edwards, et al., 1960; Rominger & Oldemeyer, 1989; Sharnoff, 1993), and according to Amy Snow' (pers. comm., 1989); forests in the Northeastern Washington Mountains are being managed with this in mind. Inhibits wood-destroying fungi to a slight extent (Lundstrom & Henningsson, 1973). Sensitivity: Sensitive to ozone. Logging may increase the exposure of the lichens to wind, light and heat. While wind may temporarily make them more available as food for caribou, it and increased light and heat will decrease the lichen population.

Aspicilia spp. --Habitat: On rocks in virtually all types of ecosystems in the region. Distribution: Throughout the region; the taxonomy is such that little specific information can be provided.

+Bryoria abbreviata--Habitat: On bark or wood of conifers (including Abies concolor, Pinus contorta, P. ponderosa, Pseudotsusa menziesii, and Tsuga spp. Mainly in open forests, especially characteristic of those in which Pinus or Pseudotsusa are abundant .(associations include Pinus ponderosa-Juniperus occidentalis, Pinus ponderosa-Populus trichocarpa, Pinus ponderosa-Quercus-Pseudotsuga, Pinus ponderosa-Pseudotsuaa;. Pseudotsuga/Physocarpus, Pinus contorta, and Abies concolor-Pinus). At moderate to occasionally higher elevations (300-900(-

2100 m)). Frequently associated lichens include Letharia spp. and Tuckermannopsis merrillii. Distribution: Mountainous areas in all provinces in the region except Northeastern WA Mountains. Role(s): * Sensitivity: Sensitive to ozone.

+Bryoria capillaris--Habitat: On bark or wood of conifers (including Pinus ponderosa and Pseudotsuaa menziesii). In coniferous forests (including Pinus oonderosa-Quercus-, Pseudotsusa, Pinus contorta, Pseudotsusa, Abies concolor, Abies concolor).. At moderate to higher elevations (900-2000 m); apparently more characteristic of more humid areas. Associated lichens include Alectoria sarmentosa and Bryoria spp. Distribution:. East Slope of Cascades (OR--near border with' Eastern Plateaus and Hills); East Slope of Cascades (WA--near border with Columbia Plateau); Northeastern OR Mountains; possibly elsewhere (sites are near the Washington/Idaho border, and may be in Idaho).. Abundant in a few places (at least in South-Central Oregon). Role(s): Sensitivity: Sensitive to sulfur dioxide and fluoride. Tolerant to fertilizer dust? (Kauppi, 1972).

+Bryoria fremontii--Habitat: On bark or wood of conifers (including Abies concolor, Larix occidentalis, Picea enslemannii, Pinus contorta, P. nonderosa, and Pseudotsusa menziesii) and occasionally hardwoods (including Cercocarpus ledifolius and Purshia tridentata). Often on branches in the canopy. At moderate to higher elevations (1000-2000 m). In communities ranging from juniper desert to montane forest (Cercocarpus ledifolius-Purshia tridentata-Artemisia tridentata, Pinus ponderosa-Juninerus, Pinus ponderosa/Agropyron, Pinus ponderosa-puercus-Pseudotsusa, Pinus ponderosa/Cercocarpus ledifolius, Pinus contorta, Pseudotsusa, Abies concolor-Pinus, Abies concolor). Associated lichens include Letharia spp.. and Brvoria spp. Distribution: Mountainous areas in all provinces of the region except possibly Northeastern WA Mountains (probably present there, but may not have been correctly identified). Frequent and sometimes a dominant species. Role(s): Important for food and nesting material for the northern flying squirrel (Glaucomys sabrinus) (Sharnoff, 1993). Sensitivity: Sensitive to ozone.

+Bryoria fuscescens--Habitat: On bark or wood (trunk or branches) of conifers (including Abies concolor, A. lasiocarpa, Larix occidentalis, Picea enalemanii, Pinus contorta, and Pseudotsuaa menziesii, in various forest types (including Abies lasiocarpa/Menziesia, Tsuga heterophylla/Pachistima, Pinus contorta, Abies concolor, and Pinus ponderosa/Quercus garryana/Pseudotsuga menziesii associations), at moderate to higher-elevations (930-1950 m). Distribution: Mountainous areas of all provinces in the region. Frequent, often common, but

Major species

usually not as-abundant a's other members of the genus. Role(s): Used by the northern flying squirrel (Sharnoff, 1993). Sensitivity: Intermediate in sensitivity to sulfur dioxide.

+Brvoria crlabra--Habitat: On bark or wood (trunk or branches) of conifers (including Abies concolor and Pinus spp.), and on old fences. In montane forests (including Abies concolor-Pinus and Abies'arandis-Pseudotsusa). At moderate to higher elevations (900-1850 m). Distribution: Mountainous areas in all provinces in the region except apparently the Northeastern.WA Mountains (probably present there but not identified correctly). Fairly frequent, sometimes rather abundant. Role(s): Sensitivity: Sensitive to ozone.

Brvoria pseudofuscescens--Habitat: On bark or wood of conifers (including Picea enslemanii, Pinus contorta, and Pseudotuaa menziesii), in montane forests (Pseudotsuqa, Pinus contorta, Abies concolor). At moderate to higher elevations (600-2130 m). Distribution: Mountainous areas in East Slope of Cascades (OR; border with Eastern Plateaus & Hills), Northeastern OR Mountains, and Northeastern WA Mountains (border with Columbia Plateau). Abundant in a few places '(at least in south-central Oregon). Role(s).: Used by the'northern flying. squirrel (Sharnoff, 1993). Sensitivity:

Brvoria spp. --Habitat: Due to the difficulty 'of identifying most of the species, frequent misidentifications especially in the older literature, and frequent intermixture of species, for many purposes the genus has to be treated as a whole. Although some members of the genus occur on soil or rock, the ones in this region apparently occur only on bark or wood of conifers, mainly in the lower 7.5 m, or up to ca. 15-20 m above the ground (Edwards, et al., 1960). They occur mostly at moderate to higher elevations, in montane to subalpine forests. At least 7 other species of Brvoria have been found once or a few times in in the region (B. friabilis, B. implexa, B. lanestris, B. oreqana, B. simplicior, B. tortuosa, and B. trichodes ssp. americana); some of these may actually be abundant in some areas, but except for B. tortuosa these additional species tend to be rather difficult to recognize, making it difficult at present to say much about them. Distribution: These additional species have been found mostly on the East Slope of the Cascades or their extensions into adjacent plateau or hill areas (OR and/or WA); B. oreqana has also been found in Northeastern WA Mountains. Role(s): The genus as a whole is a component of the winter diet of woodland caribou (Edwards, 'et al., 1960; Rominger & Oldemeyer, 1989). One species of the genus (referred to as "Alectoria jubata"--an ambiguous name) strongly inhibits wood-destroying fungi (Lundström & Henningsson, 1973); the same may be true of the species found in the Columbia Basin. Sensitivity: One of the additional species

Major species

(B. trichodes spp. americana) is known to be sensitive to intermediate to sulfur dioxide.

Buellia spp. --Habitat: One species (B. "papillata") occurs on moss, -plant debris and dung; several others (including B. retrovertens) occur on rocks; the rest (at least 6 other species) occur on bark or wood (mostly of hardwood trees or shrubs, sometimes on junipers). Due to the taxonomic difficulties, little else can be said at present, but I suspect that several species are probably quite frequent and abundant. Several occur in "biscuit scablands" or juniper-sage-desert-grasslands; others occur in hardwood-dominated woodlands at low elevations; true B. papillata is to be expected in alpine areas. Distribution: Most of the species have been identified from the East Slope of the Cascades (OR, WA) or adjacent areas, near the Columbia River. Role(s): * Sensitivity:'

+Caloplaca saxicola--Habitat: On rocks (most often basalt, but sometimes granite or other kinds), especially on dry vertical cliffs or rimrock, and on the parts of boulders or outcrops exposed to strong nutrient enrichment from birds or small mammals (e.g., Neotoma spp.). On exposed, north- or south-facing surfaces, and often towards tops of large boulders. or outcrops. At moderate to higher elevations (360-2040 m). Mostly in open areas dominated by Artemisia tridentata, Juniperus occidentalis, or Pinus ponderosa; sometimes in montane forests or woodlands (e.g., Abies concolor-Pinus; Castanopsis chrysophylla/Arctostaphylos patula-Amelanchier ainifoi'ia-Symphoricarpos community). Precipitation ca. 25 cm per year. Distribution: In all provinces in the region, except apparently the Northeastern WA Mountains (perhaps due to the infrequency of the species' occurrence on granitic rocks, which predominate in that-province). Role(s): Sensitivity:

Caloplaca spp. (especially the complexes centered around the C. holocarpa, C. cerina, and C. ferruginea)--Habitat: The various species in these complexes-occur on a wide variety of substrates, over wide ranges of altitudes and ecosystems; due to taxonomic problems it is difficult to say much about most of the individual species at present. One group (including C. jungermanniae, C. stillicidiorum, and C. tiroliensis) is very frequent and common on mosses, plant debris, or soil in open areas dominated shrubs or grass (most collections examined were from low to moderate elevations, but these species are also to be expected in alpine sites); at least one other species, C. tominii; occurs directly on soil. One species (C. eoithallina) is very frequent as an epiphyte on other crustose lichens. The remaining species (probably at least 10) occur either on bark or wood or on rocks, bones, etc., and some appear to be quite common in some areas. Distribution: At least several members of this genus have been

Major species

found in most of the provinces in the region, except apparently the Northeastern WA Mountains (where they almost certainly do occur but'have not been identified). Role(s): Sensitivity:

+Candelaria concolor--Habitat: Usually on bark or wood (trunks and branches) of'hardwoods (including Amelanchier, Artemisia rigida, A. tridentata, Crataegus, 'Quercus garryana, Rosa sp., Salix spp., and Symphoricarpos albus); or of ~~Juninerus~~ occidentalis; occasionally on ponderosa or other conifers, exceptionally on burnt stumps or steep faces of rock (basalt). At low to moderate-elevations (60-1050 m). In shrub-steppes (including Artemisia tridentata ssp. tridentata/Stipa comata and Symphoricarpos albus/Festuca idahoensis), bottoms of ravines in biscuit scablands (Juninerus occidentalis) and open woodlands (Pinus ponderosa/Symphoricarpos albus and garryana). Often in areas exposed to some nutrient enrichment from dust (e.g., along roads or in agricultural areas)..Sometimes .a dominant species, by itself or with species of Melanelia, Phvscia, or Xanthoria spp. Distribution: East Slope of the Cascades (WA, OR); Columbia Plateau (WA); Eastern Plateaus & Hills (OR). Role(s): Sensitivity: Sensitive to intermediate to sulfur dioxide; sensitive to fluoride.

Candelariella spp.--Habitat: Some species (C. efflorescens and C. xanthostigma), are restricted to bark or wood of hardwoods. Others (e.g., C. "citrina", C. "terrigena") occur only on soil, moss, or plant debris. One species (C. aurella) is restricted to calcareous rocky substrates. (in the Columbia Basin, mainly concrete), but has been erroneously reported from various other substrates. Still others (C. rosulans, C. vitellina) are typically on rock, but may occasionally also occur on other substrates. Most have been found mainly in various open community types (grasslands and shrub-steppe up to pine forests) at moderate elevations. Most are quite frequent and often abundant (especially in areas exposed to moderate amounts of nutrient enrichment from dust or other sources), but are difficult to distinguish from each other. Distribution: East Slope of Cascades (WA, OR), Columbia Plateau (WA), and Eastern Plateaus and Hills (OR). Role(s): Sensitivity: Candelariella vitellina is intermediate to sulfur.dioxide; tolerant to fluoride; sensitive to herbicides and fungicides (Alstrup, 199); C. rosulans was killed by fire (Boykin, unpublished).

+Cetraria aculeata--Habitat: On soil. At high-elevations ((1900-)2250-2600 m), or rarely at moderate elevations (780 m). Mainly in the alpine zone, but sometimes in grasslands at lower elevations. According to Thomson (1984), in the Arctic the species occurs on sandy soil or among mossses at the edge of frost boils, sometimes over rocks with thin soil, occasionally at the base of shrubs. In alpine areas on the east slope of the

Major species

North Cascades (Douglas & Bliss, 1977), the species is fairly important in some dwarf-shrub communities (Salix nivalis), and some dry graminoid communities, (Calamoorostis purpurascens and Carex nardina), and is also present in Drvas octonetala dwarf-shrub communities, Carex breweri snowbed communties, and Carex phaeocephala dry graminoid communities. It is best developed on level to moderate or steep, exposed, mainly south- or southwest-facing slopes, on well-drained soils that are often extremely rocky and often show indications of frostaction; snow accumularion is often slight; and snowmelt is relatively early (April to' early June). Associated lichens. include Thamnolia spp. and sometimes Cladonia pyxidata, or Cetraria islandica and C. ericetorum. Distribution: East Slope of Cascades of WA, Northeast.Mountains of WA, Nprtheast Mountains" of OR.

+Cetraria ericetorum--Habitat: On soil and humus, especially among 'mosses, in dry or moist habitats. Usually at high elevations (1750-)2250-2450 m). Usually in the alpine zone, sometimes extending down in subalpine areas. In alpine areas on the east slope of the North Cascades (Douglas f-Bliss, 1977), it 'is fairly important in Carex capitata snowbed communities; Arctostaphvlos uva-ursi dwarf-shrub communities, and several dry graminoid communities (Calamosrostis purpurascens, Carex phaeocephala, and Kobresia mvosuroides). . It occurs on all aspects, but especially south- or southwest-facing; moderate to steep slopes, on level to slightly concave sites, often with hummocky topography, on soils that are often poorly developed and well-drained, but also on soils that remain moist well into the summer due to drainage from upslope; snow accumulation is slight, and snowmelt is relatively early (April to mid-June. Associated lichens include Cladonia pvxidata, Cetraria aculeata, C. 'islandica, or Thamnolia spp. Distribution: East Slope of Cascades of WA, Northeast Mountains of WA.

+Cetraria islandica--Habitat: On soil or moss, 'on all aspects and soil types ranging from well drained, on smooth slopes, to more poorly drained on hummocky terrain, with light to heavy accumulations of snow, with snowmelt occurring early (mid April) to late (late July), avoiding-the wettest and driest areas. At high elevations ((1800-)1950-2600 m). An impbrtant component of alpine areas on the east slope of the North Cascades; the dominant lichen in Phvllodoce slanduliflora communities, and fairly important in other dwarf shrub communities (Salix nivalis, Salix cascadensis), some snowbed communities (Antennaria lanata, Carex breweri), and some dry graminoid communities (Danthonia 'intermedia, Calmoqrostis purpurascens, Carex scirpoidea var. pseudoscirtioidea, and Kobresia mvosuroides). Sometimes also in subalpine areas (Abies lasiocarpa/Menziesia community). Distribution: East Slope Cascades of WA, Northeast Mountains of WA. Role(s): Aqueous extracts (of strain containing

fumarprotocetraric acid) inhibit the growth of vascular plants '(especially Dicotyledons, namely peas and. beans), especially the roots'and to some extent the germination of seeds and development of seedlings (Vainshtein & Tolpysheva, 1975). They also suppressed growth of many'mycorrhizal fungi (Brown & Mikola, 1974). Sensitivity: Intermediate to sulfur dioxide.

Cladonia cariosa--Habitat: On soils, especially those rich in humus,. but also on trail cuts, thin soils, soil over rock-, and compressed duff, sometimes associated with decaying bunchgrass clumps. On well drained uplands,. north-facing slopes of shallow valleys. In exposed or relatively shadead areas, mostly in various forest communities (moderately open, sometimes climax types, including Pinus ponderosa/Symphoricarpos albus, association, and various montane forests, such as ones with Pseudotsuga, Abies, or Picea enselmannii), but sometimes in scabflat grasslands (e.g., Festuca idahoensis-Poa sandbergii-Stipa comata-Bromus tectorum community). At low to fairly high elevations (100-1800 m). Sometimes associated with Peltiaera canina s. lato (including P. rufescens). Distribution: All provinces in the region except perhaps Eastern Plateaus and Hills of OR. Role(s): Sensitivity: Connected with permanent grasslands, on richer soil, on sloping terrain. Probably sensitive to habitat loss (conversion of natural lands for human use) and disturbance of the soil (due to grazing, trampling, vehicles, or fire) (Alstrup, 1992).

Cladonia chlorophaea group (C. chlorophaea complex, C. fimbriata, and C. pyxidata complex)--Habitat: On soil, moss, plant debris, rotting wood, or sometimes bases of trees, at moderate to high elevations, in a wide variety of community types, from shrub-steppes through forests into the alpine. Frequent and often abundant. Although the C. pyxidata complex (including C. poccillum) tends to be more tolerant of dry, exposed habitats, than the others; in other respects this group of closely related and sometimes difficult to distinguish species is probably best treated-together at present. Distribution: All provinces in, the region, except perhaps Northeastern-WA Mountains (C. chlorophaea has been collected there, and the others are expected there). Role(s): Sensitivity: Cladonia chlorophaea is tolerant (to slightly sensitive) to even high (5 'x normal) doses of herbicides (MCPA, paraquat/diquat, and 2,4-D) (Seaward, 1977); C. fimbriata is sensitive to intermediate to sulfur dioxide.

Cladonia spp.--Habitat: On soil, moss, plant debris, rotting wood, or bases of trees, in a wide variety. of habitats over a wide range of elevations, but predominantly in moister, cooler situations, from forests to alpine. Frequent and often dominant, but most of the 30 or so species that have been identified are presently known apparently from only one or a few localities

(this may be partly, but by no means entirely, an artifact of misidentifications having multiplied the apparent number of species). Many species (including the C. chlorophaea group discussed above) frequently occur only as basal squamules (especially in shrub-steppe habitats), making already difficult-to-distinguish species almost impossible to identify. Furthermore, with a few exceptions (e.g., C. ecmocyna is a dominant species at least along trailsides in one montane forest parts of the North Cascades),. little is known about the ecology of individual species based only on information form collections in the Washington/Oregon part of the Columbia Basin, even though much can be inferred from the literature from other regions. Distribution: At'least some additional species occur in each province in the region. Role(&): Sensitivity: Several members of the genus are sensitive to ozone. Probably sensitive to habitat loss (conversion of natural lands for human use) and disturbance of the soil (due to grazing, trampling, vehicles, or fire).

Collema spp. --Habitat: At least one species (C. nisrescens) occurs on bark of Quercus garryana and other hardwood trees near the Columbia River; at least one other (C. tenax) is probably common and somewhat more widely distributed on soil or moss in shrub-steppes or scablands at low to moderate elevations. Distribution:. Collections to which species names have been assigned (whether correctly or not) appear to be only from a few areas of the East Slope of Cascades (WA, OR), especially around the Columbia River; however, it is likely that unidentified species occur elsewhere in the region. Role(s): Nitrogen fixation. Enhancement of soil properties. Physical barrier to seedling establishment (St. Clair, et al., 1984). Sensitivity: Sensitive to intermediate to ozone; apparently tolerant to sulfur dioxide. Probably sensitive to habitat loss (conversion of natural lands for human use) and to some extent to disturbance of the soil (due to grazing, trampling, vehicles, or fire); howver, Anderson, et al. (1982) and Johansen & St. Clair (1986) found that C. tenax was common on ranges that had been-at least moderately grazed.

Dermatocarpon spp. (attached forms) --Habitat:.One species or group (named as D. arnoldianum, D. luridum, and D. rivulorum, but perhaps only one or two of these is correctly identified) occurs on rocks periodically inundated by streams. The others (of which D. miniatum and D. reticulatum are by far the most widespread and common) can occur in forested areas on steep to overhanging surfaces exposed to occasional seepage or runoff, but are perhaps more characteristic of rather dry rock surfaces or dry, open and sunny habitats, especially in shrub-steppes and pine or oak woodlands. These latterspecies occur on various rocks (basalt, sandstone-conglomerate, etc.), often exposed to or containing some calcium at moderate to higher elevations. Although there

are quite a' few collections identified as either D. miniatum or D. reticulaturn, the taxonomy of the genus is such that many of these identifications cannot be trusted at present. Distribution: East Slope of Cascades (WA, OR), Columbia Plateau (WA), Eastern Plateaus and Hills (OR).. Role(s): Sensitivity: Frequency and cover of D. miniatum decreased after fire (Boykin, unpublished).

Dermatocarpon spp. (vagrant forms)--Habitat associations, processes and requirements: At least the two common species (D. miniatum and D. reticulaturn) can become "vagrants", growing loose on soil in between small basalt rocks,. in flat, open areas, usually in depressions or channels where water ponds or trickles in the spring. Removal of plant debris by wind; lack of extensive cover by associated vascular plants (Rosentreter & McCune, 1992). Restricted to sites where water ponded during winter and spring (McCune, 1992), creating ephemerally-saturated conditions for growth of these forms. Distribution: The vagrant form of D. miniatum occurs in the Columbia Plateau (WA), Eastern Plateaus and Hills (OR) and Northeastern OR Mountains, while the vagrant iorm of D. reticulatum occurs in the Eastern Plateaus and Hills (OR), and possibly elsewhere (one collection of vagrant forms in' the Columbia Plateau has not yet been identified). Scattered, but often locally very abundant. Role(s): Sensitivity:

Dimelaena oreina--Habitat: On acid rocks (including basalt, granite, and schist), on fully exposed surfaces towards the tops of large boulders or outcrops, including those used as woodchuck lookouts or bird perches (but away from the direct source'of manuring) and steep surfaces of northwest-facing cliffs. At moderate to high elevations (910-2040 m). In sagebrush-steppe (Artemisia tridentata), juniper-sage desert (Juniperus occidentalis/Artemisia tridentata). Average annual precipitation 250 mm. Associated lichens include Lecanora muralis, Rhizoplaca spp., and others. Distribution: East Slope of Cascades of WA (Okanogan Co.), Columbia Plateau of WA (Rittitas Co.); Eastern Plateaus and Hills of OR (Baker Co., Harney Co., Lake Co.)

Dimelaena thysanota--Habitat: On acid rocks (including basalt, granite, and schist), including outcrops and boulders in rock' flows, on steep to vertical surfaces (north- and south-facing), and also on moderately sloping surfaces. At low to moderate elevations (60-1400 m). In grasslands (Agropyron spicatum/Poa sandberqii), sagebrush-steppe (Artemisia tridentata), juniper-sage desert (Juniperus occidentalis/Artemisia tridentata), and open woodlands (Populus trichocarpa). Average annual precipitation 25 cm per year. Associated lichens include Lecanora muralis, and others. Distribution: Columbia Plateau of WA (Chelan Co./Douglas Co., Kittitas Co., Klickitat Co., Yakima Co.)I Northeastern Mountains of WA (Ferry Co.), Eastern Plateaus and Hills of OR (Baker Co., Deschutes Co., Lake Co., Union Co.)

Major species

Diploschistes "muscorum"--Habitat: According to Lumbsch (19) D. muscorum occurs on moss (including moss over rock) or lichens (Cladonia), but also directly on soil, and-prefers areas with calcareous influences; in my experience (in the Cascades of WA, and elsewhere) it is tightly attached and can occur in fairly moist 'or shaded forested sites (with little or-no calcareous influences) as well as in dry, open places. In contrast, D. diacapsis occurs directly on soil and calcium-high rock, and in my .experience.(in somewhat dry but often fog-influenced islands in southern California) it forms.cohesive clumps' or mats that can be removed intact. However, both species have been frequently confused with-each other and with D. scruposus and others, which usually occur on siliceous rocks (directly and firmly- according to Poelt) in a wide range of habitats in the region, but according to Lumbsch (19) can also occur on soil. Without careful study of the specimens and fairly detailed information on their substrate and habitat, they are difficult to identify to species. Most material from the Columbia Basin has been found on bare soil (including loamy soil, but also thin soil over or among basalt rocks),, in dry, open,. flat areas, sometimes on north-facing canyon slopes, at moderate elevations (810-1200 m). Soil-dwelling material occurs in sage-steppes (Artemisia tridentata ssp. tridentata/Agropyron spicatum, Artemisia rigida communities), bunchgrass communities (Festuca idahoensis-Agropyron spicatum-Poa sandbergii, Festuca. idahoensis/Symphoricarpos albus, Festuca idahoensis-Poa sandbersii-Stioa comata-Bromus tectorum), juniper-sage deserts (Juniperus occidentalis/Artemisia tridentata and Juniperus occidentalis/Artemisia risida, sometimes with Pinus ponderosa and Pseudotsusa menziesii), biscuit scablands (edges of stone rings around mound communities), lava bed deserts with little vascular vegetation, and occasionally open pine forests (Pinus nonderosa). Average annual precipitation 200-350 mm. Soil-inhabiting material sometimes forming balls or' inverted cones *(removable intact), possibly due to flooding and frost heaving, and can be extremely abundant in shrub-steppes. Material on moss (almost certainly true D. muscorum) has been found at lower (60 m) as well as moderate elevations (870 m), in communities generally similar to those of the soil-inhabiting material, but does not seem to be-as frequent or abundant'in these habitats. Distribution: East Slope of Cascades of WA (Chelan Co.), Northeast Mountains,of WA (Ferry Co.) and OR (Klamath Co. [perhaps on moss]), Columbia Plateau of WA (Klickitat Co. [partly on moss], Lincoln Co., Whitman Co.), Eastern Plateaus and Hills of OR (Baker Co., Crook Co., Deschutes Co. [partly on moss], Gilliam Co., Harney Co., Grant Co. ["on soil . . . associated with" the moss Ceratodon purpureus"]), Klamath co. [perhaps on moss]. Lake Co. [perhaps on moss], and Wasco co. ["on stabilized soil . . . associated with" the moss Tortula ruralis]. Material growing on moss or Cladonia has also been found in moist forests west of

the Cascades of WA and OR, while material on soil has apparently not been found there. While Lumbsch reported D. muscorum from OR and WA, and D. scruposus from OR, he reported D. diacapsis only from more southern localities (including CA and UT).

+Hypogymnia imshausii--Habitat: On bark or wood of gymnosperms (including Abies concolor, A. arandis, Juniperus occidentalis, Larix occidentalis, Pinus contorta, P. monticola, P. ponderosa, Pseudotsusa menziesii, and Tsuga mertensiana), or less often hardwoods (including Cercocarpus ledifolius and Crataegus doualasii), or rarely soil. On branches in the crowns, lower dead limbs, and sometimes also on trunks (smooth or rough bark). At moderate to high elevations (600-2100 m). In a wide range of shrub or forest communities, including Cerocarnus ledifolius-Purshia tridentata-Artemisia tridentata communities, bottoms of ravines in biscuit scablands (Juniperus occidentalis), yellow pine woodlands (Pinus ponderosa-Juniperus occidentalis, Pinus ponderosa/Agropyron spicatum, Pinus ponderosa/Symphoricarpos albus, Pinus ponderosa/Cercocarpus ledifolius, Pinus ponderosa-Pseudotsusa), and montane forests (Pinus contorta-Abies concolor, Pseudotsuga/Physocarpus malvaceus, Abies concolor-Pinus, Abies concolor, Abies srandis-Pseudotsusa, Tsusa heterophylla/Pachistima mvrsinites), up to the subalpine zone (Tsusa mertensiana). Often associated with species of Melanelia, Platismatia, Tuckermannopsis, and Vulpicida, or sometimes with species of Letharia or Bryoria. Distribution: In mountainous areas of all provinces in the region. Role(s): Sensitivity: Tolerant to intermediate to ozone and apparently also to sulfur dioxide,

Hypogymnia spp. --Habitat: Perhaps 8 other members of the genus occur, on bark or wood of various trees or shrubs; sometimes on soil, moss, or rocks, mostly in various woodland or forest habitats at moderate to higher elevations. Although several of these (e.g. H. physodes and H. tubulosa) are readily identifable, they are generally not common in the region, while others that may be at least locally abundant (H. enteromoroha and H. au&erodes/H. bitteri complexes) in some areas are often difficult to identify. Distribution: At least one additional species occurs in each province in the region. Role(s): Sensitivity:

+Lecanora muralis--Habitat: Usually on rocks (virtually all kinds; including andesite, basalt, schist, sandstone, and calcareous rocks; but apparently not on granite), but not uncommon on moss or soil (including natric soils) in some areas; sometimes on concrete; rarely on bark or wood. Found on all degrees of slope, aspect, and exposure, and on all sizes of rocks, from pebbles to boulders or cliffs. Often in areas exposed to light to fairly heavy amounts of nutrient enrichment.

Major species

In an extremely wide range of habitats, mostly in drier.or more open areas, including grasslands (Aqroovron spicatum/Poa sandberqii and Aqropvron spicatum/Festuca idahoensis), shrub-steppes (Artemisia tridentata associated with either perennial bunchgrasses or annual grasses;, Artemisia riqida/Poa sandberqii), juniper-sage deserts (Juniperus occidentalis/Artemisia tridentata, Juniperus occidentalis/Artemisia riqida), and open woodlands (Pinus ponderosa and puercus qarrvana), but sometimes in montane' forests (Pseudotsuqa/Physocarpus malvaceus, Abies concolor-Pinus); sometimes in riparian areas. At low to moderate elevations, but sometimes higher (60-1000 (-1915 m)). 'Summer temperature maxima ca. 26-34(-36)° C. Precipitation ca. 25 cm per year. Distribution: All provinces in the region except apparently the Northeastern Washington Mountains (probably present there but not yet identified). Role(s): Sensitivity: Tolerant to sulfur dioxide. Somewhat sensitive to herbicides and fungicides (Alstrup, 199). Apparently tolerant to (perhaps even promoted by) fire (Boykin, unpublished).

+Lecanora phaedrophthalma--Habitat: On acidic rocks' (including andesite, basalt and occasionally schist 'or granite),' on horizontal to gently or sometimes steeply sloping surfaces, towards the tops of larger, exposed rocks, above or along the sides of washes. Possibly also on bone (identification needs checking!), not uncommonly on pockets of thin soil, or spreading onto mosses on rock. At low to moderate elevations (60-1400 m). In various shrub-steppes (Aqropvron spicatum/Poa sandberqii, Aqroovron spicatum/Festuca idahoensis, Artemisia tridentata associated with either perennial bunchgrasses or annual grasses, Artemisia riqida/Poa sandberqii), juniper-sage deserts (Juniperus occidentalis, Juniperus occidentalis/Artemisia tridentata, Juniperus occidentalis/Artemisia riqida), and open woodlands dominated.by Pinus ponderosa (sometimes with puercus or Pseudotsuqa). Appears to prefer some nutrient enrichment from dust or other sources. Summer temperature maxima ca. 26-34(-36)° C. Precipitation ca. 25 cm per year. The ecology of this species in North America appears to be rather different from that in central Asia. Distribution: In all provinces in the region, but not in the higher mountainous areas. Role(s): Sensitivity:

+Lecanora pseudomellea--Habitat: On hard acid rocks (mainly basalt; sometimes schist, granite, or others), often on small rocks on gently sloping surfaces (possibly intermittent stream beds), but sometimes on vertical faces under trees, mainly at moderate elevations (1175-1585 m), in shrub-steppes (Artemisia tridentata with various grasses), and woodlands dominated by Pinus ponderosa (sometimes with Pseudotsuqa menziesii) 'or occasionally Quercus qarrvana. Summer temperature maxima ca. 26-34(-36): C. Precipitation ca. 25 cm per year. Distribution: In

Major species

all provinces.of the region except Northeastern WA Mountains. Role(g): Sensitivity:

+Lecanora rupicola--Habitat: On acid rocks (basalt or andesite), often on steep.or vertical surfaces (north-facing), sometimes on tops of exposed cliffs, sometimes in "stone rings" in biscuit scablands. At-moderate to higher elevations (550-2000 m). Occasionally -in shrub-steppes (Artemisia tridentata/grass, and Artemisia rigida/Poa sandberqii) or juniper-sage deserts (Juniperus occidentalis/Artemisia tridentata), more often in open woodlands or forests (Quercus qarryana, Pinus ponderosa, Pinus ponderosa-Pseudotsuqa, Abies concolor, Abies lasiocarpa), and alpine. In the alpine, it is sometimes joined by a similar and closely related species, L. bicincta. Distribution: East Slope of Cascades (OR, WA), Columbia Plateau (WA), Eastern Plateaus and Hills (OR). Role(s): Sensitivity:

Lecanora spp. --Habitat: Probably several dozen other members of the genus occur in the region; although quite a few are fairly identifiable and may have very distinctive habitats, these species are apparently rather restricted in distribution, while numerous difficult to identify species are probably quite widespread 'and common. The members of the genus occur on all substrates, but most are either on bark or wood or on rock; much more study is needed to give a good description of their ecology within the-region. Distribution: At least a few of the additional species occur in all provinces in the region.' Role(s): Sensitivity:

Lecidea "atrobrunnea/cascadensis" group--Habitat: On hard acidic rocks, probably in all or most habitats, over a wide range of elevations from low to very high. Although the group as a whole is extremely frequent and often dominant, the taxonomy is such that it is meaningless at present to say anything about the ecology of individual species. Distribution: Throughout the region. Role(s): Sensitivity: Lecidea atrobrunnea has been assumed to be tolerant to sulfur dioxide.

Lecidea tessellata--Habitat: On various types of rock (most often basalt), usually on the flattened upper portions of larger rocks in exposed areas, but occasionally on pebbles above washes, or rarely on steep surfaces under trees; sometimes near streams. At moderate to higher elevations (420-2000 m). In open habitats, including shrub'steppes (Artemisia tridentata, Artemisia riqida/Erioqonum thvmoides, and Artemisia rigida/Poa sandberqii communities), juniper deserts (Juniperus occidentalis/Artemisia tridentata), open woodlands (Pinus ponderosa, Pinus ponderosa/Agropyron spicatum, Pinus ponderosa-Pseudotsuqa, Abies concolor-Pinus). Distribution:. In all provinces in the region except apparently the Northeastern WA Mountains (perhaps not

identified yet). Role(s): Sensitivity:

Lecidea spp. --Habitat: The very numerous other species of this genus (in the broad sense,, including various segregate genera) are mostly either restricted in distribution, very difficult to identify,. or-both, but are among the most frequent;. widespread, and abundant crustose lichens in the region; The group occurs on all substrates in a wide variety of habitats over the full range of elevations. Without much more study' it is meaningless to comment on the ecology of most individual species.--Distribution: In all provinces in the region. Role(s): Sensitivity:

+Lepraria "neglecta"--Habitat: In contrast to the other members of the genus, this complex.tends to occur most often on'more or less gently sloping surfaces, on the tops of rocks, as well as on soil. (loamy or rocky), mosses (including Grimmia montana and G. ovalis), or.other substrates on rock or on the ground), in areas exposed to sun and precipitation, including both dry sites and periodically rather moist ground. At.moderate to high elevations (ca. 1500-2400 m). In juniper-sage deserts (Juniperus occidentalis/Artemisia tridentata), ravine communities over basalt cliffs in biscuit scablands (Poa sandbercii-Lomatium coos), 'open'forests (including Pinus ponderosa, Abies grandis-Pseudotsuaa, 'Abies concolor-Pinus, Abies lasiocaroa), and especially subalpine to alpine areas. In the North Cascades it' is the dominant lichen in several snowbed communities (Antennaria lanata, Carex breweri) and fairly important in some dwarf shrub communities (Phyllodoce emnetriformis, Phyllodoce slanduliflora, Salix nivalis, and Salix cascadensis), and it occurs especially in concave sites, on poorly to more often well drained soils (including'rocky soils), that become snow-free in mid May to more often June to late July, and become dry during late summer.. Distribution: Presently identified from East Slope of Cascades (WA, OR), Columbia Plateau (WA), and Eastern Plateaus and Hills (OR), but probably present throughoutthe region. Role(s),: Sensitivity:.

Lepraria spp, (L. "incana" and similar species)--Habitat: On all substrates, usually in fairly humid areas but on steep or overhanging surfaces but sheltered from sun and precipitation, mainly in forests but probably also in protected microhabitats elsewhere, over a wide range of elevations. Distribution:--:" Probably throughout the region, though restricted to few localities'in the drier provinces. Role(s): Sensitivity: Tolerant to sulfur dioxide.

Leptochidium albociliatum--Habitat: On mosses (including Grimmia montana) or--soil (including disturbed and exposed, deep mesic clay/loamy or loessal/ashy soils), or thin loamy soil over rock (mainly basalt), in open, semi-arid to somewhat moist areas, on

Major species

gentle to sometimes steep slopes, sometimes on shaded cliffs under trees. In sagebrush steppe (Artemisia tridentata ssp. tridentata/Agropyron spicatum), juniper-sage desert (Juniperus occidentalis/Artemisia tridentata), biscuit'scablands in mound (Festuca idahoensis/Agropyron spicatum and intermound (Artemisia riqida/Poa sandberqii) communities; Quercus garryana and Pinus ponderosa woodlands, and sometimes montane forests (Abies concolor-Pinus), at low, to higher elevations (20-1950 m). Average annual precipitation 230-300 mm. Often associated with Leptoqium spp., especially the superficially similar L. hirsutum. Distribution: East Slope of Cascades (WA, OR); Columbia Plateau (WA); Eastern Plateaus and Hills (OR). Role(s): Sensitivity: Sensitive to intermediate to ozone.

Leptoqium californicum/lichenoides complex--Habitat: On moss or soil (deep, loessal/ashy soils,. and thin, loamy soils), often over rock (mainly basalt), or rarely wood. On gently sloping to steep surfaces, in exposed to sheltered sites, including flat areas, ridgetops, and canyons, sometimes under trees. At moderate to higher elevations (600-1950 m). In shrub-steppes, including Artemisia riqida communities, and mound (Festuca idahoensis-Aqropyron spicatum) and intermound (Artemisia riqida/Poa sandberqii) communities in biscuit scabland, Artemisia tridentata spp. wvominqensis communities with Aqropyron soicatum and Festuca idahoensis), Purshia tridentata/Bromus tectorum communities, juniper-sage woodlands (Juniper-us occidentalis/Artemsia tridentata), and open climax forests (including Pinus oonderosa, Pinus ponderosa/Agropyron spicatum, Pseudotsuqa, Pseudotsuqa/Physocarpus malvaceus, and Abies concolor-Pinus communities). Although, the label data suggest some possible ecological differences between L. californicum and L. lichenoides (the latter perhaps extending into higher elevations and more mesic areas than the former), this may be at least partly an artifact due to taxonomical problems. Distribution: East Slope of Cascades (WA, OR), Columbia Plateau (WA), Eastern Plateaus and Hills (OR). Material identified as L. lichenoides also occurs in the Northeastern OR Mountains. Role(s): Sensitivity: Leptoqium californicum is sensitive to intermediate to ozone.

Letharia columbiana--Habitat: On bark or wood'(often on higher branches), usually of gymnosperms (including Abies concolor, A. qrandis, Juninerus'occidentalis, Larix lyallii, L. occidentalis, Pinus albicaulis, P. contorta, P. ponderosa, Pseudotsuqa menziesii); rarely on hardwoods (Alnus sp., Cercocarpus ledifolius), rarely on rock (basalt). Sometimes on ridgetops. At low to high elevations (120-2340 m). Especially in forests dominated by Pinus nonderosa (including Pinus ponderosa-JuniPerus occidentalis, Pinus ponderosa-Quercus qarryana-Pseudotsuqa menziesii, Pinus ponderosa/Cercocarpus ledifolius, and probably Pinus ponderosa/Agropyron soicatum and Pinus

ponderosa/Symphoricarpos albus), and in montane forests (Pinus contorta, Abies concolor-Pinus, Abies concolor, and probably Pseudotsuga/Physocarpus malvaceus), and krumholz, (subalpine) stands (Larix lyallii, Pinus albicaulis), and in juniper-sage woodlands or shrub communities (Juniperus occidentalis/Artemisia tridentata, Cercocarpus ledifolius-Purshia tridentata-Artemisia tridentata). Often a -dominant species, especially in pine forests, often with L. vulpina and the same types of other,, lichens associated with that species (see below). Although the distribution and'ecology are generally. very similar to those of L. vulpina, L. columbiana tends to occur higher up in trees, and may differ in some other respects,. Distribution: In all provinces in the region except apparently the Northeastern,. Washington Mountains (probably present there also). Role(s): Poisonous, therefore not likely to be eaten-by animals. Sensitivity: Tolerant to intermediate to ozone. Possible threat to some local populations due to over-harvesting for commercial uses.

Letharia vulpina--Habitat: On bark, or wood (especially lower limbs and-trunk), usually of gymnosperms (including Abies concolor, A. grandis, A. lastiocarpa, Juniperus occidentalis, Larix occidentalis, Picea enalemannii, Pinus albicaulis.; P. contorta, P. monticola, P. ponderosa, Pseudotsuaa menziesii), sometimes on fenceposts (including "cedar" ones), rarely on hardwoods (Alnus sp., Artemisia riaida, A. tridentata, and Cercocarpus ledifolius), and rarely on rocks (basalt cliff outcrops), moss, or soil. At low to high'elevations (120-2400 m). Usually in forests dominated by yellow pines (including Pinus ponderosa-Juniperus occidentalis, Pinus ponderosa/Agropyron spicatum, Pinus ponderosa/Symphoricarpos albus, Pinus ponderosa/Cercocarpus ledifolius, Pinus ponderosa-Pseudotsuaa, Pinus ponderosa-Ouercus-Pseudotsuga). Also frequent and sometimes abundant in woodlands dominated by junipers (Juniperus occidentalis/Artemisia tridentata, and Juniperus occidentalis in bottom of ravines in biscuit scabland), and in montane forests (including Pinus contorta, Pseudotsuga/Physocarpus malvaceus, Abies concolor, Abies grandis/Pachistima myrsinites communities (Abies lasiocarpa/Menziesia ferrusinea) up into the subalpine (krumholz areas). Occasionally in shrub-steppes (Artemisia tridentata/Bromus tectorum), mound (Artemisia rigida/Poa sandberaii) communities in biscuit scabland, and other shrub communities (Cercocarpus ledifolius-Purshia tridentata-Artemisia tridentata). A dominant species, especially in pine forests, either by itself or with L. columbiana; other frequently associated lichens include Brvoria spp. (especially B. abbreviata), Hypogymnia imshaugii, and species of Platismatia, Tuckennannopsis and Vulpicida. Distribution: In all provinces of. the region. Role(s) in the ecosystem and sensitivity-to disturbance: Same as for L. columbiana.

Major species

1+Megaspora verrucosa--Habitat: On moss (e.g., Tortula ruralis), spike moss (Selaginella sp.) or plant debris, -over soil or rock (mainly basalt), or directly on soil, or on bark or wood (including Quercus'oarrvana, and branches of Artemisia riaida). Soil types include relatively well drained, deep loessal/ashy soils and thin loamy soils. On flat open areas, north-facing canyon slopes, or sometimes in riparian areas near streams or waterfalls. At low to moderate elevations (120-1340 m), in open communities including sagebrush-steppes (including Artemisia tridentata ssp. tridentata/Agropyron spicatum communities), juniper-sage'desert, mound (Festuca idahoensis/Agropyron spicatum) and intermound (Artemisia rigida/Poa sandbersii) communities in biscuit scabland, and puercus oarrvana woodlands. Precipitation 9-12 inches per year. **Distribution:** East Slope of Cascades (OR, WA), Eastern Plateaus and Hills (OR), and westernmost parts of Columbia Plateau (WA).

+Melanelia elegantula--Habitat: On rocks, soil over rocks, mosses, and bark or wood (branches or trunk) of Juniperus occidentalis or hardwoods. (including Acer sp., Artemisia riaida, A. tridentata, Populus trichocaroa, Quercus oarrvana, and Rosa sp.), or sometimes on branches in the crowns of Pinus ponderosa, Pseudotsusa, or other conifers. At low to moderate or sometimes higher elevations (300-1150(-1800 m)), in grasslands (including Festuca idahoensis/Symphoricarpos alba association), biscuit scablands (Artemisia rigida/Poa sandbersii communities, on soil mounds, and Juniperus occidentalis communities at bottom of ravines), juniper-sage desert (Juniperus occidentalis/Artemisia tridentata, sometimes with Pinus ponderosa), Quercus garryana woodland, Pinus ponderosa-Juniperus occidentalis woodlands, Pinus ponderosa/Symphoricarpos albus communities, Pinus ponderosa-Populus trichocarpa woodlands, and montane forests (Pseudotsuga/Physocarpus malvaceus, and Abies concolor).. Frequent and often abundant. Can be rather easily confused with other isidiate members of the genus that have been identified from'the region (especially M. subeleaantula, and perhaps M. exasoeratula). Associated lichens include Candelaria concolor and. other Melanelia spp., species of Phvscia, Phvsconia, and Xanthoria, or sometimes Parmelia sulcata or species of . . Hypogymnia, Tuckermannoosis and Vulpicida.' Distribution: In all provinces in the region'. Sensitivity: Tolerant to ozone.

+Melanelia multispora--Habitat: On bark or wood of hardwoods (including Alnus rubra, Amelanchier sp., Artemisia riaida, Crataegus spp., Pyrus fusca, and Rosa spauldinsii, Symphoricarpos albus) and gymnosperms (Juniperus occidentalis, Pinus ponderosa). At low to moderate elevations (120-1050 m). In grasslands (Festuca idahoensis/Symphoricarpos association), biscuit scablands (Artemisia rigida/Poa sandberaii communities and Juniperus occidentalis at bottom of ravines), Crataegus douslasii

communities, Quercus garryana woodlands, Populus trichocarpa woodlands, and forests dominated by Pinus ponderosa (sometimes with Pseudotsuga menziesii). Associated species include M. elegantula and Candelaria concolor or species of Physcia, Physconia, and Xanthoria. Distribution: In all provinces in the region except apparently Northeastern WA Mountains.

+Melanelia subolivacea--Habitat:- On bark or wood of 'hardwoods (including Betula papyrifera, Cercocarpus ledifolius, and twigs of Quercus garryana) and conifers (including Abies concolor and Pinus contorta). At low to moderate or occasionally higher elevations (30-1650(-2000 m)), often on north- or west- facing slopes. In Cercocarpus ledifolius-Purshia tridentata-Artemisia tridentata and Pinus ponderosa/Cercocarpus ledifolius communities, forests dominated by Pinus ponderosa (sometimes with Quercus garryana or Pseudotsuga menziesii), Pinus contorta, or Abies concolor. Associated lichens include Hypogymnia imshaugii, Parmelia sulcata, and others. Some apparent ecological differences between this species and M. multispora (which can'be readily. distinguished only by counting the spores) may be due to misidentifications; however, M. subolivacea seems to have a wider ecological amplitude, since it is quite common southward to southern California,, while M. multispora apparently occurs mainly in the Pacific Northwest. Distribution: In all provinces in the region except apparently Northeastern WA Mountains. Sensitivity: Tolerant to intermediate to ozone.

Melanelia &pp.--Habitat: Several species (M. granulosa, M. infumata, M. nanniformis, M. sorediata, M. substygia) occur mainly or only on acidic rocks; others (M. exasperatula, M. subelesantula) occur mainly on bark of hardwoods; still others (M. fuliainosa, M. subaroentifera, M. subaurifera) occur on either rock or bark/wood. Insufficient information is available for these species in the region. The species on bark or wood are likely to be'confused with each other and with the apparently more widespread and common M. elegantula. Distribution: Most Of the additional species have been found in the East Slope of Cascades of WA and OR, Columbia Plateau of.WA, or Eastern Plateaus and Hills of OR provinces; M. exasperatula has also been reported from Northeast Mountains of -WA. Role(s): Sensitivity: M. exasperatula is intermediate to sulfur dioxide.

+Neofuscelia veiruculifera--Habitat: On acid rocks (mainly basalt), often on horizontal to moderately sloping surfaces, often towards the tops of large or-small outcrops above or- along the sides of washes in open areas; sometimes-in sheltered canyons. At low to moderate or sometimes higher elevations (60-1700(-2040m).). In grasslands (Agropyron spicatum/Poa sandbergii), sagebrush-steppe (including Artemisia tridentata/Bromus tectorum), juniper-sage desert (Juniperus

occidentalis/Artemisia tridentata), and open forests (Pinus ponderosa and Pseudotsusa). The similar and closely related species N. subhosseana occurs in similar habitats but has been found on granite as well as basalt,, and has in addition been recorded from Asroovron spicatum/Festuca idahoensis grasslands, mound and intermound communities of biscuit scablands, and' Populus trichocarna stands. Both species are frequent, but usually not abundant. Distribution: In all provinces in the region except apparently Northeastern WA Mountains (N. subhosseana seems to be restricted to the Columbia Plateau of WA and Eastern Plateaus and Hills OR). Role(s): Sensitivity: Neofuscelia verruculifera is sensitive to fungicides, and to a lesser extent to herbicides (Alstrup, 199).

+Parmelia saxatilis --Habitat: On acid rocks (e.g., basalt; on larger boulders, outcrops or cliffs), mosses, or sometimes soil; less often on conifer trees (Pinus ponderosa, Pseudotsuga menziesii), and old wood. In exposed to sheltered situations. At low to higher elevations (120-2020 m). In ravines in biscuit scabland, and open forests (Pinus ponderosa/Agropyron spicatum, Pseudotsuga/Physocarpus malvaceus, Abies concolor-Pinus, and Abies srandis-Pseudotsusa); also in moist woodlands in riparian areas. Frequent, occasionally abundant, especially in fairly humid areas, but in the moistest habitats it is sometimes accompanied by or replaced by the similar P. hygrophila, a primarily west-side species. Distribution: In all provinces in the region. Associated lichens include Umbilicaria spp. Role(s): Sensitivity: Tolerant to ozone; intermediate to sulfur dioxide; sensitive to fluoride. Sensitive to fungicides (Alstrup, 199). Sensitive to 5x normal dose of the herbicide MCPA (but not to lower doses, nor to even high doses of paraquat/diquat or 2,4-D) (Seaward, 1977).

+**Parmelia sulcata**--Habitat: On rock (basalt, etc.), moss, humus, soil, bark or wood (trunk or branches) of hardwoods (including Acer sp., Amelanchier sp., Betula papyrifera, Cercocarpus ledifolius, Crataegus spp., Populus trichocarpa, and Salix sp.) and conifers (including Abies concolor ~~and Pseudotsuaa~~ menziesii), at moderate to higher elevations (300-1150(-1800 m), on cliffs in ravines in biscuit scabland, and on woody plants or sometimes mossy rocks in open scrublands (Cercocarnus ledifolius-Purshia tridentata-Artemisia tridentata), open forests (Pinus ponderosa/Symphoricarpos albus, Pinus ponderosa/Cercocarpus ledifolius, Populus trichocaroa), and montane forests (Pseudotsuga/Physocarpus malvaceus, Abies concolor-Pinus, Abies srandis-Pseudotsusa). Also in both conifer and hardwood forests in lowland to montane riparian areas. Frequent, occasionally abundant, particularly in moister habitats. Associated lichens include Melanelia spp., Hypogymnia spp., and others. Distribution: In all provinces in the region. Role(s):

Major species

Sensitivity: Sensitive to intermediate to ozone, nitrous oxides and PAN, and fluoride; intermediate to tolerant to sulfur dioxide. Sensitive to alkaline dust pollutants (Türk & Wirth, 1975). Sensitive to 5x normal dose of the herbicide MCPA (but not to lower doses, nor to even high doses of paraquat/diquat or 2,4-D) (Seaward, 1977).

+Parmeliopsis ambiqua--Habitat: On bark (branches and trunks) or more often wood, usually of conifers (including-Abies lasiocarpa, Larix spp., Pinus albicaulis, Pinus contorta, P. monticola, P. ponderosa, Pseudotsuqa menziesii), often on rotting decorticate logs or sometimes burnt wood; sometimes along creeks; at moderate to-higher elevations (853-2125 m), in scablands,. forests (Pinus ponderosa/Agropyron spicatum; Pinus ponderosa/Symphoricarpos albus, Pinus ponderosa-Populus trichocaroa, Pseudotsuga/Physocarpus malvaceus, Pinus contorta,, Abies concolor-Pinus, Abies concolor). Frequent, sometimes a dominant, by itself or with P. hyperopta. Distribution: In all regions in the province. Role(s): Sensitivity: Intermediate to sulfur dioxide; tolerant to fluoride.

+Parmeliopsis hyperopta--Habitat: On bark (branches and trunk) or more often wood, of conifers (Abies spp., Pinus contorta, P. ponderosa, Pseudotsuqa) or sometimes hardwoods (Prunus spp.), old stumps or logs, -sometimes on burnt wood. At moderate to higher elevations (600-2125 m). In montane forests (Pinus ponderosa, Pinus contorta, Abies concolor, Abies srandis-Pseudotsuqa). Frequent, sometimes abundant. Distribution: In all -provinces except apparently Northeastern OR Mountains. Role(s): Sensitivity: Intermediate to sulfur dioxide.

+Peltisera aphthosa complex--Habitat: On acid soil, humus, mossy rocks; and rotting logs and stumps, in moist places, including level benches at.the bottom of slopes, and steep slopes of canyons, occasionally on south-facing slopes but more often on north-, east-, or west-facing ones. At moderate to higher elevations (690-1800 m). In open to more often dense, often more or less climax; montane to subalpine forests (Pseudotsuqa/Physocarpus malvaceus, Abies grandis/Pachistima mvrsinites, Abies qrandis-Pseudotsuqa, Picea enqlemannii, Abies lasiocaroa). Also in lowland riparian woodlands.- Most collections in the region, particularly in drier areas, are probably P. leucophlebia. Rather infrequent and restricted in distribution in the WA/OR part of the Columbia Basin; but where it occurs it is often a dominant lichen. Associated.lichens include other Peltiqera spp., and often species of Cladonia. Distribution: In all provinces in the region except Eastern Plateaus and Hills (OR).. Role(s): Nitrogen fixation. Inhibits wood-destroying fungi to some extent (Lundström & Henningsson, 1973). Sensitivity: Apparently intermediate to sulfur dioxide.

Major species

Sensitive to fertilizer and to some extent some herbicides (Ryan, unpublished data); nitrogen fixation inhibited at high concentrations of the herbicides diuron, atrazine and ioxynil (Kallio & Wilkinson, 1977).

+Peltisera "canina"--Habitat: On soil (including sandy soil), rocks,. rotten logs, and bases of trees, usually-in moist, rather shaded habitats, including north- or northwest-facing slopes below cliffs.or in shallow valleys., At moderate to higher elevations (690-1920 m). Usually in lowland to montane riparian woodlands (including Populus tremuloides), and bogs, or montane to subalpine forests (Abies grandis/Pachistima myrsinites--"v. albescens", Abies concolor-Pinus, Abies lasiocarpa). Occasionally also in open climax pine forests (Pinus ponderosa/Agropyron spicatum--"v. ulorrhiza" and Pinus ponderosa/Symphoricarpos albus--"v. albescens"), grasslands (Festuca idahoensis/Symphoricarpos albus ("v. sponqiosa"). A minor component in alpine snowbed communities (Antennaria lanata, Carex capitata) dwarf shrub communties (Phyllodoce slanduliflora, Salix cascadensis), and dry graminoid communities (Carex scirpoidea v. pseudoscirooidea) in the North Cascades. Rarely also in Juniperus occidentalis/Artemisia tridentata shrub-steppe; one collection is from near the mouth of a limestone cave. In alpine areas, the species occurs in level to concave or hummocky sites on various aspects, with well drained soils (drying during late summer) to poorly drained soils (in hummocky areas, or remaining moist well into the summer because of drainage from upslope); snow accumulation varies from slight to considerable, and melts early to late June, or sometimes earlier. Associated lichens include other Peltisera spp. and sometimes Cladonia spp. Many of the collections, particularly in drier areas, may belong to the various segregate species (P. didactyla, P. membranacea, P. ponoiensis, P. oraetextata, P. rufescens, and perhaps others), but P. canina in a more-or-less strict sense does occur frequently in moister and cooler areas in the region, and is an important lichen in some communities. Distribution: In all provinces in the region, except apparently-Northeastern WA Mountains. Role(s): Nitrogen fixation. Inhibition of germination and seedling growth of grasses (including Festuca spp. and Poa sp.) (Pyatt, 1967). Sensitivity:. Sensitive to ozone and fluoride; tolerant to sulfur dioxide. Sensitive to fertilizer and to some extent some herbicides (Ryan, unpublished data), but tolerant to the herbicide Prefix (Seaward, 1977).

*Peltigera rufescens s. lato--Habitat: On soil (including rocky or sandy soil, but also deep loessal/ashy soils) or occasionally rock, often in rather dry areas, (including north-, east-, or west-facing slopes, steep west-facing slopes, in canyons or shallow valleys, and on gravelly till plains, and well-drained uplands). At moderate to higher elevations (420-2040 m). In

bunchgrass communities (Festuca idahoensis/Symphoricarpos albus, juniper-sage desert (Juniperus occidentalis/Artemisia tridentata), all communities in biscuit scabland but especially mound communities (Festuca idahoensis/Agropyron spicatum), open climax forests dominated by yellow'pine (including Pinus ponderosa/Agropyron spicatum, Pinus ponderosa/Symphoricarpos albus, Pinus ponderosa/Cercocarpus ledifolius, Pinus ponderosa-Populus trichocarpa, and Pinus ponderosa-Quercus garryana-Pseudotsuca communities) or Douglas fir (Pseudotsuga/Physocarpus malvaceus), or other conifers (Abies grandis/Pachistima myrsinites, Abies concolor-Pinus); probably also in the drier communities in the alpine zone (but lumped under P.' canina). The species is more tolerant of dry, warm, exposed areas than most other members of. the genus except perhaps P. nonoiensis, with which it may have been frequently confused. Frequent and often a dominant species, by itself or with other Peltigera spp., Cladonia spp., and sometimes Diploschistes "muscorum". Distribution: In all provinces in the region except apparently Northeastern WA Mountains. Role(s): Nitrogen fixation. Possible enhancement of soil qualities. Sensitivity: Sensitive to intermediate to ozone. Probably sensitive to habitat loss (conversion of natural lands for human use) and disturbance of the soil (due to grazing, trampling, vehicles, or fire). Effects of fires on this species in north-central Oregon were mentioned by Rossman (1977).

Peltiuera spp.--Habitat: Several additional species (including ones identified as P. desenii, P. kristinsonii, P. malacea, P membranacea, P. praetextata, and various taxa in the P. horizontalis/P. oolvdactvlon group) occur in the region, mostly on soil, moss, humus, mossy rocks, or rotten wood in moist; forested areas at moderate to high elevations, or up into the alpine. At least some of these species are important lichens in some areas, but due to taxonomic difficulties not much can be said about them at present. One species, P. nonoiensis, has been collected on sandy, desert soil (with Artemisia tridentata and Chrvsothamnus viscidiflorus), and may perhaps be more widespread and common in the region, but has probably been confused with P. rufescens or P. didactyla. A distinctive species, P. venosa, is treated separately under "Species of Special Concern". **Distribution:** Role(s): Sensitivity:

Phaeophyscia spp. --Habitat: Two species (P. "decolor" and P. sciastra) occur mainly on acidic rocks, sometimes spreading to mosses or tree bases, at moderate to higher elevations. One species (P. orbicularis) 'occurs. on bark (e.g., Quercus sarrvana) as well as on rock, at low to moderate elevations. The species are often inconspicuous and difficult to identify, and may be more frequent than the limited collections suggest. Distribution: One or more species occurs in each province in the region, and each of the species is known from several widely scattered parts

Major species

of the region. Role(s): Sensitivity:

+Physcia adscendens--Habitat: On trunks and branches of trees and srhubs, expecially hardwoods (including Acer macroohvllum; Quercus oarrvana, and Rosa spp.), occasionally on old wood, rocks, and concrete. At moderate elevations (600-93'0 m). In Palouse grassland (Festuca idahoensis/Symphoricarpos albus), open forests' (Pinus ponderosa/Symphoricarpos albus, Pinus oonderosa-Quercus sarrvana-Pseudotsusa, Pseudotsuga/Physocarpus malvaceus), and lowland riparian forests.. Fairly frequent, and sometimes co-dominant with Xanthoria spp. and associated'crustose taxa. The similar and closely-related species P. tenella has been found on Crataeous sp. in Pinus ponderosa/Symphoricarpos albus and Pinus ponderosa-Populus trichocarpa communities at moderate elevations. Distribution: Columbia Plateau (WA), Northeastern OR Mountains. Role(s): Sensitivity: Phvscia adscendens is intermediate to sulfur dioxide, and sensitive to fluoride. It is tolerant (to slightly sensitive) to even high (5 x normal) doses of herbicides (MCPA, paraquat/diquat, and 2,4-D) (Seaward, 1977).

+Physcia spp.--Habitat: Several additional species (including ones identified as P. 'caesia, P. callosa, P. cascadensis, P. dubia, P. maqnussonii, P. phaea, P. "subtilis" and P. "tribacia") occur only on rocks, or moss or thin soil over rock (mainly basalt); others (including P. biziana, P. dimidiata, P. stellaris) can occur on bark in addition to rock; and still others (P. aipolia) occur mainly on bark, usually of Quercus or other hardwoods. These various taxa have been found mostly at low to more or less moderate elevations, usually in habitats exposed to moderate amounts of nutrient enrichment; P. dubia has also been reported from alpine areas up to 2400-2500 m. Several of these (especially P. aipolia and P. dubia) are widespread in the Columbia Basin, and may be abundant in some places, but they can'be difficult to identify, making it difficult to say much about the ecology of most of the individual species at present. Distribution: The additional species occur in East Slope of Cascades (WA), Columbia Plateau (WA) and Eastern Plateaus and Hills (OR). Role(s): Sensitivity: Phvscia aipolia is intermediate to sulfur dioxide, and sensitive to fluoride.

+Phvsconia 'detersa--Habitat: On bark or wood (especially trunks) of hardwood trees or shrubs, or occasionally conifers, and on moss (including Grimmia), over soil or rocks (basalt, etc.). At moderate, to occasionally high, elevations (420-1050(-2400) m). In biscuit scablands' (in ravines, with Poa sandbersii-Lomatium coos), juniper-sage deserts (Juniperus occidentalis-Artemisia), Pinus oonderosa forests, montane forests (Abies concolor-Pinus), and occasionally on lava flows in alpine areas. Frequent and sometimes abundant. Distribution: East Slope of Cascades (OR, WA), Columbia Plateau (WA), and Eastern Plateaus and Hills (OR).

Major species

Role(s): Sensitivity: This species (or at least some species in this complex, partly, identified as "Physcia grisea") is tolerant to ozone and intermediate to sensitive to sulfur dioxide.

+**Physconia enteroxantha**--Habitat: On bark or wood of hardwoods (base of Artemisia; Quercus garrvana) and Juniperus occidentalis, on moss (e.g., Grimmia montana) over rock, on tops of sides of N-facing rock walls-, in crevices or under overhangs, sometimes in canyons, and on sandy soil on northwest-facing slopes, at low to moderate elevations (90-1950 m), in sagebrush steppe, juniper-sage desert, Festuca grassland in the juniper zone, Quercus woodland, and montane conifer forests. Distribution: East Slope of Cascades (WA, OR), Columbia Plateau (WA), Eastern Plateaus and Hills (OR). Role(s): Sensitivity:.

+**Physconia muscigena**--Habitat: On moss or humus over soil or rock (including basalt), or rarely over bark; usually in areas exposed to calcareous influences or manuring from birds; sometimes on N-facing cliffs or walls of canyons; moderate to higher elevations (300-2000 m), in sagebrush-steppes, Festuca grassland in the juniper zone, juniper-sage desert, Abies concolor-Pinus forests, and krumholz (subalpine) areas (Abies lasiocarpa zone). Distribution: In all provinces in the region except apparently Northeast OR Mountains. Role(s): Sensitivity:

+**Physconia perisidiosa**--Habitat: On moss over rock, on rock (basalt), including crevices in vertical faces, on sandy soil on northwest-facing slopes, and on bark or wood (including Juniperus occidentalis and Quercus garrvana), at moderate elevations (870-1835 m, in juniper-sage desert, open areas with Pinus ponderosa (sometimes with puercus garrvana or Pseudotsuga menziesii), and Abies concolor-Pinus forests. Distribution: East Slope of Cascades (OR), southwestern part of Columbia Plateau (WA), Eastern Plateaus and Hills (OR). Role(s): Sensitivity:

+**Physconia** spp. --Habitat: Several additional species have been identified in the region, and most of the members of the genus are taxonomically problematic and easily confused with each other. Material identified as "Physcia grisea" (often, but not always, based on misidentification of Physconia detersa) has also been found on soil and on Rosa spauldingii in bunchgrass areas (Festuca idahoensis/Symphoricarpos albus). What appears to be true P. grisea has been found on moss and thin soil at 150 m. Material identified as "Physconia isidiigera" has been found on bark of Juniperus occidentalis in juniper-sage deserts, and on other types of trees in the bunchgrass zone.. Material identified as "Physconia americana" has been found on Quercus garrvana in a Pinus ponderosa-Quercus garrvana-Pseudotsuga menziesii forest at 930 m. Physconia distorta has been found on bark of Quercus garrvana, and on moss, soil, or rock (including basalt and

granite), at moderate elevations (240-1290 m).

+Platismatia glauca--Habitat: On bark or wood (including 'lower dead limbs, and branches in the crown), usually of conifers (including Abies concolor, A. grandis, A. lasiocarpa, Larix occidentalis, Picea enselmannii, Pinus contorta, P. ponderosa, Pseudotsuga menziesii, and Tsuga heterophylla), or occasionally rocks (overhanging faces in shaded crevices) or rarely soil. At moderate to higher elevations (560-1920 m). In open woodlands (Pinus ponderosa-Juniperus occidentalis, Pinus ponderosa/Agropyron spicatum, Pinus ponderosa/Symphoricarpos albus), montane forests (including Abies- concolor, Pseudotsuga/Physocarpus malvaceus, Abies concolor-Pinus, Abies grandis/Pachistima myrsinites, and Tsusa heterophylla/Pachistima myrsinites communities) and subalpine forests (including Abies lasiocarpa/Menziesia ferruginea, and in lowland moist forests. Associated lichens include species of Hypogymnia, Tuckermannopsis, and Vulpicida, and-sometimes Melanelia and Parmelia. Distribution: In mountainous or other moist areas in all provinces in the region; Role(s): Strongly inhibits wood-destroying fungi (Lundström & Henningsson, 1973). Alters precipitation chemistry in forests, by decreasing pH and ammonium ions and increasing calcium, magnesium and potassium ions (Lang., et al., 1976). Sensitivity: Sensitive to ozone;.intermediate to sulfur'dioxide.

+Pseudephebe minuscula--Habitat: On rocks, including rock faces, boulders, and windswept gravels, in dry areas. Usually at higher elevations (2000-2950 m) but sometimes occurring at moderate elevations.. Primarily in the alpine zone, but sometimes extending into exposed areas within the subalpine or montane forest zones. Widespread, but apparently not as abundant as P. pubescens; little information is available on the ecology of P. minuscula in the Columbia Basin. Distribution: In the higher mountainous areas in all provinces in the region, but in the Oregon Cascades apparently absent from all but the northernmost part. Role(s): Weathering of rock; Sensitivity: Intermediate to ozone.

+Pseudephebe pubescens--Habitat: On acid rocks (including andesite and basalt), on on gently to more often (especially at low to moderate elevations) steeply sloping, surfaces of outcrops and boulders, and on gravels and in crevices in rimrock; rarely on conifer wood. In exposed, dry areas. At low to more often moderate to high elevations ((150-)1950-2950 m). Usually in alpine areas, but sometimes also in biscuit scabland (on cliffs or large rocks lining ravines), juniper-sage desert, and lava fields and other very exposed rocky areas in pine forests (Pinus ponderosa), mixed conifer forests' (including Abies concolor-Pinus, Abies concolor, and Abies grandis-Pseudotsuaa), and

subalpine forests. Distribution: In mountainous areas in all' provinces in the region except apparently Northeast WA Mountains. Role(s): Weathering of rock. Sensitivity: Intermediate. to ozone.

+Psora nipponica--Habitat: On soil (including'sandy soil), moss over rock.-(including basalt and.andesite), and cracks or crevices of rocks (often on steep or vertical surfaces, such as rimrock), sometimes on'north-facing surfaces..,-At low to higher elevations (150-1960 m). In juniper-sage desert (Juniperus occidentalis-Artemisia), Quercus garrvana woodland, Pinus oonderosa forests, montane forests (Pseudotsusa, and Abies concolor-Pinus), and alpine or subalpine communities. Distribution: East Slope of Cascades (WA,- OR), and at least the western parts of Columbia Plateau (WA); Eastern Plateaus and Hills: (OR) and Northeast OR Mountains; -Role(s): Sensitivity: .

Psora spp. --Habitat: On soil, often over basalt or among basalt. pebbles, but often in areas with calcareous influences, in open, flat areas or sometimes steep slopes, at low to moderate elevations, in dry, open habitats. At least six additional species (including P. cerebriformis, P. decioiens, P. slobifera, P. luridella, P. montana, and P. tuckermannii) occur in the region, and at least one (identified as P. slobifera) appears to be widely distributed and frequent; however, many specimens have probably been misidentified or remain unidentified, making it difficult to say much about the ecology of individual taxa. Distribution: One or more of the additional species occurs in each province of the region except apparently Northeast WA Mountains. However, the genus is best represented in the Eastern Plateaus and Hills of OR and perhaps the southern parts of'the Columbia Plateau. Role(s): Sensitivity: Frequency and cover of P. decioiens decreased after fire (Boykin, unpublished).

+Rhizocapon bolanderi--Habitat: On acidic rocks (mainly basalt). The typical variety has been found at moderate to higher elevations (300-1620 m), in juniper-sage desert (Juniperus occidentalis-Artemisia .tridentata), biscuit scabland; Quercus sarrvana'woodlands, and lava fields in montane conifer forests (Abies concolor). Without microscopic examination it is easily confused with brown species of Lecidea, and is probably more frequent and abundant than the limited number of identified specimens suggest-. The easily recognizable-but less common variety sulphurosa has been found at 550-1290 m, in Quercus garrvana woodland, Juniperus occidentalis/Artemisia tridentata communities; and open riparian areas with Pinus ponderosa and Artemisia tridentata. Distribution:-All provinces except apparently Northeast WA Mountains; v. sulphurosa is known from the East Slope of Cascades (WA, OR). Role(s): Sensitivity:

+Rhizocarpon geographicum s. lato--Habitat: On acidic rocks.

Major -species

(andesite, basalt, etc.). At moderate to higher elevations (914-1960 m). In grasslands (Asropvron spicatum/Poa sandberoii), biscuit scablands, open pine woodlands (Pinus ponderosa/Agropyron soicatum), open areas (including lava fields) in montane forests (including Abies concolor and Abies qrandis-Pseudotsuqa, Pseudotsuqa/Physocarpus malvaceus), subalpine forests, and alpine areas. In the bunchgrass zone, this complex is probably often replaced by the superficially similar R. cookeanum. Frequent, and often a dominant, especially at higher elevations. Frequently associated lichens include other Rhizocaroon spp., Lecanora rupicola and species of Aspicilia and Lecidea, or sometimes others. Distribution: All provinces except apparently Northeast WA Mountains. Role(s): Weathering of rock. Sensitivity: Tolerant to sulfur dioxide and fluoride. Sensitive to fungicides (Alstrup, 199). Sensitive to 5x normal dose of the herbicide MCPA (but not to lower doses, nor to even high doses of paraquat/diquat or 2,4-D) (Seaward, 1977).

+Rhizocarpon spp.--Habitat: At least 8 additional species occur, on hard, acid rocks (basalt, andesite, granite, schist), at moderate to high elevations, in a wide range of habitats (grasslands, shrub-steppes, forests, and alpine areas), depending on the species. Several of these taxa (e.g., R. "disporum", R. arande, and other gray or brown species, and the yellow species R. lecanorinum and R. macrosporum s. lato), are probably widespread and abundant, but not enough material has been identified at present. Distribution: East Slope of Cascades (OR, WA), Columbia Basin (WA), Eastern Plateaus and Hills (OR). Role(s): Sensitivity:

+Rhizoplaca chrysoleuca--Habitat: On acid rock (basalt), usually towards the upper parts of rock outcrops in exposed areas, sometimes on N-. or W-facing surfaces, sometimes on vertical surfaces; usually in areas enriched by some degree of bird manuring. At low to high elevations (120-2350 m). In sagebrush steppe (Artemisia tridentata with perennial bunchgrasses or annual grasses), bunchgrass areas (Agropyron spicatum/Poa sandberoii, Aaropvron spicatum/Festuca idahoensis), juniper-sage desert (Juniperus occidentalis/Artemisia tridentata), biscuit scabland (Artemisia risida, Festuca idahoensis, etc.), and Pinus ponderosa woodlands (Pinus ponderosa/Agropyron spicatum), and occasionally in the alpine zone. Although the reports of "Lecanora rubina" by Cooke (1955) may be based at least partly on R. melanophthalma), R. chrysoleuca also occurs in those types of habitats. Distribution: All provinces except apparently Northeast WA Mountains. Role(s): Weathering of rock. Sensitivity: Sensitive to sulfur dioxide and to nitrous oxides/PAN.

+Rhizoplaca melanophthalma--Habitat: On rocks (andesite, basalt, schist, granite, sandstone), often towards the tops of outcrops,

but also on vertical surfaces, usually in open areas and exposed to some bird manuring or other nutrient enrichment, but also tolerant of somewhat more shaded or protected areas. At moderate to high elevations (380-2460 m). In sagebrush steppe (Artemisia tridentata with perennial bunchgrasses or annual grasses), bunchgrass areas (Agropyron spicatum/Poa sandbersii, Agropyron spicatum/Festuca idahoensis), juniper-sage desert (Juniperus occidentalis/Artemisia tridentata), open woodlands with hardwoods (Quercus garryana or Populus trichocaroa), open coniferous forests (Pinus ponderosa, P. contorta, Pseudotsusa menziesii, Abies concolor, A. arandis), and alpine'areas. Also in open hardwood forests in riparian areas. Although the species occurs in virtually all of the habitats where R. chrysoleuca does and is often directly associated with it, R. melanoohthalma is more common and has a wider ecological amplitude, as well as more frequently being-'abundant at higher. elevations. In at least one. locality, R. melanoohthalma becomes detached and grows loose (vagrant) on soil (see discussion under "Species of Special Concern"). Distribution: All provinces except apparently Northeast WA Mountains. Role(s): Weathering of rock. Sensitivity: Sensitive to sulfur dioxide. .

+Rinodina spp. --Habitat: At least one species occurs on rock, several on soil or plant debris, and the rest on bark or wood, at 'low to high elevations in various habitats. Several species are probably frequent and abundant, but the genus is inconspicuous and taxonomically very difficult. Distribution: East Slope of Cascades (OR, WA), Columbia Plateau' (WA), and Eastern Plateaus & Hills (OR). Role(s): Sensitivity:

Staurothele spp. --Habitat: On rock, from low to high elevations, in various communities; at least one species (e.g., S. fissa) occurs along streams or occasionally lakes, where it is periodically inundated; others occur on drier rocks; including barren talus slopes. The genus is probably frequent and abundant, but is not often collected or identified. Distribution: East Slope of Cascades (WA, OR), Columbia Plateau (WA), Eastern Plateaus and Hills (OR); probably also elsewhere. Role(s): Sensitivity:

Thamnolia ssp.--Habitat: On soil or rock, At high elevations (1860-2600 m). In'the alpine zone-. On the east slope-of the North Cascades (Douglas and Bliss, 1977), the genus is fairly important in Salix nivalis dwarf shrub communities and Carex phaeoceohala and Carex nardina dry graminoid communties, and also occurs in Dryas octopetala dwarf shrub communities, snowbed communities (Carex breweri and Carex capitata), and dry graminoid communities (Danthonia intermedia, Calamogrostis purpurascens, Carex scirpoidea var. pseudoscirooidea, and Kobresia mvosuroides); it is best developed on level to moderate or

sometimes steep, exposed, slopes, on all aspects (including southern slopes); soils'are usually dry, well drained, often extremely rocky, and often show indications of frost action; snow accumulation is usually slight, and snowmelt is usually early (late April to May or early June). In the central part of the WA Cascades, the genus occurs on gentle slopes of large basalt or andesite boulders on very exposed, windy points on ridgetops. **Distribution:** East Slope of Cascades of WA (Okanogan Co., Pierce Co./Yakima Co., Pierce Co.)

+Trapeliopsis granulosa--Habitat: On soil, humus; rotten 'stumps or logs, old wood (including fenceposts), and occasionally on bark (base of Pseudotsuca menziesii); often onsubstrates charred by fire; usually in open but fairly moist'areas, such as N-facing slopes. At low to more often high elevations (150-)1500-2400 m). In forests (including Pinus ponderosa/Quercus garryana/Pseudotsuga), up through montane forests (including Abies grandis), into subalpine and alpine areas. In alpine areas of the North Cascades (Douglas & Bliss, 1977), the species is fairly important in Carex scirpoidea var. pseudoscirpoidea dry graminoid communities, on dry, well-drained slopes at all. elevations and aspects, in areas that become snow-free between. mid-April and early May, and also occurs (in small amounts) in Antennaria lanata snowbank communities, where snowmelt occurs in late June to late July). Distribution: East Slope of Cascades (OR, WA) and western parts of Columbia Plateau (WA) and Eastern Plateaus and Hills (OR). Role(s): Sensitivity: Tolerant (to slightly sensitive) to even high (5, x normal) doses of herbicides (MCPA, paraquat/diquat, and 2,4-D) (Seaward, 1977).

+Tuckermannopsis chlorodhvlla--Habitat: Usually on twigs of gymnosperms (e.g., Abies concolor, Juniperus occidentalis, Pinus ponderosa, and Pseudotsuga menziesii), sometimes on wood (fenceposts), occasionally on rock (steep faces); at low to higher elevations (120-1960 m). In yellow pine forests (Pinus ponderosa-Quercus'aarrvana-Pseudotsuga menziesii, Pinus ponderosa/Agropyron spicatum, Pinus ponderosa/Symphoricarpos albus, Pinus oonderosa-Juninerus occidentalis) and montane forests (Pseudotsuga/Physocarpus malvaceus, Abies grandis/Pachistima myrsinites, Abies concolor-Pinus, Abies concolor). This species appears to prefer somewhat more moist conditions than T. merrillii and T. platyphylla. Associated lichens include other Tuckermannoosis spp., and species of Hypogymnia, Melanelia, Parmelia, and Platismatia. Distribution: All provinces except apparently Northeastern OR Mountains. Role(s): Sensitivity: Sensitive to sulfur dioxide; intermediate to fluoride.

+Tuckermannopsis merrillii--Habitat: On bark or wood (lower dead branches, and branches in the crown) of gymnosperms (including

Major species

Abies concolor, Juniperus occidentalis, Larix, Pinus contorta, P. ponderosa, Pseudotsuaa menziesii). Mostly at.moderate, but occasionally at lower or higher elevations (120-)900-1950(-2400 m)). In biscuit scablands (Juniperus occidentalis at bottom of ravines), and most often in open yellow pine forests and woodlands (Pinus ponderosa-Juniperus occidentalis, Pinus ponderosa/Agropyron spicatum, Pinus ponderosa/Symphoricarpos albus, Pinus ponderosa-Quercus sarrvana-Pseudotsuaa menziesii, Pinus ponderosa/Ceanothus velutinus), and sometimes montane forests (Abies concolor-Pinus) or rarely subalpine forests or low elevation riparian forests. This species is more restricted to dry areas than other members of the genus.. Frequent and often abundant. Associated lichens include other Tuckermannoosis spp., Vuloicida spp., Brvoria abbreviata, Letharia spp., Distribution: All provinces. Role(s): Sensitivity: Sensitive to intermediate to ozone.

+Tuckermannopsis platmhvlla--Habitat: On bark or wood (including lower dead branches, and branches in the crown) of conifers (including Abies amabilis, A. concolor, Larix, Pinus contorta, P. ponderosa, and Pseudotsusa menziesii), or sometimes hardwoods (e.g., Crataegus spp.) or on fenceposts. At moderate to higher elevations (690-2000 m). In open Crataegus douslasii stands, yellow pine forests or woodlands (Pinus ponderosa-Juniperus occidentalis, Pinus ponderosa/Agropyron soicatum, Pinus ponderosa/Symphoricarpos albus, Pinus oonderosa-Pseudotsuga) and especially in montane forests (Pseudotsuga/Physocarpus malvaceus, Abies arandis/Pachistima mvrsinites; Abies concolor-Pinus, Abies concolor, and Tsuaa heterophylla/Pachistima mvrsinites, Abies amabilis communities), probably also extending into subalpine, forests. Also occasionally in low elevation riparian forests. Frequent and sometimes abundant. Small or poorly difficult specimens can be difficult to distinguish from T. orbata, which also occurs in'the Columbia Basin but is less common and primarily associated with moister areas (including the west side). Associated lichens include species of Hypogymnia, Melanelia, and Platismatia, other Tuckermannoosis spp., and sometimes Vuloicida spp. Distribution: All provinces except apparently Northeast OR Mountains. Role(s): Sensitivity:

+Umbilicaria hyperborea--Habitat: On acidic rocks- (andesite, basalt, granite, etc.)., usually on larger boulders or outcrops, but occasionally on small rocks, in open areas, sometimes on ridgetops, sometimes on cliffs or rocks lining ravines. On steep surfaces (both north- and south-facing, often near the tops. of rocks or on ledges). At moderate to very high elevations (910-2950 m). In sagebrush-steppe (Artemisia tridentata/Bromus tectorum),' biscuit scabland, juniper-sage desert (Juniperus occidentalis-Artemisia), Artemisia risida habitat, A. tridentata ssp. vaseyana/Festuca idahoensis communities, open yellow pine

Major species

woodlands (Pinus ponderosa/Artemisia 'tridentata spp. tridentata, Pinus ponderosa/Agropyron soicatum), and'lava fields in. montane conifer forests (Abies concolor, and Abies arandis-Pseudotsusa), up into subalpine areas; sometimes near streams. Associated lichens include other Umbilicaria spp. and sometimes Parmelia saxatilis.. Distribution: All provinces. Role(s): Weathering of rock. Sensitivity;

+Umbilicaria kraschenninkovii--Habitat: On acid rocks (basalt, andesite, schist, etc.), on steep to vertical surfaces (both north- and south-facing), especially when growing at lower elevations. At moderate to more often high elevations (1120-)1860:2950 m). Occasional in sagebrush steppe (Artemisa tridentata/Bromus tectorum), but more commonly in alpine areas. Distribution: All provinces. Role(s): Sensitivity:

+Umbilicaria phaea--Habitat: On acid rocks (basalt, schist, granite, etc.), often on steeply sloping surfaces (both north- and south-facing, often near tops of rocks and on ledges), especially at lower elevations. At low to moderate -or sometimes high elevations (120-1050(-2020) m). Usually in exposed, hot, dry areas, including outcrops in sagebrush-steppe (Artemisia tridentata/Bromus tectorum),, boulders and stone rings in biscuit scabland (Artemisia tridentata/A rpyron spicatum communities),. juniper desert, open pine woodlands (including Pinus ponderosa/Agropyron spicatum), and sometimes montane forests (Abies concolor); sometimes near streams. Associated lichens include species of Melanelia and Xanthoparmelia. Distribution: All provinces. Role(s): Weathering of rock. Sensitivity:

+Umbilicaria virginis--Habitat: On acid rocks (including andesite). At high elevations (1830-2950 m).. In alpine areas. No other information is available from label data; in my experience with the species (in California and the Cascades of WA) it is restricted to dry but shaded microhabitats (under overhanging cliffs or boulders) in the high alpine. Distribution: East Slope of Cascades (WA), Columbia Plateau. (WA), Northeast OR Mountains, and Eastern Plateaus and Hills (OR). Role(s): Sensitivity:

+Umbilicaria spp.--Habitat: Several additional species have been found, on acid rocks, at moderate to high elevations, in the alpine zone, or open areas mostly in subalpine or montane forests. Several of these (e.g., U. americana, U. decussata, U. deusta, U. polyphylla, U. polyrrhiza, U. proboscidea, U. torrefacta, and U. vellea) are probably abundant at least in some areas, but do not appear to be as frequent or widely distributed in the Columbia Basin as the species treated separately above, and relatively little is known of their ecology in the region. Distribution: Additional species have been found mostly in the

Major species

East Slope of Cascades of OR and WA, Northeast Mountains of WA provinces, and mountainous areas of the Columbia Plateau of WA; U. decussata, U. polyrrhiza, and U. torrefacta have also been found in Northeast Mountains of OR.

Verrucaria spp.--Habitat: On rocks; some species occur in or along streams or lakes, where they are at least occasionally submerged; others occur in drier habitats; both groups probably occur at low to high elevations..The genus is not often collected, and the species are extremely difficult to identify, but several are probably very frequent and abundant. Distribution: At least one aquatic species and one terrestrial one occur in East Slope of Cascades (OR, WA); the genus probably also occurs elsewhere in the region. Role(s): Sensitivity:

+Vulpicida canadensis--Habitat: On bark or wood (usually twigs or branches), mostly of conifers (including Larix, Pinus contorta, P. nonderosa, and Pseudotsuga menziesii) or wooden fence posts; rarely on hardwoods (twigs of Salix), at low to moderate or fairly high elevations (120-1750 m), in open forests dominated by Pinus nonderosa (sometimes with P. contorta or Pseudotsuga menziesii); and in hemlock forest (Tsuga/Pachistima association). Distribution: All provinces, but more restricted in distribution than the common lichens with which it is usually associated. Role(s): 'Sensitivity: Sensitive to ozone.

+Xanthoparmelia cumberlandia/"taractica" complex--Habitat; On acid rocks (including basalt), sometimes spreading onto soil'or moss, or rarely bark or wood (common on twigs of Artemisia riqida and Juniperus occidentalis according to Rossman, 1992, but this needs to be confirmed), in open areas, often on gently to moderately sloping surfaces, sometimes towards the tops of rocks exposed to nutrient enrichment, but away from direct manuring. 'At low to moderate elevations (60-130 m). In bunchgrass communities (Aqropvron spicatum/Poa sandberqii, Festuca idahoensis), and other grassland communities, shrub-steppes (including Artemisia-Atriplex confertifolia, Artemisia tridentata), volcanic scablands, and open yellow pine woodlands (Pinus ponderosa/Agropyron spicatum and others). Additional species. (identified as X. coloradoensis, X. somioensis and X. "taractica", and formerly as "Parmelia conspersa") can easily be confused with each other or with X. cumberlandia, but may also occur in the region in similar habitats. Unidentified members of the genus, probably belonging to this'complex, have also been found in montane or subalpine forests and up into the alpine zone. Distribution: East Slope of Cascades (WA, OR), Columbia Plateau (WA), Northeast OR Mountains. Role(s): Weathering of rock. Sensitivity: Sensiitve to sulfur dioxide. Unidentified members of this genus decreased somewhat in frequency and cover after fire (Boykin, unpublished).

+Xanthoparmelia mexicana/plittii complex--Habitat:, On acidic

Major species

rocks (andesite, basalt, schist, etc.), in open areas, sometimes on horizontal surfaces, sometimes on northeast-facing cliffs, at low to moderate elevations. Older collections of "Parmelia conspersa v. isidiata" from the Columbia Plateau are probably misidentifications of these two species, which differ mainly in chemistry. X. mexicana has been found on exposed basalt cliffs (including areas towards' the base); in grasslands (Agropyron spicatum/Poa sandberaii), puercus qarryana woodlands, and other habitats. X. plittii has been found on larger rock outcrops (andesite, basalt, schist) and sometimes gravel, in juniper-sage desert (Juniperus occidentalis/Artemisia rigida), biscuit scabland, grasslands, and communities dominated by Artemisia tridentata spp. wyomingensis, with Agropyron spicatum and Festuca idahoensis. Distribution: Columbia Plateau (WA) and Eastern Plateaus and Hills (OR), possibly extending somewhat into adjacent areas of other provinces. Role(s): Sensitivity:

+Xanthoria "candelaria"--Habitat: On bark or wood (trunks and branches) of hardwoods (including Acer negundo, A. sp., Amelanchier spp., Artemisia tridentata, Celtis reticulata, Gravia spinosa, Populus tremuloides, P. trichocarpa, puercus qarryana, and Robinia pseudacacia) and less often gymnosperms (Juniperus occidentalis, Pseudotsuqa menziesii, and Thuia plicata), wooden fenceposts, rocks (including tombstones, and basalt cliffs), and occasionally bones, moss, and cow dung, in open situations exposed to nutrient enrichment from dust or manuring (e.g., roadsides in agricultural areas). At moderate to higher elevations (270-1800 m). On bark or wood in shrub-steppes (including Artemisia tridentata ssp. tridentata/Agropyron spicatum and Sarcobatus vermiculatus/Grayia spinosa/Artemisia communities), biscuit scablands (Juniperus occidentalis in bottom of ravines), open woodlands (Pinus ponderosa-Juniperus occidentalis, Pinus ponderosa-Populus trichocarpa, Pinus ponderosa-Populus tremuloides, and others), and montane conifer forests (including Pseudotsuga/Physocarpus malvaceus). Material on rock has been found in montane forests (Pseudotsuaa menziesii/Physocarpus malvaceus, Abies concolor-Pinus). Frequent and often abundant. Associated lichens include other Xanthoria spp., Candelaria concolor, and species of Melanelia, Phvscia, and Phvsconia. Distribution: All provinces. Role(s): Weathering of rock. Sensitivity: Sensitive to ozone; intermediate to tolerant to sulfur dioxide.

Xanthoria elegans--Habitat: On siliceous rocks (basalt, andesite, and schist; apparently not on granite) and calcareous rocks, on horizontal to perhaps more often sloping or vertical surfaces of outcrops or cliffs, usually in exposed, relatively sunny areas (but sometimes on north-facing surfaces, or in canyons), often towards the tops of boulders or outcrops that are strongly enriched by bird or mammal excretions. Also on old bones, and

occasionally on old wood or on moss. At low to high elevations (130-2464 m). In open habitats, including sagebrush steppe (Artemisia tridentata), juniper-sage desert (Juniperus occidentalis/Artemisia tridentata), Artemisia arbuscula communities,, and subalpine to alpine areas.. Sometimes near streams.., Distribution: East Slope of Cascades (WA, OR), Columbia Plateau (WA), and Eastern Plateaus and Hills (CR), possibly extending into adjacent areas of other provinces. Role(s): Sensitivity:

*Xanthoria fallax--Habitat: On hardwood trees or shrubs (including Artemisia, Celtis reticulata, Populus tremuloides, and P. trichocarpa); also on Juniperus occidentalis, rocks (basalt cliffs), and occasionally moss or old wood. At moderate, or occasionally high, elevations (420-910(-2400) m). On bark or wood in Juniper-sage deserts (Juniperus occidentalis/Artemisia tridentata), open mixed forests (e.g., Pinus ponderosa/Populus trichocaroa) or along roads,. Material on rock has been found in open woodlands or scrublands (Artemisia tridentata zone but with riparian vegetation and Pinus ponderosa also present), near streams, and in open montane to subalpine conifer forests, (Abies concolor-Pinus). Frequent and often abundant; can be confused with X. "candelaria". Distribution: East Slope'of Cascades (WA, OR), Columbia Plateau (WA), and Eastern Plateaus and Hills (OR), possibly extending into adjacent areas of other provinces. Role(s): Weathering of rock. Sensitivity: Tolerant to ozone; intermediate to sensitive to sulfur dioxide; sensitive to nitrous oxides/PAN.

*Xanthoria "polycarpa" s. lato--Habitat: On bark or wood '(trunks and branches) of hardwoods (including Alnus spp., Amelanchier spp., Artemisia riaida, A. tridentata (ssp. tridentata, vasevana and wvominsensis), Crataesus spp., Populus tremuloides, P. trichocarpa, Rosa spauldinsii, and Salix spp.); also on Juniperus occidentalis, or less often branches and twigs (in the crown) of conifers (Pinus oonderosa, Abies concolor and Pseudotsuaa menziesii); at moderate to high elevations (600-1590 m), in Palouse grassland (Festuca idahoensis/Symphoricarpos albus), biscuit scablands ('all communities), sagebrush steppes (Artemisia risida, A. tridentata ssp. tridentata/Agropyron spicatum, and A. tridentata ssp. vaseyana/Festuca idahoensis communities), juniper-sage deserts (Juniperus occidentalis/Artemisia tridentata), and yellow pine woodlands (Pinus ponderosa/Symphoricarpos albus, Pinus ponderosa-Populus trichocaroa), and montane forests (Pseudotsuga/Physocarpus malvaceus, Abies concolor-Pinus). Frequent and abundant, often a dominant species, by itself, or frequently with species of Phvscia, Phvsconia, and Melanelia, or sometimes other Xanthoria spp. and Candelaria concolor. Distribution: All provinces except apparently Northeast WA Mountains. Role(s): Sensitivity: Tolerant

Major species

to ozone; intermediate to sensitive to sulfur dioxide.

Xanthoria spp. --Habitat: In general, the members of this genus prefer areas enriched by nutrients, which may come from birds or animals, or from agricultural fertilizers, agricultural dust, or dust from dirt roads or arid areas with fine silty soils (Rosentreter, 1990).

2b. Additional Species of Special Concern (Apparently Rare in the Columbia Basin, At Least Oregon/Washington Part).

The following species are '(as far.as known) too rare in the Oregon/Washington part of the Columbia Basin to be considered as "major" species, but are of "special concern" within this area precisely because of this rarity. Among species that are common outside of the area covered by this report the ones treated in depth in the list below are ones that are likely to be . . . . particularly sensitive to disturbance (mainly pollution) and/or have special ecological significance (mainly nitrogen fixation), and a few others-for which detailed ecological information is available.

Apparently Rare Throughout Their Range. (At- Least in North America)

Some of these species treated below (e.g., vagrant.species of Aspicilia, Rhizoplaca, and Xanthoria).are locally abundant at least in some areas in Idaho, the Great Basin, or the Great Plains.

Other species that are apparently rare in North America, but for which little or nothing is known regarding their roles or sensitivities, include Biatorella hemispherica, Carbonea vitellinaria, . Catinaria atropurpurea, Euopsis sranatina, . Lecania, dubitans, Melaspilea proximella, Phvlliscum demanaeonii, Rimularia insularis, Stenocvbe major, Stransospora moriformis, and others that are easily overlooked or have not often been collected or properly identified; some of these are probably more characteristic of moist areas.

Arthonia glebosa--Habitat: On bare soil (mesic, clayey/loamy), at moderate to high elevations (960-2400 m), in mound communities in biscuit scabland, and in Artemisia tridentata/Agropyron spicatum communities; may be confined to grasslands. Distribution:. Columbia Plateau (WA), Eastern Plateaus and Hills (OR), Northeast OR Mountains. Role(s): * Sensitivity: *

Aspicilia fruticulosa--Habitat: On soil. Requires removal of plant debris by wind, and lack of extensive cover by associated vascular plants (Rosentreter & McCune, 1992). Calcareous sites; restricted to areas where water accumulates in winter and spring (Kunkel, 1980). Distribution: Widespread and often locally abundant in Idaho; also present in Montana and Utah, but presently known from only two areas of Oregon (Northeast OR Mountains: Grant Co. and Eastern Plateaus and Hills: Lake Co.--Rosentreter, 1993). Role(s): Sensitivity:

Aspicilia hispida--Habitat: On bare soil, at low to moderate

elevations (750-1050 m), in mound-community in, biscuit scabland, and in Artemisia tridentata shrub-steppe. Requires removal of plant debris by wind, and lack of extensive cover by associated vascular plants (Rosentreter & McCune, 1992). Distribution: Perhaps common at least in some parts of Idaho, but apparently known from only one locality in Oregon (Eastern Plateaus and Hills: Wasco Co.). and one in Washington -(Columbia Plateau: Yakima Co.); the identification of both.of these collections needs to be checked, since they may be A. fruticulosa instead. Role(s): sensitivity to disturbance: Probably sensitive to habitat loss (conversion of natural lands for human use) and disturbance of the soil (due to grazing, trampling, vehicles, or fire).

Asnicilia "reptans"--Habitat: On soil, often over clumps of decaying bunchgrasses at edges of ravines or depressions, at moderate elevations (300-600 m) in open shrub-steppe communities. Distribution: Widespread and common in drier interior areas of western North America; so far.1 have examined only two collections from Washington (Western Columbia Plateau:. Chelan and Yakima Counties), but I suspect the species is more widespread and common in the region. Role(s): * Sensitivity: *

Aspicilia sp. (undescribed, vagrant)--Habitat: On soil; at moderate elevations 1530 m, in somewhat shaded area among rocks, at edge of conifer forest. Distribution: So far I have examined material from only one locality in Oregon (Eastern Plateaus and Hills: Klamath Co.), and the species was very rare there. Role(s): * Sensitivity: *

Biatorella hemisnherica--Habitat: On basalt outcrops and on the ground, at moderate elevations. Distribution: Columbia Plateau of WA (Klickitat Co.), Eastern Plateaus and Hills of OR. (Lake Co.).

Brvoria friabilis--Habitat: On bark or wood of conifers. Distribution: Known from one locality in Washington (East Slope of Cascades: Klickitat Co.). Role(s): * Sensitivity: *

Brvoria simplicior--Habitat: On bark or wood of-'conifers (including Pseudotsusa menziesii), on north-facing slopes, at moderate to high elevations 930-1950 m, in Pinus ponderosa/Ouercus garryana/Pseudotsuga menziesii woodland. Distribution: East Slope of Cascades (WA, OR). Possibly more widespread and abundant but not yet-properly, identified. Role(s): Sensitivity:

Bryoria tortuosa--Habitat: On bark or wood of conifers (including Pinus nonderosa), at low elevations, in mixed Pseudotsuaa forest. Distribution: East Slope of Cascades (WA). Role(s): *Sensitivity:*

Rare species

Calonlaca tominii--Habitat: On soil, sometimes on north-facing canyon slopes, at high elevations 2400 m. Distribution: East Slope of Cascades (OR), Eastern Plateaus & Hills (OR), Columbia Plateau (WA). Role(s): Sensitivity:

Chromatochlamys muscorum v. octosnorum--Habitat: On mesic clayey/loamy soil, at moderate elevations (720-960 m), in sage-steppe (including Artemisia tridentata ssp. wyomingensis/Agropyron spicatum/Festuca idahoensis and A. tridentata ssp. tridentata/A. spicatum associations). Distribution: Eastern Plateaus and Hills (OR), Northeast OR Mountains. May well be.more widespread and abundant, but has probably not been-often collected or identified. Role(s): Sensitivity:,..

Gyalecta jenensis--Habitat associations, processe and requirements: Distribution:

Haematomma sp.--Habitat: On bark; no other data available. Distribution: East Slope of Cascades (WA); presently. known from a single locality (Klickitat Co.). Role(s): Sensitivity:

Hypogymnia rugosa--Habitat: Distribution:

Lecanora laatokkaensis--Habitat: On rock (e.g., basalt), often initially parasitic on other crustose lichens (e.g., Aspicilia, Candelariella, Lecidea, and Rhizocarpon); in exposed to somewhat sheltered sites, at moderate elevations (960-1350 m), in'pine woodland/grassland and open canopy pine/Douglas fir woodlands. Distribution: Known from few widely scattered localities in. western North America, and apparently uncommon throughout its range. East Slope of Cascades (OR, WA); Eastern Plateaus and Hills (OR). Role(s): Sensitivity:
Neofuscelia loxodes

Phylliscum demangeonii--Habitat: Distribution:

"Pyrenopsis melanbola"

Rhizoplaca melanophthalma s. lato (vagrant forms only)--Habitat: On soil,, often somewhat calcareous, but usually among-siliceous stones (e.g., basalt). Requires removal of plant debris by windm and lack of extensive cover by associated vascular plants (Rosentreter & McCune, 1992). Distribution: Although the attached forms are extremely widespread and common, the vagrant forms are presently known from only one locality in Oregon (Eastern Plateaus and Hills: Malheur Co.). Role'(s): Eaten by. domestic sheep (at least in Idaho), and perhaps by certain kinds of native mammals. Sensitivity: Sensitive to grazing by sheep, though apparently not to grazing by cattle (Rosentreter, 1993).

Rare species

Strangospora moriformis--Habitat: On dead, prostrate tree trunks, at ca. 200 m, in riparian forest. Distribution: East Slope of Cascades of WA (Klickitat Co.).

Texasporium sancti-iacobi--Habitat: The-ecology and status of the species is discussed in detail.by McCune & Rosentreter (1992). The species&occurs primarily on dead bunchgrass stubble. thoroughly impregnated.with soil, and on old partly deomposed small-mammal dung. It-is restricted to arid to semi-arid grasslands,' shrublands, or savannas, at elevations up to 1000 m; soils are developed from non-calcareous parent-materials (basalt, as in the Oregon sites, or granite or mixed alluvium), varying from thin, very fine-textured layers over bedrock (as in the Oregon sites), to moderately to very deep. layers and sandy loams or soils high in fine or coarse sand.'In the northern sites (including Oregon), the species occurs in areas dominated by Artemisia (most commonly A. tridentata ssp. wyominsensis) and bunchgrasses (especially Poa sandbersii), and the Oregon site also had-widely scattered Juniperus occidentalis. It is usually associated with various other (mostly crustose or squamulose) lichens. Distribution: Idaho,.Oregon, and California. Rare throughout its range. Known from a single limited area in Oregon' (Eastern Plateaus and Hills of OR: Jefferson Co.); not yet found in Washington. **Role(s):** Potential enhancement of soil qualities (if the species were abundant enough). Sensitivity: Probably sensitive to any sort of disturbance of the soil (e.g., grazing and/or trampling by livestock; use.by motorcycles and off.-road vehicles; fire), -which generally involves conversion of sagebrush-bunchgrass communities to alien annual grasslands. Also sensitive to loss of habitat by development for farming, housing, etc. Apparently can recolonize areas where the soil disturbance is stopped and conditions revert to a more natural state, but the rate and conditions for such recovery are unknown. Population trends:' Populations-are difficult to find, and when they are found, the colonies tend to be few, small and dispersed. Evidence (mainly from Idaho and California) strongly suggests that the species is declining in distribution and abundance.

Thelomma ocellatum--Habitat: On wooden fenceposts (including ones made from Larix), at moderate elevations (450-1230 m), 'in Artemisia rigida/Poa grasslands and Pinus ponderosa forests. Distribution: East Slope of-Cascades (WA); Northeast OR Mountains. Role(s): Sensitivity:

Tuckermannopsis pallidula--Habitat: On bark or wood of conifers (including Pinus ponderosa and Pseudotsusa menziesii), at moderate elevations' (600-960 m), in open canopy forests dominated by Pinus ponderosa (sometimes with Pseudotsusa menziesii). —or Larix occ
Distribution: East Slope of Cascades (WA). Role(s): Sensitivity:

Rare species

Rare species

Species Apparently Rare in WA/Or Part of Columbia Basin, But More or Less Common In Other Regions

Species Characteristic of Dry Areas of North America

In addition to the species below, others that have a generally similar distribution pattern, but for which little or no information is available on their roles or sensitivities, include Acarospora thamnina, Ahtiana sphaerosoorella, Caloplaca decioiens, C. trachyphylla, Lecanora araopholis, Lobothallia praeradiosa, and Protoparmelia badia.

Acarospora schleicheri--Habitat: On soil and plant debris, in flat, open areas, at moderate elevations (420-1230 m), in mound communities in biscuit scabland, and in sagebrush-steppe. Distribution: Widely distributed in drier intermontane parts of western North America. Drier parts of all provinces except perhaps East Slope of Cascades (OR, WA). Role(s): Sensitivity:

Catapyrenium spp.--Habitat: On soil, mostly at moderate elevations, usually in open shrub-steppe and juniper-sage desert (but C. lachneum has also been collected at 2400 m, in alpine communities). Both C. lachneum and C. souamosulum are generally connected with permanent grasslands on richer soil on sloping terrain (Alstrup, 1992). Although the label data suggests some apparent differences in their ecology of the two species, these may be partly artifacts of the scarcity of properly identified collections from the region. Distribution: The genus is widely distributed in drier intermontane parts of western North America. Columbia Plateau (WA), Eastern Plateaus and Hills (OR), probably spreading into adjacent parts of East Slope of Cascades (OR, WA). Role(s): Sensitivity: The frequency and cover of C. lachneum decreased after fire (Boykin, unpublished). Both C. lachneum and C. souamosulum are probably sensitive to habitat loss (conversion of natural lands for human use) and disturbance of the soil (due to grazing, trampling, vehicles, or fire) (Alstrup, 1992).

Endocarpon pulvinatum--Habitat: On bare soil; at moderate elevations (990-1400 m), in ravines in biscuit scabland, Artemisia tridentata ssp. tridentata/Agropyron spicatum association, and A. rigida/Poa sandberoii grassland with scattered junipers below basalt cliffs. Distribution: Eastern Plateaus and Hills (OR). Role(s): Sensitivity:

Flavoparmelia caperata--Habitat: On rock, at moderate elevation (780 m). Elsewhere in its range, the species usually occurs on bark or wood of hardwoods. Distribution: Common in California and eastern North America, but known from only one locality in Oregon (Wallowa Co.). Role(s): Sensitivity: Sensitive to fluoride fumigation (Nash, 1971),

Rare species

Flavopunctelia flaventior--Habitat: On rock, at moderate elevation (780 m). Elsewhere in its range, the species often occurs on bark or wood, of hardwoods. 'Distribution-: Common in California; but known from only one locality in Oregon (Wallowa Co.). Role(s): Sensitivity:

Lecanora pringlei--Habitat: Distribution: Widely distributed in alpine areas of the drier parts of western North America, but known from only a few localities in the Columbia Basin, in East Slope of Cascades of OR (Deschutes, Hood River and Klamath counties), and WA (Pierce Co./Yakima Co., Pierce Co.).

Peltuia euploca--Habitat: On rock (e.g., basalt), often on cliffs, at moderate elevation (720 m), in Artemisia tridentata ssp. wyomingensis/Agropyron spicatum/Festuca idahoensis association. Distribution: Widely distributed in arid areas of the intermontane west, butpresently known from only one locality in Oregon (Eastern Plateaus and Hills: Jefferson Co.). Role(s): Sensitivity:

Squamarina lentigera--Habitat: On bare soil, at moderate elevations (990-1050 m), in mound community in biscuit scabland. Distribution: Widely distributed in arid areas of intermontane west, up to the Arctic, -but presently known from only one locality in Oregon (Eastern Plateaus 'and Hills: Wasco Co.) Role(s): Sensitivity:

Toninia spp. --Habitat: On soil, or moss over rock, usually at moderate elevations in dry, open communitiies. The species have not been collected or identified often enough in the region to. say much else at present. Distribution: Eastern Plateaus and Hills (OR); Columbia Plateau (WA), Northeast OR Mountains. Role(s): Sensitivity:

Trapeliopsis cf. wallrothii--Habitat: On moss or thin soil, often over or among rocks (e.g., basalt), at low to moderate elevations (120-720 m), in Artimesia tridentata spp. wyomingensis/Agropyrno spicatum/Festuca idahoensis association. Distribution: Widely distributed in the drier mountainous areas of California.. Columbia Plateau (WA), Eastern Plateaus and Hills (OR). Role(s): Sensitivity:

+Umbilicaria decussata--Habitat: On acid rocks. Often on rocks enriched by bird manure. Usually at high elevations (1980-2950 m), but also reported from moderate elevations' (900 m). In open areas in montane forests (Abies concolor-Pinus) up into the subalpine and alpine; also reported from yellow pine woodlands (Pinus ponderosa/Agropyron spicatum). Distribution: East Slope of Cascades of WA and OR; Northeast Mountains of OR; mountainous areas of Eastern Plateaus and Hills of OR. Role(s): Sensitivity:

Rare species

+Umbilicaria polyphylla--Habitat: On acid rocks, often along rills in the surface. At high elevations (1860-1900 m). In montane forests (Abies concolor-Pinus), up into alpine areas. Distribution: East Slope of Cascades (WA, OR); Columbia Plateau (WA). Role(s): Sensitivity:

● mbilicaria polvrhhiza--Habitat: On acid rocks. Usually at higher,elevations, but sometimes at low elevations (120-1900 m). In pine forests (Pinus ponderosa), montane forests (Abies arandis-Pseudotsuoa), up to the alpine zone. Distribution: East Slope of Cascades (WA, OR), Northeast WA Mountains. Role(s): Sensitivity:

+Umbilicaria torrefacta--Habitat: On acid rocks (basalt, etc.), in exposed places. At low to high elevations (120-2240 m). In montane forests (Abies concolor-Pinus, Abies grandis-Pseudotsuaa), up into subalpine or alpine areas. Distribution: East Slope of Cascades (OR, WA), Northeast WA Mountains, westernmost part of Eastern Plateaus and Hills (OR). Role(s): Sensitivity:

+Umbilicaria "vellea"--Habitat: On acid rocks (basalt, or sometimes conglomerate), on open or shaded cliffs, often near shores of lakes or streams, at moderate to high elevations (910-2240 m), in juniper desert (Juniperus occidentalis) and open pine woodland (Pinus ponderosa). Distribution: All provinces, except apparently Northeast OR Mountains. Role(s): Sensitivity:

Vulpicida pinastri--Babitat: On bark or wood of conifers; probably similar in ecology to V. canadensis. Distribution: Fairly frequent in the Rocky Mountains, but in the WA/OR part of the Columbia Basin it is apparently known from a single locality in East Slope of Cascades (WA) (Okanogan Co.). Role(s): Sensitivity:

Xanthoparmelia spp. (soil-inhabiting forms)--Habitat: On soil, usually among small rocks, mostly in drier, open areas, from low to high elevation, often in shrub-steppe communities. The truly. vagrant forms (likely to occur in eastern WA or OR, but to my knowledge not yet definitely documented from the area) 'require removal of plant debris by wind and lack of extensive cover by associated vascular plants (Rosentreter & McCune, 1992). More collections, and closer study of existing ones, are needed before much more can be said. Distribution: Widespread and locally abundant in parts of Idaho and the Great Basin, but apparently known from rather few localities in Oregon (mainly Eastern Plateaus and Hills) and Washington (mainly Columbia Plateau). Role(s): Sensitivity:

Species More or Less Common on West Side or in Northern Idaho

In addition to the species treated below, several other species,, for which little or nothing is known regarding their roles or sensitivity, have a similar general distribution , pattern: Alectoria lata, Arthonia spp., Bacidia spp., Biatora spp., Buellia spp., Caloplaca spp., Graphis scripta, Jaoewia tornoensis, Leorocaulon spp.., Lopadium disciforme, Mycobilimbia spp., Mycoblastus affinis, Normandina pulchella, Ochrolechia spp. (other than O. "upsaliensis", Opegrapha orotuberans, Parmelia hygrophila, Pertusaria spp., Pilophorus acicularis, Placynthiella ulioinosa, Polychidium muscicola, Porpidia spp., Protoparmelia ochrococca, Psoroma hypnorum, Rinodina spp., Teohromela atra, Trapelia spp., Tuckermannoosis orbata, and Xylographa spp.

Another group of species, which are widely distributed and common at least in the Arctic, but are apparently rather-rare (or at least known from only one or two localities) within the WA/OR part of the Columbia Basin, namely the East Slope of Cascades (mostly Okanogan Co. to Yakima Co., WA), includes Alectoria-nioricans, Allantoparmelia alpicola, Brodoa oroarctica, Cetraria hepatizon, Cetraria muricata, Cladina mitis, Cornicularia normoerica, Dactylina arctica, Flavocetraria cucullata, F. nivalis, Ophioparma lapponicum, Teohromela anneniaca, and Tremolecia atrata.

Brvoria implexa--Habitat: On bark or wood of conifers, at moderate elevations (700 m). Distribution: East Slope Cascades (WA), Columbia Plateau (WA), Northeast WA Mountains, Role(s): Sensitivity: Sensitive to sulfur. dioxide.

Brvoria oregana--Habitat: On bark or wood of conifers (including Pinus contorta and Pseudotsuaa menziesii), at high elevations (1620-2130 m). Distribution: East Slope of Cascades (OR); Northeast WA Mountains. This apparent disjunction suggests that the species is likely to also occur in East Slope of Cascades (WA). Role(s): Sensitivity: Sensitive to sulfur dioxide.

Calicium viride--Habitat: On bark (base and trunk) of conifers (Pseudotsuaa menziesii), at moderate elevation (480 m). Distribution: Southern part of East Slope of Cascades (WA): Klickitat Co. Role(s): Sensitivity! Sensitive to ozone.

Calicium spp.--Habitat: On bark or-wood. Too few'collections have been made or identified to say much about the ecology of individual species. Distribution: East Slope of Cascades (WA, OR); probably' in moist or mountainous areas elsewhere. Role(s): Sensitivity:

Chaenotheca furfuracea--Habitat: On soil, and roots of coniferous trees in microhabitats sheltered from precipitation (e.g., on

bases of upturned trunks, under overhanging banks) but in moist areas, at moderate to higher elevations (914-1660 m), in or at edges of coniferous forest (e.g., Pseudotsusa menziesii forest). Distribution: East Slope of Cascades (OR); Northeast OR Mountains. Role(s): Sensitivity:

Chaenotheca spp. --Habitat: On bark or wood. Too few collections have been-made or identified to say much about the ecology of individual species. Distribution: East Slope of Cascades (WA, OR); probably in moist or mountainous areas elsewhere. Role(s): Sensitivity:

Cladina rangiferina--Habitat: On soil or moss, sometimes within rock slide areas, at moderate to high elevations (1585 m), in moist Abies forest, and open areas up into the alpine zone. Distribution: Common on the West Side but apparently very restricted on the East Side (one locality in East Slope of Cascades, WA: 'Yakima Co., and a locality bordering'the West Side in the northern part of the Cascades of Oregon). Role(s): Sensitivity: Sensitive to intermediate to sulfur dioxide; intermediate to fluoride;

Cladonia bellidiflora--Habitat: On bases or stumps or logs of coniferous 'trees (including Pseudotsuaa menziesii). Distribution: East Slope of Cascades (WA) and Northeast Mountains (WA). Role(s): Part of the diet of woodland caribou (Sharnoff, 1993) (but may not occur within the range of the animals in Washington). Sensitivity: Sensitive to intermediate to sulfur dioxide.

Cladonia furcata--Habitat: On soil, at moderate elevation (660 m), in moist woodlands,' and Pinus ponderosa/Pseudotsuaa menziesii forest. Verseghy (1977), studying the species in grasslands, found that in winter the radiation mininmum and humidity level were important factors affecting the species, while in summer, the radiation minimum (in Bromus communities) or the energy of radiation (in Festuca communities) had the greatest effects on productivity of the species'. Distribution: East.Slope of Cascades (WA, OR); Columbia Plateau (WA). Role(s): Sensitivity:

Cladonia gracilis--Habitat: On thin soil along roadsides, on duff, and on mossy rock banks, at low to moderate elevations (120-900 m), in moist forests (including Pseudotsusa menziesii forest). Distribution: East Slope of Cascades (WA) and Northeast WA Mountains; Role(s): Sensitivity: Tolerant to intermediate to sulfur dioxide; intermediate to fluoride.

Cladonia spp.--Habitat: On soil, humus, moss, rotting wood, or sometimes bases of trees, at low to high elevations in various associations. Many of the species presently identified from the

East Side are widespread elsewhere apparently very restricted in distribution in-the OR/WA part of the Columbia Basin; however, more collections, and re-evaluation of identifications, are needed before much more can be said about these individual species. Distribution: Mostly in moist or mountainous areas; in all provinces. Role(s): Sensitivity:.

Collema spp.

Evernia prunastri--Habitat: On bark or wood of hardwoods (including Quercus aarrvana) or rarely conifers (including Abies concolor and Pinus nonderosa), at low to moderate or rarely fairly high 'elevations (120-1590 m), in open woodlands or forests. 'Distribution: Common on the West Side but very'rare on the East Side. East Slope of Cascades (WA, OR). Role(s): The species has been reported to be partly parasitic on trees ( ), but this needs to be confirmed. Sensitivity: Sensitive to ozone and fluoride; intermediate to tolerant to sulfur dioxide.

Hydrothyria venosa--Habitat: On rock, submerged in perennial streams or rills (usually in'moving water; sometimes in pools, but where.there is a constant flow of water into and out of them), 'at moderate to high elevations (2000 m), usually in forested areas. Distribution: Widespread, and locally abundant in some areas on the West Side, but relatively uncommon throughout its range; known from only two localities at the west edge of the Columbia Basin (East Slope of Cascades of OR): Deschutes Co. and Klamath Co. Role(s): Nitrogen fixation. Probably provides habitat and possibly food for fish or invertebrates. Sensitivity: Probably sensitive to the. amount and quality of water (temperature, turbidity, pollution).

Hymenelia lacustris--Habitat: On rock, at least periodically submerged in lakes or streams, at moderate elevations (1585 m). Distribution: Probably widesrpead, but overall distribution not well known. Presently identified from one locality in East Slope of Cascades (WA): Yakima Co. Role(s): Sensitivity: May be sensitive to changes in amount or quality of water.

Hypogymnia physodes--Habitat: Usually on bark or wood-(twigs or branches) of hardoods (e.g., Crataegus spp.) or conifers (e.g., Pseudotsusa menziesii),, occaionally on soil, moss, or rocks; at moderate to higher elevations (780-1750 m), in forests (including Pseudotsuga/Pachistima association). Distribution: Common on the West Side. East Slope of Cascades (WA), Northeast WA Mountains; east part of Columbia Plateau (WA). Role(s): Strongly inhibits wood-destroying fungi (Lundström & Henningsson, 1973). Sensitivity: Sensitive to intermediate to fluoride. Sensitive to herbicides and fungicides (Alstrup, 199). Sensitive to 5x normal dose of the herbicide MCPA (but not to lower doses,

nor to even high doses of paraquat/diquat or 2,4-D) (Seaward, 1977). Tolerant to fertilizer dust (Kauppi, 1980), but sensitive to alkaline dust pollutants (Türk & Wirth, 1975).

Hypogymnia tubulosa--Habitat: On bark or wood (including Pinus ponderosa), at low elevation (120 m), in open forests. Distribution: Moderately common on the West Side. Columbia Plateau (WA). Role(s): Sensitivity: Possibly sensitive to fluoride.

Leptogium spp. (other than L. californicum and L. lichenoides)--Habitat: On soil,. moss, rock or bark, usually in moist habitats, at moderate elevations. Not enough collections or identifications have been made in the region to say much about the less common individual species. Distribution: All provinces except apparently Northeast WA Mountains. Role(s): Nitrogen fixation,. Sensitivity:

Lobaria hallii--Habitat: On trees (including Acer macrophyllum), in moist forests. Distribution: Fairly uncommon throughout its range, but known from a fair number of areas on the West Side. Known from one locality near Columbia River (Klickitat Co., WA). Role(s): Nitrogen fixation. Sensitivity: Probably sensitive to sulfur dioxide.

Lobaria linita--Habitat: On tree bases, rocks or soil, often among mosses, at higher elevations (1950 m), mainly alpine. Distribution: Common on the West Side. Rare in Columbia basin, known only from two localities on at west edge of East Slope of Cascades (Yakima Co., WA and Deschutes Co., OR). Role(s): Nitrogen fixation. Sensitivity: Probably sensitive to sulfur dioxide.

Lobaria orecrana--Habitat: On bark or wood of trees, at moderate elevation (1200-1350 m), in moist forests. Distribution: Common on the West Side; rare on the East Side, known from one locality on East Slope of Cascades (Yakima Co., WA). Role(s): Nitrogen fixation; on the West Side this is very important in this regard in montane coniferous forests. Sensitivity: Sensitive to sulfur dioxide.

Lobaria pulmonaria--Habitat: Usually on bark or wood of hardwoods (Acer macrophyllum) or conifers (Tsusa), at moderate elevations (1410 m), in moist forests (including Tsuga/Pachistima association). Distribution: Common on the West Side; rare on the East Side, known from two localities in East Slope of Cascades of WA (Klickitat Co., Yakima Co.) and one site in Northeast WA Mountains. Role(s): Nitrogen fixation; on the west side this is often an important species in montaine forests. Sensitivity: Sensitive to sulfur dioxide; apparently at least somewhat tolerant to ozone.

Rare species

Massalongia carnosa--Habitat: On mosses (e.g., Grimmia) and humus, on boulders and rock faces, rarely directly on soil (mesic clayey-loamy); at moderate elevations (960-1400 m), in sage-steppe (including Artemisia tridentata ssp. tridentata/Agropyron spicatum association and A. risida communities (someitmes with Poa sandberaii and scattered junipers). On the west side it also occurs in open areas in moist coniferous forests. May actually be more widespread or common but not collected or identified often enough. Distribution: East Slope of Cascades (WA), Columbia Plateau (WA), Northeast OR Mountains. Role(s): Nitrogen fixation. Sensitivity:

Melanelia subaurifera--Habitat: On bark, or sometimes rocks (north-facing cliffs), at moderate elevations (1290 m), in sagebrush-grassland. On the West Side the species often occurs on hardwood trees in open woodlands or forests; Distribution: Common on the West Side. Eastern Plateaus and Hills (OR); Columbia Plateau (WA). Role(s):. Sensitivity: Sensitive to ozone and sulfur dioxide.

Mycocalicium spp. --Habitat: On wood of conifers (including Abies spp.), at more or less moderate elevations (910-1600 m), in mixed conifer forests '(including Larix occidentalia/Pinus nonderosa and Abies/Pseudotsuga menziesii forests). Distribution: Mountainous areas in East Slope of Cascades (OR), Eastern Plateaus and Hills (OR); probably elsewhere, but rarely collected or identified. Role(s): Sensitivity:

+Nephroma parile--Habitat associations, processes, and requirements: On moist, shaded, mossy rocks and trees, exposed roots (Pseudotsusa), and old wood, moderate to higher elevations (600-1800 m) in mixed conifer forests (including Abies/Pseudotsuga). Distribution: East Slope of Cascades (OR, WA), Northeastern Mountains (OR, WA); Columbia Plateau (WA). Role(s): Sensitivity:

Nephroma spp. (other than N. parile)--Habitat: On twigs or bark of trees (including Acer macrophyllum and various conifers), or mossy rocks, in moist, more or less shaded, areas, at low to moderate elevations, in forests. Distribution: Common on the West Side. East Slope of Cascades (OR, WA); N. resupinatum also occurs in Northeast WA Mountains. Role(s): Nitrogen fixation. Sensitivity:

Ochrolechia androgyna--Habitat: On bark or branches of conifers (including Abies'concolor); also reported from rocks in other parts of the country or world. Perhaps more common, but rarely collected or identified. Distribution: Mountainous areas of East Slope of Cascades (WA, OR) and western part of Eastern Plateaus and Hills (OR). Role(s): Sensitivity: Sensitive to 5x normal dose

of the herbicide MCPA (but not to lower doses, nor to even high doses of paraquat/diquat or 2,4-D) (Seaward, 1977).

+Ochrolechia "upsaliensis"--Habitat associations, processes, and requirements: On moss, (including Grimmia spp.) or Selaginella, on over rock (basalt or andesite), pine needles, soil among talus blocks and in cracks in north-facing rimrock, at low to high elevation (1262400 m), in juniper-sage desert (Juniperus occidentalis/Artemisa tridentata), biscuit scabland (on cliffs in ravines, perhaps associated with Poa sandbergii-Lomatium coos community); also in alpine areas (Calmasrostis purourascnes and Carex nardina dry graminoid communities in the North-Cascades). Distribution: East Slope of Cascades (OR, WA), Columbia Plateau (WA), Northeastern WA Mountains. Role(s): Sensitivity:

Pannaria spp.--Habitat: On twigs or bark of trees, and soil or moss over rocks (e.g., over steep cliff. faces), in moist habitats, at low to high elevations (1950 m), usually in forests, or sometimes in alpine areas. Distribution: Some species are common on the West Side. The genus is apparently rare on the East Side, being known from one locality in East Slope of Cascades (WA) and one in the mountains of Eastern Plateaus and Hills (OR). Role(s): Nitrogen fixation. Sensitivity:

Parmelia omphalodes--Habitat: On rock, usually at higher elevations (1950 m), in the alpine zone. Distribution: Known from one locality in East Slope of Cascades (WA): Yakima Co. Role(s): Sensitivity: Sensitive to 5x normal dose'of the herbicide MCPA (but not to lower doses, nor to even high'doses of paraquat/diquat or 2,4-D) (Seaward, 1977).

+Parmelia saxatilis--Habitat associations, processes, and requirements: On acid rocks (e.g., basalt), mosses, or sometimes soil; less often on conifer trees (Pinus ponderosa, Pseudotsusa menziesii), and old wood, at low to higher elevations '(120-1920 m), in ravines in biscuit scabland, and open forests (Pinus ponderosa/Agropyron spicatum association); also in moist woodlands in riparian areas. Distribution: In 'all provinces in the region. Associated lichens include Umbilicaria spp. Role(s): Sensitivity: Tolerant to ozone; intermediate to sulfur. dioxide; sensitive to fluoride. Sensitive to fungicides (Alstrup, 199). Sensitive to 5x normal dose of the herbicide MCPA (but not to lower doses, nor to even high doses of paraquat/diquat or 2,4-D) (Seaward, 1977).

Parmeliella cyanolepra--Habitat: On rock, at moderate elevation (960 m). Not collected or identified often enough to say more at present. Distribution: Moderately common on the West Side. Known from one locality in East Slope of Cascades (Klickitat Co., WA)

and one site in Northeast OR Mountains (Grant Co.). Role(s): Nitrogen fixation. Sensitivity:

+Peltigera collina--Habitat: On mosses, rocks, and rotting logs, sometimes near creeks. At moderate to higher elevations (990-1950 m). In open woodlands (including Pinus ponderosa-Populus trichocarpa and Abies concolor-Pinus) and lowland riparian forests. Rather infrequent; more common on the west side, where it also grows frequently on mossy bark of various trees (including trunk and branches some distance above the ground, in contrast to other members of the genus). Sometimes associated with other Peltigera spp. and Cladonia spp. Distribution: In all provinces in'the region except apparently Northeastern WA Mountains. Role(s): Nitrogen fixation. Sensitivity: Sensitive to ozone.

Peltigera didactvla--Habitat: On soil (often disturbed), At low to more or less moderate elevations (200-1800 m). In open woodlands (including Pinus oonderosa-Cercocarpus ledifolius, Abies concolor-Pinus), sometimes in somewhat boggy areas along lake shores. Distribution: In all provinces in the region except apparently Northeastern OR Mountains (probably present there but not yet properly identified). Role(s): Nitrogen fixation. Possible enhancement of soil qualities. Sensitivity: Sensitive to ozone. Probably sensitive to habitat loss (conversion of natural lands for human use) and disturbance of the soil (due to grazing, trampling, vehicles, or fire). Tolerant to the herbicide Prefix (Seaward, '1977).

Peltigera malacea--Habitat associations, processes, and requirements: On mossy rocks and soil among mosses, at 1775-1950 m, in moist montane forest (Abies srandis-Pseudotsuaa) up into the alpine zone. Little information about the ecology of this species in the Columbia Basin is available. According to Thomson (1984), in the Arctic the species occurs particularly among shrubby vegetation. Distribution: East Slope of Cascades of WA (Okanogan and Yakima counties); Northeast Mountains of WA (Ferry Co.).

Pelticfera membranacea--Habitat associations, processes, and requirements: On soil, humus, mossy rocks, stumps and logs, sometimes on moist stream banks, more or less moderate elevations (1775 m). Distribution: In mountainous or other moister areas in all provinces in the region except Eastern Plateaus and Hills (OR). Role(s): Sensitivity:

Pelticfera venosa--Habitat 'associations, processes, and requirements: On soil in cool, moist areas (including northeast-facing slopes). At 500-1500 m. Mostly in lowland riparian forests and moist, dense, more or less climax montane to

subalpine forests, especially the' Abies arandis (including Abies grandis/Pachistima myrsinites association) and Abies concolor zones, but apparently also collected twice in presumably lower and drier community types in the moist part of the bunchgrass zone. Although widely distributed in the Columbia Basin, the species is probably not often abundant there, and little information is available on the ecology of this species in the region. According to Thomson (1984), in the Arctic the species can also grow on "rocks with calcareous seepage, moist cliffs, talus slopes, edges of tussocks, edges of animal burrows, and like microhabitats,,; in my experience (mainly on the west side of the Cascades, but also in the Southwest),. the species usually grows on moist, bare (disturbed) soil in forested areas, at low to more or less high elevations. Distribution: In mountainous or other moist areas in all provinces in the region except Eastern Plateaus and Hills (OR). Role(s): Sensitivity:

Peltigera spp. --Habitat associations, processes, and requirements: Several additional species (including P. malacea, P membranacea, P. oraetextata, and various taxa in the P. horizontalis/P. oolydactylon group) occur in the region,. mostly' on soil, moss, humus, mossy rocks, or rotten wood in moist, forested areas at moderate to high elevations, or up into the alpine. One species, P. donoiensis, has been collected on sandy, desert soil (with Artemisia tridentata and Chrysothamnus viscidiflorus), and may perhaps be more widespread and 'common in the region, but has probably been confused with P. rufescens or P. didactyla. Distribution: At least one additional species has been recorded in each province. Role(s): Nitrogen fixation. Peltiaera oolydactylon s. lato inhibits seed germination, root production and elongation, in grasses (Richardson, 19__, . Vanishing Lichens). Sensitivity: Nitrogenase acitivity of P. praetextata decreased by the herbicides 2,4-D and Krenite, and by ammonium fertilizer; nitrogen fixation not affected by'the herbicides, but fertilizer killed the mycobiont (Hällbom & Bergman, 1979); P. polydactylon is tolerant to the herbicide Prefix (Seaward, 1977).

Pe'rtusaria spp.--Habitat: On bark of hardwoods or conifers, at low to moderate elevations, in moist forests. Distribution: Common on West Side. Apparently extends just barely into the east side, around the Columbia River (Klickitat Co., WA). Role(s): Sensitivity: Pertusaria amara is sensitive to fungicides and to a lesser extent to herbicides (Alstrup, 199).

Phaeophyscia orbicularis--Habitat: On bark (including Quercus garryana); on rock (basalt), at low to moderate elevations (30-960 m). Distribution: East Slope of Cascades (WA): Klickitat Co.; Northeast OR-Mountains: Union Co. Role(s): Sensitivity: Sensitive to ozone and fluoride; intermediate to sulfur dioxide.

Rare species

Phaeonhvscia sciastra--Habitat: On acidic rocks (including basalt) and mosses (usually over rock), sometimes on NE-facing 'vertical walls; at moderate elevation (1200-1290 m). **Distribution:** Northeast WA Mountains, East Slope Cascades (OR), and adjacent parts of Columbia Plateau (WA) and Eastern Plateaus and Hills (OR),. respectively. Role(s): Sensitivity: Sensitive to ozone.

Physcia caesia--Habitat: On rock (e.g., basalt), or moss or thin soil over rock, at moderate elevations (990-1950 m), in ravines in biscuit'scabland. Distribution: Eastern part of Columbia Plateau (WA); Eastern Plateaus and Hills (OR), perhaps extending into adjacent part of East Slope.of Cascades (OR). Role(s): Sensitivity:, Intermediate to sulfur dioxide. Sensitive to fungicides, and to a lesser extent to herbicides (Alstrup, 199).

Phvscia tenella [treated under **major species;** need to decide where it belongs] --Habitat: On bark or rock (e.g., on N-facing rock walls), at moderate elevation (1290.m). Distribution: Northeast part of Columbia Plateau (WA); Eastern Plateaus and Hills (OR). Role(s): Sensitivity: Sensitive to fluoride; intermediate to sulfur dioxide; tolerant to ozone.

Placopsis selida--Habitat: On acid rock, in exposed sites, at' moderate elevations (1200-1350 m). Distribution: Common on West Side. Uncommon in East Slope of Cascades (WA). Role(s): Nitrogen fixation. Sensitivity:

Platismatia stenophylla--Habitat: On bark or wood (including Pseudotsusa menziesii), sometimes on north-facing slopes, at moderate elevations (930 m), in woodlands (e.g., Pinus ponderosa/Quercus garryana/Pseudotsuga menziesii). Distribution: Somewhat infrequent on West Side, but occasionally abundant (e.g. in some places in Skamania Co., WA). Uncommon in East Slope of Cascades (WA), Northeast WA Mountains, and east part of Columbia Plateau (WA). Role(s): Sensitivity:

Pseudocyphellaria anthrastiis--Habitat: On bark of trees, in moist forests, probably at low elevation.- Distribution: Primarily West Side; extends just barely into East Side near the Columbia River (Klickitat Co., WA). Role(s): Sensitivity: Sensitive to ozone.

Ramalina farinacea--Habitat: On bark, usually of hardwoods but rarely conifers (e.g., of Abies concolor), at moderate elevations (1600 m), mostly in open but moist woodlands. On the West Side, the species is most common at low elevations. Distribution: Common on the West Side. Rare on the East Side; 'known from one locality in East Slope of Cascades (WA): Klickitat Co. and one site in Eastern Plateaus and Hills (OR): Lake Co. Role(s): Sensitivity: Sensitive to ozone and fluoride; sensitive to

intermediate to sulfur dioxide.

Solorina crocea--Habitat: On moist, disturbed soils, or occasionally on'north sides of shaded rocks, at higher elevations (1775-1950 m), 'in montane forests (Abies srandis) and subalpine forests (Abies lasiocaroa), or more commonly in alpine areas. According to Thomson (1984), in the Arctic the species prefers moist spring seepage areas, below late snowbanks, over -clay soils, but may also be found on frost boils and in drier limestone barrens. In alpine areas of the North Cascades (Douglas & Bliss, 1977), the species occurs (not abundantly) in Carex breweri snowbed communities, which are on all aspects, mainly in concave sites that are snow-free by late July and become dry during late summer. In my own experience on the east slope of the Cascades, the species occurs rarely in protected niches in alpine areas (Yakima Co., WA), but in one area (in Okanogan Co., WA) 'is a dominant species on disturbed soil in a moist montane forest. Distribution: East Slope of Cascades of WA (Chelan, Okanogan, and Yakima Counties). Role(s): Possible enhancement of soil qualities. Sensitivity:

Sphaerophorus alobosus--Habitat: Usually on bark of conifers, mostly at moderate elevations, in moist coniferous forests. Distribution: Common on the West Side. Extending just barely into the East Side, along the Columbia River (Klickitat Co., WA). Role(s): Sensitivity:

Stereocaulon spp.--Habitat: On soil, moss, or rock, mostly at moderate to high elevations, in open areas, mostly in moist forests, up into the alpine zone. Distribution: Common on the West Side. Apparently uncommon on the East Side, in East Slope of Cascades (WA), and northwest edge of East Slope of Cascades (OR). Role(s): Nitrogen fixation. Sensitivity:

Tuckermannopsis subalpina--Habitat: On bases of shrubs (often Vaccinium spp., at least on West Side), or occasionally spreading to soil; at fairly high elevations (1500-1680 m), in open to somewhat sheltered areas of the subalpine zone, Distribution: Common- on West Side. Known from one locality in East Slope of Cascades (WA): Yakima Co. Role(s): -Sensitivity:

Usnea spp.--Habitat: On bark or wood of conifers or hardwoods, at low to moderate elevations, in fairly open woodlands or forests. Too few collections (or at least proper identifications beyond genus) have been made in the region to say much else. Distribution: Common on the West Side. Members of the 'genus have apparently been found in only a few areas on the East Side, in East Slope of Cascades (OR, WA), southeast part of Columbia Plateau (WA), and Northeast OR Mountains. Role(s): Various, members of the genus are used by the northern flying squirrel

(Sharnoff, 1993). At least the U. lapponica -group is eaten by white-tailed deer (Odocoileus virsinianus) (Sharnoff, 1993). Sensitivity: Several species are sensitive to ozone; U. subfloridana is sensitive to fluoride and sensitive to intermediate to sulfur dioxide; U. filipendula group is sensitive to sulfur dioxide.

Xylographa spp. --Habitat: On rotting wood of conifers (including Abies concolor), usually on logs, but occasionally on stumps; at more or less moderate to higher elevations (1200-2000 m), in moist coniferous forests. Distribution: East Slope of Cascades (WA); moist mountainous areas of Eastern Plateaus and Hills .(Lake Co., OR); may be more widespread, but probably not often collected or identified. Role(s): May be involved in decay of wood. Sensitivity:

Ecogroup corticolous

3. ECOLOGICAL GROUPS

3.1 CORTICOLOUS/LIGNICOLOUS

3.1.1.1. GENERAL

3.1.1.1.1 OVERALL

Most of the information on the-lichens found on particular species of vascular plants is given under the discussions of the particular zones or communities where the lichens were collected. However, for each plant species there is also a summary of the distribution and ecology of each plant species and the lichens found on it. In cases where the kind'of plant host is-known but the specific zone or community is unknown or uncertain, see the summaries under the plant species; in cases where the type of plant is unknown; see the summaries under the discussions of the broad category, or the particular zone or community.

3.1.1.1.1.1. Habitat: The numerous ecological factors affecting lichens on bark or wood have been studied extensively in Europe (Barkman, 1958, and many others), and to a lesser extent in various parts of North America, but few if 'any studies have been made in the WA/OR part of the Columbia Basin., A few of the major factors are briefly summarized here.-

Type of substrate: Different lichen species show varying degrees of specificity for particular types of bark or wood. Important factors include the chemistry, texture, and stability of the bark or wood, whether the substrate is alive or dead, and the degree of decomposition,.

Amount of canoov closure or exposure: This affects the physical conditions of light, heat, moisture, and wind (the effects of which can be difficult to distinguish), and also modifies the impacts of air pollution.'

Inclination of stems of substrate: Eccentric or leaning stems are beneficial for lichen taxa that require shelter from light, heat, precipitation, or nutrient enrichment.

3.1.1.1.1.2. Distribution:

Lichens on bark or wood occur in all provinces, but are the most diverse and abundant in the mountainous areas.

3.1.1.1.1.3. Role(s):

Modification of chemistry and content of water flowing throush the canoov: Lichens, particularly the larger'fruticose or foliose ones (e.g., Hypogymnia spp., Platismatia glauca, and others); alter precipitation chemistry (Lang, et al., 1976; Basabe, pers. comm., 1994) and affect nutrient cycling. Leachates

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Providina habitat or food for animals: Few data are available on this function of lichens in the WA/OR part of the Columbia Basin, except perhaps in some areas in NE Mountains, WA (see under Tsuaa heterophylla/Pachistima Association). However, studies in other areas have shown that various squirrels, ungulates, and other mammals, and some kinds of birds, use various corticolous macrolichens for food or nesting material, to some extent.

Nitrogen fixation: Although this is an important function in various other regions, only a few nitrogen fixers occur on bark or wood in the WA/OR part of the Columbia Basin, in the moistest communities adjacent to the west side or to Idaho, and nothing is known about the abundance of these lichens in those areas.

Effects on host Plants: It has been generally assumed that most lichens do not directly damage their hosts. However, many crustose kinds penetrate the outer layers or, are even immersed in them, and some (including "allied fungi" traditionally treated with lichens) may be at least partly parasitic. There have been a few reports suggesting that at least some foliose or fruticose lichens (e.g., Evernia prunastri) also penetrate the bark or wood and perhaps extract nutrition from it. Lichens may also indirectly affect the host by blocking air and light, retaining moisture (perhaps facilitating growth of other organisms), providing habitats for invertebrates, releasing substances with antibiotic or other biologically significant properties, and when very abundant occasionally causing loss of bark or branches due to the added weight (when wet).

Other effects: When larger, protruding or hanging, macrolichens are extremely abundant on branches of trees or shrubs, they provide shade for other organisms (including other lichens) growing below them; this could be important especially in hot or dry areas, with lichens on host plants that are dead or have deciduous leaves.

3.1.1.1.1.2. Sensitivity:

Elimination or modification of the habitat: Whether by partial or complete removal of the substrate by logging, clearing for agriculture or human settlements, pathogens or insects, or fire, this is a potential major problem especially for corticolous lichens, in many zones and communities.

Fire: Burning is also directly damaging to lichens, although species that frequently grow on burnt bark or wood might eventually benefit.

Air pollution: Lichens growing on trees or large shrubs are generally more likely to be impacted by air pollution than are kinds on other substrates.

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3.1.1.1.2. MISCELLANEOUS ZONES
(SPECIES FOUND ON UNSPECIFIED BARK OR WOOD)

3.1.1.1.2.1. GENERAL:

3.1.1.1.2.1.1. Distribution: These types of substrates can obviously occur anywhere, in any'type of habitat.

3.1.2.2. On fences or other processed wood:'

3.1.1.1.2.2.1. Habitat: Fences and other man-made structures often provide habitats that are rather different from those available in the surrounding vegetation. They are likely to be especially important in areas with few or no woody plants, including agricultural areas in steppes or shrub steppes, where especially the tops of upright posts are often used as bird perches and thus receive extra nutrient enrichment. Fences may also be important in riparian or wetland communities, because the wood is above the moist areas, but often out in the open, such that conditions are dry, sunny, and nutrient rich (in contrast to adjacent closed canopy forests or woodlands). In areas dominated by hardwood trees or shrubs, fences or other structures provide a substrate for species that prefer or require 'conifer wood.

3.1.1.1.2.2.2. Distribution: Lichens were collected in E. Slope of Cascades, WA (450 m, Kittitas Co.; 60 m, Klickitat Co.); Columbia Plateau, WA (700 m, Garfield Co.; 750 m, Whitman Co.); E. Plateaus and Hills, OR (1400 m, Klamath Co.; 900-1050 m, Wasco do.), and NE Mountains, OR (1000 m, Union Co.).

3.1.1.1.2.2.3. Sensitivity: Extensive replacement of wooden structures with ones made out of other materials (especially metal) could be detrimental, especially for Thelomma ocellatum and, other species that are uncommon in the region as a whole or in particular areas.

3.1.1.1.2.2.3. Representative species: Although many of the lichens found on fenceposts, including all of the macrolichens, are common on trees or shrubs, several crustose species seem to be quite characteristic of fenceposts, particularly on or around the flat tops of upright posts. This is especially true of Thelomma ocellatum, a member of the Caliciales, which was found found at the Kittitas Co. (WA) and Union Co. (OR) sites. Another member of the Caliciales, Cyphelium incuinans, was common on fences at the Wasco Co. (OR) site. Other lichens found on fences in WA include Buellia mvriocarpa (Klickitat Co. site), Xanthoria "candelaria" (Garfield Co. site); Brvoria glabra (Whitman Co. site). In OR, at the Wasco Co. site, Lecanora hypoptoides, was common, and Letharia vulnina was also present; at the Klamath Co. site, Evernia prunastri, Letharia vulpina, Tuckermannoosis chlorophylla, and Xanthoria candelaria were found; at the Union Co. site, Thelomma ocellatum was found.

On charred bark or wpod (usually of conifers.):

Representative species: Biatora varians, Hypocenomyce friesii, H. scalaris, Parmelionsis spp., and Trapeliopsis sranulosa are the most frequent species. Candelaria

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concolor has also been found at one site (Columbia Plateau, WA: 750 m, Whitman Co.).

On rotting wood. (usually of conifers):
Representative species: Species of Biatora, Cladonia, Hypocenomyce, Lecanora, Lecidea s. lato, Parmeliopsis, Trapeliopsis, and Xylographa have been found.

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3.1.2. DECIDUOUS WOODLAND (Vitt, et al.).

3.1.2.1. GENERAL

Habitat: Deciduous woodlands generally provide cooler, moister, and more shaded conditions than most dry coniferous forests. Hardwood trees and shrubs generally have different lichen floras than gymnosperms do, and there is also a lot of variation in the floras found on different hardwood species.

Distribution: Primarily west of the Cascades; but extending into the western edge of the Columbian Basin along the Columbia River, and in large patches in many riparian or other wetland areas.

Role(s): Nitrogen-fixing lichens occur on trees in the vicinity of the Columbia Gorge, but at present it is not known whether they are abundant enough there to contribute significantly to the ecosystem.

Sensitivity: In the Columbia Gorge, there is probably some threat from air-pollution, due to winds from the Portland-Vancouver area, and from traffic-along Interstate Highway 84..

3.1.2.2. LICHENS ON UNSPECIFIED BARK OR WOOD (PROBABLY OF HARDWOODS)

Distribution: Lichens were collected in E. Slope of Cascades, WA (ca. 60-500 m, Klickitat Co.')

Representative species: Arthopatellulata, "Arthopyrenia punctiformis", Biatora snhaeroides, B. varians, Buellia discifonnis, Caloplaca cinnabarina, C. "ferruginea", C. spp., Candelariella sp., Catinaria atroourpurea, Collema nigrescens, Graphis eleaans, Lecania dimera, Lecidea mvriocarnoides (on dead, prostrate tree trunks), Letharia vulpina, Melanelia multisoora, Nephroma helveticum, N. resuninatum, Normandina pulchella, Ochrolechia spp., Opegrapha orotuberans (on dead, prostrate tree trunks), Pannaria sp., Pertusaria leioplaca, P. spp.,'Phvscia adscendens, P. stellaris, Pseudocyphellaria anthrasois, Ramalina farinacea, Rinodina "confragosa", Stransosoora moriformis (at least partly on dead, prostrate tree trunks), Xanthoria "candelaria", and X. polycarpa were found.

3.1.2.3. LICHENS ON PARTICULAR KINDS OF WOODY PLANTS

Acer glabrum

Distribution: Lichens were collected in E.-Slope of Cascades (300 m, Klickitat Co.).

Representative species: Rinodina hallii

Acer macrophyllum

Distribution: Lichens were collected in E. Slope of Cascades (100-500 m, Klickitat Co.).

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Representative species: Caloolaca "ferruginea", Lecanora sp., Lecidea sp., Lobaria hallii, L. oulmonaria, Nephroma helveticum, Phvscia adscendens, Phvsconia sp.

Acer nequndo .

Distribution: Lichens were collected in Columbia. Plateau, 'WA (ca. 500 m, Columbia Co.).

Representative species:. Xanthoria "candelaria" was f o u n d .

Acer (unspecified)

Habitat:. The Spokane Co. site was in a dense, near-climax Pseudotsusa forest at the bottom of an east-facing slope.

Distribution: Lichens were collected on unspecified species of Acer in E. Slope of Cascades, WA (90 m, Klickitat Co.) ; Columbia Plateau, WA (600 m, Spokane Co.)

Representative species: Melanelia exasperatula was found on Acer at the Klickitat Co. site; Cladonia cariosa and C. chloroohaea were found on 'rotten wood at the Spokane co. site.

Alnus rhombifolia

Distribution: Lichens were collected on A. rhombifolia in E. Slope of Cascades, .WA (900 m, Yakima Co.).

Representative species: A member of the Caliciales, Calicium adaeouatum, was found on trunks of A. rhombifolia.

Alnus rubra

'Distribution: Lichens were collected on A. rubra 'in E. Slope of Cascades, WA (ca. 200-500 m, Klickitat Co.), and E. Slope of Cascades, OR (1050 m, Jefferson Co.).

Representative species: In WA, Arthonia radiata, Bacidia rubella, Buellia disciformis, Caloplaca "ferruginea", Diplotomma penichrum, and Rinodina hallii were found. At OR site (in a mixed conifer forest), Melanelia multispora (at the edge of a lake), and a member of the Caliciales, Calicium adaeuuatum, (on twigs) were found on A. rubra.

Alnus **(unspecified)**

Distribution: Lichens were found on unspecified alders in E. Slope of Cascades, WA (60 m, 200 m, 930 m, and 960 m, Klickitat Co.); NE Mountains, OR (1000 m, Union Co.).

Representative **species:** In WA, Letharia columbiana was found at the 930 and 960 m sites; Ochrolechia sp. was found at the 200 m site; and Caloolaca sp. was found at the 60 m site. In OR, Hypogymnia imshausii and Xanthoria polycarpa were found.

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Amelanchier alnifolius

Distribution: Lichens were collected in E. Slope of Cascades, WA (1290 m, Klamath Co.).

Representative species: Xanthoria "candelaria" was found on A; alnifolia.

Amelanchier (unspecified)'

. Distribution: Lichens were collected in Columbia Plateau, WA (690 m, Whitman Co.).

Representative species: Candelaria concolor, Melanelia eleaantula, M. exasoeratula, and M. multisoora were found on branches.

Berberis aquifolia

Distribution: Lichens were collected on B. asuifolia in E. Slope of Cascades, WA (ca. 800-1100 m, Yakima Co.)

Representative species: Tuckermannoosis merrillii

Betula papyrifera

Distribution: Lichens were collected in NE Mountains, OR (locality unspecified,. Blue Mountains).

Representative species: Melanelia subolivacea, Parmelia sulcata.

Cercocarpus ledifolius

Distribution: The plant grows on high open ridges in NE Mountains, OR (Blue Mountains) and E. Plateaus and Hills, OR (south-central part; lichens were collected at 1350-1440 m, Klamath Co.).

Representative species: Brvoria cf. fremontii, Candelariella xanthostigma, Hypogymnia imshausii, Lecanora sp., Letharia columbiana, L. vulpina, Melanelia subolivacea, Parmelia sulcata, and Usnea cf. lapponica.

Celtis reticulata

Habitat: In open, often rocky areas, especially along' rivers such as the Snake River.

Distribution: Eastern WA and OR. Lichens were collected in Columbia Plateau, WA (foot of Dry Palls, Grant Co.) ; E. Plateaus and Hills, OR (120 m, Wheeler Co.)

Representative species: Xanthoria "candelaria" was found at the WA site; X. fallax was found at the OR site.

Cornus nuttallii

Distribution: Lichens were collected in E. Slope of Cascades (60 m, Klickitat Co.).

Representative species: Bacidia fuscorubella was found.

Crataegus doucrlasii

Ecogroup corticolous

Habitat: In wettish places like edges of streams and meadows; common along roadsides and fields; wide range from low to middle mountain elevations; mostly yellow pine zone. The Spokane Co. site was in a moderately open climax Pinus ponderosa forest in a shallow valley.

Distribution: Lichens were collected in E. Slope of Cascades (ca. 430 m, Klickitat Co.); Columbia Plateau, WA (600 m, Spokane Co.; 690-750 m, Whitman Co.).

Representative species: "Arthopunctiformis" was found on C. doualasii at the Klickitat Co. site. Candelaria concolor, Leoraria sp. (L. incana group), Lecanora subrugosa, L. sp. (L. "rugosa"), Lecidella elaeochroma, and Phvscia tenella were found on smooth trunk bark of C. douglasii at the Spokane Co. site. Hypogymnia imshaugii, H. phvsodes, and Tuckermannoosis platyphylla were found at one 750 m Whitman Co. site; 'Melanelia exasperatula, M. multisoora and Xanthoria polycarpa were found at the other; Xanthoria polvcaroa was also found at the 700 m Whitman Co. site. Candelaria concolor, Melanelia elesantula, M. exasperatula, and M. multispora were found at the 690 m Whitman Co. site, on branches.

Eleagnus sp.

Distribution: Lichens were collected in E. Plateaus and Hills, OR (1440 m, Harney Co.)

Representative species: Rinodina sp. has been found on a dying tree.

Fraxinus (unspecified)

Distribution: Lichens were collected in E. Slope of Cascades (60 m, Klickitat Co.).

Representative species: Caloolaca pollinii, Rinodina "exiqua".

Populus tremuloides

Habitat: Somewhat more moist than oak woodlands. Nutrient enrichment is important.

Distribution: Lichens were collected in E. Slope of Cascades, WA (ca. 500 m, Klickitat Co.); E. Slope of Cascades, WA/NE Mountains, WA (Hough homestead, 900 m, Okanogan Co.); NE Mountains, WA (ca. 800 m, Ferry Co.), E. Slope of Cascades, OR (990 m, Deschutes Co.).

Representative species: In WA, Xanthoria polycarpa was found at the Klickitat Co. site; X. fallax was found on the bark and "bird scars" of P. 'tremuloides at the Okanogan Co. site, and Lecania cyrtella was found at the Ferry Co. site. In OR, Caloolaca sp. (C. holocarpa group), Lecidea sp., Rinodina sp., and Xanthoria "candelaria" were found on bark at the Deschutes Co. site.

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Populus trichocarpa

Distribution: Lichens were collected in E. Slope of Cascades, WA (ca. 400-540 m, Chelan Co.; 500 m, Kittitas Co.); Columbia Plateau, WA (750 m, Whitman Co.); E. Slope of Cascades, OR'(1620 m, Klamath Co.); E. Plateaus'and Hills of OR (129.0 and 1400 m, Klamath Co.).

Representative species: In WA, Parmelia sulcata and Phvscia 'stellaris were found at one Chelan Co. site, and Xanthoria polycarpa was found at the other; X. fallax was found at the Kittitas Co. site; Lecanora haaeni, Phvscia sp., and Xanthoria "candelaria" were found at the Whitman co. site. In OR, Caloplaca cerina and Lecanora populicola were found at the 1620 m and 1400 m sites; Caloplaca sp., Melanelia eleaantula, Phvscia tenella,' Xanthoria candelaria, X. fallax, and X. polycarpa were found at the 1400 m site.

Populus (miscellaneous)

Distribution: Lichens were collected in Columbia Plateau, WA (780 m, Whitman Co.)

Representative species: Xanthoria "candelaria" was found on "Carolina poplar".

Prunus emarginata

Distribution:. Lichens were collected in E. Slope of Cascades (60 m, Klickitat Co.)

Representative species: Bacidia naeaelii,' Buellia "glaucomarioidea", Diplotomma penichrum, Lecidea carnulenta, L. hypomela, Ochrolechia sp., Pertusaria oohthalmiza, and Pvrrhosnora cinnabarina were found.

Prunus virginiana

Distribution: Lichens were collected in E. Plateaus and Hills, OR (900-1050 m, Wasco Co.)

Representive species: Lecidella alomerulosa was common, and.Xanthoria polycarpa was also present, on "twigs and bark".

Prunus (unspecified)

Habitat: In orchards of cultivated cherry or'prune trees in dry areas, lichens occur only occasionally, mainly on wood or rough bark in areas of the trees where moisture from irrigation sprinklers (and probably also nutrient-rich dust) accumulates (e.g., in crotches of the main branches).

Distribution: Lichens were collected in E. Slope of Cascades, WA (ca. 700 m, Kittitas Co.) and Columbia Plateau, WA (270 m, Yakima Co.).

Representative species: Parmeliopsis hyperopta was found on'bark of "cherry".

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Purshia tridentata Distribution: Lichens were collected in E. Plateaus and Hills, OR (1350 m, Crook Co.).
Representative species: Brvoria fremontii was found.

Pyrus fusca
-Distribution: Lichens were collected in E. Slope of Cascades (60 m, Klickitat Co.).
Representative species: Melanelia multispora was found.

Quercus garryana
Habitat:' The 930 m site was in a 'mixed forest with Pinus ponderosa and Pseudotsuaa menziesii.
Distribution: Lichens were collected in E. Slope of Cascades, WA (3160 m, Yakima Co.; ca. 60 m, 90 m, 300 m, 500 m, and 930 m, Klickitat Co.), and E. Slope of Cascades, OR (ca. 200 m, Wasco Co.).
Representative species: At the Yakima Co. site,' Phvscia stellaris (on branches) and Xanthoria fallax were found.- In Klickitat Co., Caloplaca sp. (C. holocarpa group),. Collema niarescens, Lecanora spp. (at least partly on twigs), Letharia vulpina, Melanelia subolivacea (at least partly on twigs), Phvscia adscendens, Phvsconia "americana", and P. perisidiosa were found at the 930 m site; Phvsconia distorta was found at the 500 m site; Ochrolechia farinacea was found at the.300 m site; Phvsconia enteroxantha was found at the 90 m site, and Xylographa abietina and "X. hians" (syntype) were found on wood of a prostrate trunk of Q. aarrvana at the 60 m site. In OR, Melanelia multispora and Phvscia aipolia were found.

Robinia pseudacacia
Distribution: Lichens were collected in E. Slope of Cascades/NE Mountains, WA (Carlton, Okanogn Co.).
Representative species: Xanthoria "candelaria" was found..

Rosa spauldinqii
Distribution: Lichens were collected in Columbia Plateau, WA (690 m, Whitman Co.)
Representative species: Lecanora carpinea, L. cf. haseni, Melanelia eleqantula, M. 'multispora, Phvscia adscendens, Phvsconia detersa, and Xanthoria polycarpa were. found on "canes", and the Melanelia species, plus Candelaria concolor, were found on "branches".

Salix
Distribution: Lichens were collected in NE Mountains, WA (Halliday Trail Fen, Pend Oreille Co.).
Representative species: Vulpicida canadensis was found on twigs of Salix sp.

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Symphoricarpos albus

Distribution: Lichens were collected in Columbia Plateau, WA (690 m, Whitman Co.)

Representative species: Candelaria concolor, Melanelia eleaantula, M. exasperatula, and M. multispora were found on branches.

Symphoricarpos oreiophilus

Distribution: Lichens were collected in E. Plateaus and Hills, OR (900-1050 m, Wasco Co.)

Representative species (presumed, from the statement that the lichen occurred- on "twigs of all woody plants"): Xanthoria polycarpa was found.

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3.1.3. GRASSLAND-SAVANNAH (Vitt, et al., 1988). STEPPE AND SHRUB-STEPPE COMMUNITIES (Franklin & Dymess, 1973).

Steppe and &rub-Steppe of the "Columbia Basin Province" (Franklin 6 Dymess, 1973; includes "Columbia Plateau Province" of WA and northern part of "E. Plateaus and Hills Province" of OR). To avoid redundancy, I also am treating the communities found in "Central and Southeastern Oregon" (Franklin & Dymess, 1973) here, under the particular provinces.

3.1.3.1. GENERAL

Habitat: Substrates for lichens are mainly shrubs (especially Artemisia), and wooden fences, and in some areas, also trees (Junioerus, Pinus ponderosa, and sometimes Populus).

Distribution: Mainly in Columbia Plateau, WA and E. Plateaus and Hills, OR, but with small areas in the other provinces.

Sensitivity: In some areas (e.g., western part of Columbia Plateau of WA), much of the habitat has already been eliminated by clearing for agriculture or human settlements, and more is likely to be removed for such purposes, especially near cities. However, there are still quite extensive areas where corticolous/lignicolous lichens should be able to flourish. The main threats are probably from fire, and from agricultural chemicals, .and (near the big cities) from air pollution.

Representative species: Xanthoria spp. occur on a very wide range of trees, shrubs, and wood in almost all community types in steppe and shrub-steppe areas, and often are the dominant corticolous/lignicolous lichens.

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3.1.3.2. ZONAL ASSOCIATIONS (Franklin & Dyrness, 1973).

3.1.3.2.1. SAGEBRUSH ZONE (Lyons, 1971)

Habitat: Precipitation: average annual precipitation is 190-389[-610] mm [according to Lyons it is mostly less than 250 cm]. Average summer precipitation is, low (24-43[-75] mm). Average annual snowfall: 34-136 cm. Temperature: Summers are warm to hot (averaging in low 20's C, maxima in the high 20's to low 30's C, but often reaching 38° C). Winters are relatively cold (averaging below freezing, from November to March).

Distribution: In WA the zone occurs at ca. O-600 m (Lyons, 1971).

3.1.3.2.1.1, ARTEMISIA TRIDENTATA COMMUNITIES:

3.1.3.2.1.1.1. Habitat: The ecology of lichens growing on the various subspecies of Artemisia tridentata has been thoroughly studied in Idaho by Rosentreter (1990); many'of his conclusions probably also apply to WA. and OR. Although-sagebrush are long-living (to more than 100 years for A. tridentata according to West, 1988), Rosentreter found that lichen growth did not appear to correlate with age of the 'sagebrush.' My own observations in WA (e.g.,' east part of Yakima Co.) and OR (e.g., east'part of Klamath Co.) support his idea that-lichens are best developed on dead sagebrush or at least the dead parts of them. Rosentreter also concluded that lichen cover increased with 'increasing stem growth ratio (eccentricity) of the sagebrush (especially A. tridentata ssp. wvominaensis) and nutrient enrichment from fertilizer or dust, but decreased with increasing elevation. Summer precipitation in sagebrush areas in general usually is light (West, 1988); the different subspecies of A. tridentata have somewhat different preferences for soil conditions (see discussion under Terricolous/Muscicolous Lichens). The presence-of large, ephemeral, spring leaves and smaller, persistent, overwintering leaves might have some influence on the lichens, by affecting radiation or moisture.

3.1.3.2.1.1.2. Distribution: Sagebrush steppe-is the major vegetation type in the western 2/3 of the Columbia Plateau of WA and most of the E. Plateaus and Hills of OR (West, 1988).

3.1.3.2.1.1.3. Role(s): Assuming that the conclusion of Rosentreter (1990) is correct, i.e., that lichens do not contribute to the death of the sagebrush, it is unlikely that lichens growing on the shrubs have an important function in this ecosystem, except possibly slight roles in providing habitat or nutrition for invertebrates or microorganisms, and in modifying precipitation chemistry or nutrient cycling. However, as discussed by Rosentreter, lichens are potentially useful as ecological indicators in these ecosystems.'

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3.1.3.2.1.1.4. Sensitivity: The corticolous/lignicolous lichens are sensitive to factors that affect their substrate. Sagebrush increases in abundance with excessive livestock grazing combined with lowered fire frequency (none of the major sagebrush species can resprout after being burned); Artemisia tridentata cannot survive flooding that creates anaerobic conditions (West, 1988). The lichens, are-also directly sensitive to burning, and at least some species are probably sensitive to agricultural chemicals.

3.1.3.2.1.6. 'Representative species: Candelaria concolor, Xanthoria "candelaria", and X. polvcarpa

3.1.3.2.1.7. Particular associations with A. tridentata ssp. tridentata: .

3.1.3.2.1.7.i. Artemisia tridentata ssp. tridentata/Agropyron spicatum Association.

Habitat: Climatic climax of the driest of the shrub-steppe zones. Annual precipitation at the site in Grant co., OR is 230-300 mm.

Distribution: Central part of Columbia Plateau, to E. Slope Cascades of WA and northern OR (Franklin & Dyrness, 1973). Lichens were collected in Columbia Plateau, WA (390-460 m, Yakima Co.); E. Plateaus and Hills, OR (Grant Co.).

Role(s):

Sensitivity:

Representative species: Candelaria concolor, Xanthoria "candelaria" and X. polvcarpa were very abundant at the Yakima Co. site. In OR, X. "candelaria" was found at the Malheur Co. site, and X. polvcarpa at the Grant Co. site.

-3.1.3.2i1.7.2. Artemisia tridentata ssp. tridentata/Stipa comata Association

-Habitat:, Annual precipitation at the lichen site is 230-270 mm.

Distribution: Lichens were collected in E. Plateaus and Hills, OR (900 m, Malheur Co.) . .

-Representative species: Candelaria concolor, C. efflorescens

3.1.3.2.1.8. Artemisia tridentata ssp. vaseyana Communities;
Habitat: This subspecies occurs at higher elevations (to over 2000 m in Spokane Co., WA).

3.1.3.2.1.8.1. Artemisis tridentata ssp. vaseyana/Festuca idahoensis Association.

Distribution: Lichens were collected in Columbia Plateau, WA (600 m, Lincoln Co.)

Representative species: Xanthoria polvcarpa .

3.1.3.2.2. "BUNCHGRASS ZONE" (Lyons, 1971). "PALOUSE PRAIRIE" (Daubenmire, 1992).

3.1.3.2.2.1. Habitat: This "zone" is actually a group of floral belts intermediate between the sagebrush and yellow pine zones. Substrates for corticolous/lignicolous lichens are few, mainly scattered conifers, poplars, or shrubs. The following information- on Palouse 'prairie comes from Daubenmire (1992), and Lyons (1971). The regional climate is one of winter wetness and summer drought. Precioitation: The annual average is 330-600 mm, which falls as intermittent, often gentle, mist-like rain; and in the winter often as snow, which blankets the ground for 'several months. Average annual snowfall is generally (25-)30-50(-60) cm. Temperature: Winter temperatures alternate between cool and cold (below freezing temperatures are experienced most of the winter); summer has warm days ("extremely hot" according to Lyons, 1971) and cool nights.

3.1.3.2.2.2. Distribution: Palouse prairie occurs in discontinuous areas in the eastern 1/3 of the Columbia Plateau'of WA, the lower, drier parts of the NE Mountains of WA, and the northwesternmost part of the E. Plateaus and Hills of OR (northern foot of Ochoco Mountains) (Daubemire, 1992). Generally at 450-720 m in WA (Lyons, 1971).

3.1.3.2.2.3. Sensitivity: Most of the habitat has already been eliminated by clearing for agriculture or human settlements. Possible threats to lichens in the remaining areas may include fire, and agricultural chemicals.

3.1.3.2.2.4. Particular associations:

3.1.3.2.2.4.1. Festuca idahoensis/Symphoricarpos albus Zone (Franklin & Dyrness, 1973).

3.1.3.2.2.4.1.1. Habitat: Cooke (1955) called the community where corticolous lichens were found the "Symphoricarpos albus/Festuca idahoensis Association", which he distinguished from areas where the grass predominated and lichens occurred only on soil. Cooke's northern plot was in a climax thicket.on a northwest facing slope betweem a country road and a field; his central plot was in a climax thicket on a north slope. Leaves of the shrubs in this zone remain green from mid May to mid October (Daubemire, 1992). Meadow-like. Precioitation: The moistest of 'the steppe zones. Temperature: Winters are relatively mild.

3.1.3.2.2.4.1.2. Distribution: The zone occurs near the eastern margin of the Columbia Plateau, north of the Snake River (Franklin & Dyrness, 1973, Daubenmire; 1992). Lichens were studied by Cooke (1955) in Columbia Plateau, WA (northern plot, 690 m, and central plot, 750 m, Whitman Co.).

3.1.3.2.2.4.1.3. Sensitivity: The foliage of the shrubs is not very flammable, and regeneration from subterranean organs is very rapid (Daubenmire, 1992). However, the lichens themselves are still potentially sensitive to fire (both directly and due to the temporary loss of substrate). The'main threat to the

community.is its conversion to cropland, which has already occurred in most areas.

3.1.3.2.2.4.1.4. Representative species:

On canes of Rosa spauldinsii (northern plot): Three foliose lichens, characteristic of more or less nutrient-enriched areas, formed a dominant community: Phvscia adscendens, Phvsconia detersa, Xanthoria polycarpa. Two crustose.lichens, Lecanora carpinea and L. cf. haqeni, were also found.

On branches' of S. albus, Crataequs doucrlasii, Rosa spauldingii, and Amelanchier sp. (central plot): Another foliose community, composed of Candelaria 'concolor, Melanelia eleqantula, M. exasneratula, and M. multispora was found.

3.1.3.2.2.4.2. Aqropyron spicatum-Festuca 'idahoensis Association

Distribution: Lichens were collected in Columbia Plateau, WA (700 m, Garfield Co.). .

Representative species: Xanthoria "candelaria" was found on fenceposts.

3.1.3.3. ASSOCIATIONS IN SPECIAL HABITATS

3.1.3.3.1. Artemisia rigida/Poa sandbergii Association

3.1.3.3.1.1. Habitat: The following information is from the Wasco Co. site (Rossman, 1992). -Precipitation: Semi-arid; average annual precipitation is280 mm', falling mostly in November to January but with heavy rains in May and June. Summers are dry, with low daytime humidity of 20-25% down to 8-10%. Average annual snowfall 150 mm. Temperature: Average maximum in summer (August to October) 26-32° C. Average winter. temperature ca. 0° C. Wind: usually less than 20 km/hour, from W to NW in summer and S to SW in winter.

3.1.3.3.1.2. Distribution: This community occurs at 450-1200 m, in E. Slope of Cascades, WA, OR; Columbia Plateau, WA, E. Plateaus and Hills, OR. Lichens were collected in E. Slope of Cascades, WA (450 m, Kittitas Co.) and E. Plateaus, OR (660 m, Baker Co.; 990-1050 m, Wasco Co. --Intermound communities in biscuit scabland (Rossman, 1992).

3.1.3.3.1.3. Sensitivity: Fire rarely carries through this vegetation,. but when it does the Artemisia is killed. outright (Daubenmire, 1992); obviously the lichens are also sensitive to these occasional fires.-

3.1.3.3.1.4. Representative species: At the Wasco Co; site, several lichens occurred on A. rigida: Lecanora sp. was common on wood; Lecidella slomerulosa was common on "twigs and bark"; M. multispora and "Parmelia cumberlandia" were common on "branches", and Melanelia elesantula and Xanthoria polycarpa were also found on "branches". Xanthoria polycarpa was also found on A. rigida at the Baker co. site. At the WA site, Melanelia subeleuantula was found on A. risdia, and Thelomma ocellatum was found on fenceposts.

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3.1.3.4. OTHER OREGON STEPPE COMMUNITIES (Franklin & Dyrness, 1973)

3.1.3.4.1. Cerocarpus ledifolius Communities--see under C. ledifolius in discussion of lichens'on particular species of hardwoods, above. Although Franklin'& Dyrness (1973) treat these communities under steppes, the sites where lichens were collected were in the Pinus ponderosa Zone.

3.1.3.4.2. Purshia tridentata Communities--see under P. tridentata in discussion of lichens on particular species of hardwoods, above. The sites where lichens were found were in the Juniperus occidentalis Zone.

3.1.3.4.3. Desert or Salt Desert Shrub Communities

3.1.3.4.3.1. Sarcobatus vermiculatus-Gravia spinosa-Artemisia shrub-steppe' (alkaline community type)

Habitat: This community forms bands around playas; soils are alkaline, although water may be reasonably abundant.

Distribution: Lichens were collected in E. Plateaus and Hills, OR (Blackwater Lake, Grant Co.' 1050 m, Harney Co.; 1500 m, Lake Co.) .

Representative species: Xanthoria "candelaria" was found on G. spinosa at the Harney Co.. site, and X. sp. was found on that species at the Grant Co. site; X. polycarpa was found on "dead twigs of a thorny bush" (probably G. spinosa) at the Lake Co. site.

3.1.3.4.3.4. Riparian and Populus tremuloides communities--See discussion under Deciduous Woodlands, above.

3.1.3.4.3.5. Crataegus douglasii communities--See under this species in discussion of lichens on particular hardwood species, above.

3.1.3.4.3.6. Plant Associations on Colluvium, Alluvium, and Talus:

3.1.3.4.3.6.1. Celtis reticulata Communities

3.1.3.4.3.6.1.1. Artemisia tridentata-Celtis reticulata Community

Distribution: Lichens were collected in E. Plateaus and Hills, OR (41-2: 120 m, Wheeler Co.)

Representative species: Xanthoria fallax was found on C. reticulata.

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3.1.3.5. MISCELLANEOUS COMMUNITIES (in Biscuit scabland--Rossman, 1992)

3.1.3.5.1. Distribution: E. Plateaus and Hills, OR (Lawrence Memorial Grassland,. 900-1050 m, Wasco Co.).

3.1.3.5.2. Habitat: Precipitation: Semi-arid; average annual precipitation is.280 mm, falling mostly in Novemeber to January but with heavy rains in May and June. Summers are dry, with low daytime humidity.of 20-25% down to 8-10%. Average annual snowfall 150 mm. Temperature: Average maximum in summer (August to October) 26-32" C. Average winter temperature ca. 0° C. Wind: usually less than 20 km/hour, from W to NW in summer and S to SW in winter.

"'3.1.3.5.3. Representative species:

On "twigs and bark" of Prunus virsiniana: Lecidella glomerulosa was common; Xanthoria polycarpa was also found.

On Svmphoricarpos oreiophilus (presumed, from the statement that the lichen occurred on "twigs of all woody plants"): Xanthoria polycarpa

On wooden- fenceposts (standing or fallen): Lecanora hypoptoides, and a member of the Caliciales; Cyphelium inquinans, were common; Letharia vulpina was also present.

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3.1.4. DRY CONIFEROUS FOREST (Vitt, et al., 1988).

3.1.4.1. GENERAL.

Vitt, et al. (1988) include the Pinus ponderosa Zone under Grassland/Savannah, but it seems more appropriate to treat it (and the Juniperus occidentalis Zone) here instead.

3.1.4.1-l. **Habitat:** Conditions are more generally cooler, moister, and more shaded than in most steppe or shrub-steppe communities.

3.1.4.1.2. Distribution: Forests dominate in all provinces in the region except Columbia Plateau, WA and E. Plateaus & Hills, OR, -where they are restricted to mountain areas.

3.1.4.1.3. Role(s): The abundance of larger corticolous. macrolichens, which are more likely to intercept precipitation, be used by animals, and otherwise contribute to the ecosystem, is generally greater in forests than in other zones.

3.1.4.1.4. Sensitivity: Main threats are probably logging and fire, and possibly air pollution in some areas.

3.1.4.1.5. Representative species:

3.1.4.1.5.1. On bark or wood of conifers: Several main lichen communites are almost ubiquitous on bark or wood of almost all gymnosperms, throughout the Columbia Basin of WA and OR. Letharia spp. (L. columbiana and L. vulpina) very frequently are the most dominant corticolous/lignicolous lichens, often forming a community by themselves, or with species of Brvoria (especially B. abbreviata, but sometimes B. fremontii or others) or rarely (in the Abies grandis/A. concolor zones), Alectoria sarmentosa.

Almost equally widespread and frequent are communities. dominated by various combinations of foliose lichens: Hypogymnia spp. (especially H. imshausii), Tuckermannopsis spp. (especially T. merrillii and'often T. platyphylla), and (in order of increasingly moist conditions) Vulpicida canadensis, Melanelia spp. (especially M. eleaantula or sometimes M. multispora/M. subolivacea), or Platismatia slauca.

Although all of these species occur throughout the elevational and ecological range of woody plants, they form dominant communities mainly from the Juniperus zone up to the Abies arandis or A. concolor zones. With increasing elevation, and especially in the subalpine zones, the Letharia community is gradually replaced by communities dominated by Alectoria sarmentosa, Brvoria spp. (other than B. abbreviata), or both, and the the foliose lichens decline in abundance.

A another major group, also more common in the moister, mostly higher elevation, zones, prefers burnt or decaying wood or bark of conifers: Parmeliopsis spp. often form a community with Hypocenomyce scalaris, Trapeliopsis

aranulosa, and other Lecidea-like genera. Species of Xylographa sometimes co-occur with these other species, but only on unburnt wood, and more often they form a community by themselves.

3.1.4.1.5.2.' On hardwoods: Most of the lichens that form the first two groups on gymnosperms are also very. frequently present on various hardwoods in drier, more open areas, except for Melanelia spp, they are usually less abundant on these substrates. On hardwoods (especially Cercocarpus, Crataegus, and Populus) in this zone, the most frequent lichens are various combinations of species of Caloplaca, Lecanora, Lecidea s. lato, Physcia (especially the P. stellaris and P. tenella groups), and Xanthoria, and often Candelaria concolor, Candelariella spp., the Melanelia subolivacea group,, or Parmelia sulcata.

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3.1.4.2. JUNIPERUS OCCIDENTALIS ZONE (Franklin & Dyrness, 1973)

GENERAL

3.1.4.2.3. Habitat: Juniper communnities are intermediate in moisture between shrub-steppe'and"ponderosa pine forest. Junipers generally, form an open vegetation structure (savanna). Most of the lichen collections were made in areas where Pinus ponderosa, Artemisia spp., 'or both; were also present.

Precipitation: The average annual is low, 200-250(-312) mm; most precipitation falls in the winter, and the hot summer months 'are often completely dry (Franklin & Dyrness, 1973).

3.1.4.2.2. Distribution: The zone occurs at 760-1400 m. The main' tree species, Juniperus occidentalis, occurs in several very limited localities in the-Columbia Plateau of WA -(Lyons, 1971), but is more widely distributed in E. Plateaus and Hills, OR (lichens collected at 720-1290 m, Deschutes Co.; 720 m, Harney co., 1350-1500 m, Klamath Co.; 1400-1740 m, Lake Co.; 900-1050 m, Wasco Co.), and adjacent parts of E. Slope of Cascades, OR (lichens were collected at 1290 m, Klamath Co.).

3.1.4.2.3. Sensitivity: Fire, and perhaps clearing of habitat, or agricultural pollution in a few areas, are the main sources of impact to the lichens.

3.1.4.2.4. Representative species: In some areas Letharia spp. are abundant on junipers; at least at one site (1680 m, Klamath Co.), L. columbiana occurred mostly on higher branches, while L. vulpina occurred mostly on lower branches. Evernia prunastri, a species primarily of moist deciduous woodlands, occurs very rarely on junipers, at 1400-1500 m, Klamath Co. Foliose lichens on junipers include Candelaria concolor and Xanthoria "candelaria", both common especially on trunks, and others found especially on dead twigs, such as species of Melanelia (M. eleoantula, and M. multisoora or M. subolivacea), Phvsconia (P. enteroxantha and P. "isidiigera", or P. perisidiosa), Tuckermannopsis (T. chlorophylla and T. merrillii), and Xanthoria (X. fallax, and X. polycarpa). Candelaria concolor, Melanelia multisoora, Xanthoria "candelaria", and "P. cumberlandia" (= Xanthoparmelia cumberlandia, but that is a primarily saxicolous species) were reported by Rossman (1992) to be common at the Wasco Co. site.

Crustose species on junipers (mostly on dead twigs) in E. Plateaus and Hills, OR (875-900 m, Deschutes Co.; 900-1050 m, Wasco Co.) include Amandinea punctata, Buellia triphraomioides, and Lecanora hypoptoides, Lecanora sp. (L. "varia"), and Lecidella glomerulosa; of these, A. punctata, L. "varia", and L. alomerulosa were described as being common at the Wasco Co. site. One member of the Caliciales, Cyphelium tigillare, was found on dead branches of junipers at one of the Deschutes co. sites. At 1680 m in Klamath Co., Candelariella sp. was found on trunks of junipers.

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3.1.4.3. YELLOW PINE ZONE (Lyons, 1971). PINUS PONDEROSA ZONE (Franklin & Dyrness, 1973).

3.1.4.3.1. GENERAL

3.1.4.3.1.1. Habitat: The following information comes mostly from Franklin & Dyrness (1973): Precipitation: Average annual is 355-760 mm. Summer precipitation is low (41-94 mm according to table; averaging. less than 25 mm according to text; in WA, according to Lyons, 1971, it is 15-50 cm). Much of the summer rain is ineffective, as it usually 'comes during brief, high-intensity convection storms. Much of the winter precipitation falls as snow (at least in WA). Temperature: Diurnal summer temperatures fluctuate widely, with hot days and 'cold nights. Average July temperatures are.ca. 16-20 degrees C, with maxima in the high 20's to low 30's C. In many areas, frost may occur any night of the year. Winter temperatures are generally low (averaging a few degrees below freezing); as a result, snow often accumulates to considerable depths.

3.1.4.3.1.2. Distribution: Pinus Donderosa is a major tree. species in a wide zone along the E. Slope of Cascades (WA, OR) and most of the NE Mountains (WA), usually at moderate elevations (450-1050 m) (Lyons, 1971). The zone occurs at 600-1200 m in WA, 900-1500 m in Northeast OR Mountains, and 1450-2000 m in pumice area of south-central OR Cascades.

3.1.4.3.1.3. Sensitivity: Logging and fire are a major potential problems-for the lichens.

3.1.4.3.1.4. Representative species:

On Pinus ponderosa: As in other dry coniferous forests in the region, the dominant fruticose lichens (on branches or often also on trunks) of yellow pine are Letharia spp. in most parts of the zone. In drier areas, Brvoria spp. (especially B. abbreviata, but often also B. fremontii) are also common. In the moistest areas other species of Brvoria (B. glabra, B. implexa, or B. lanestris), and rarely Alectoria spp. (A. sarmentosa or A. imshauaii) can occur.

A major group of foliose lichens consists of various combinations of species of Hypogymnia (especially H. imshaugii, but sometimes also H. metanhysodes, H. occidentalis, or H. tubulosa), Tuckermannopsis (especially T. merrillii, but in moister areas often also T. platyphylla and T. chlorophylla, and rarely T. pallidula), and (perhaps especially in slightly moister areas) Vulpicida canadensis. In the moistest areas, species of Melanelia (especially M. elegantula, less often the M. subolivacea group), and Platismatia (P. glauca and P. stenophylla) can also be present in these communities. Parmeliopsis ambigua P. hyperopta, are also fairly common, especially on charred or rotting bark or wood.

The few crustose species definitely known to occur on P. ponderosa include Biatora varians and Hypocenomyce scalaris (fairly common on charred or burnt surfaces), and Lecanora spp.

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3.1.4.3.1. PARTICULAR ASSOCIATIONS

3.1.4.3.1.1. Pinus ponderosa/Agropyron spicatum Association.

Habitat: Cooke's site was an open climax forest on a gravelly till plain.

Distribution: Lichens were studied in Columbia Plateau, WA (northern plot, 600 m, Spokane Co.--Cooke, 1955).

Representative species:

On branches in the crown of Pinus ponderosa (Cooke, 1955):

Fruticose lichens were Brvoria fremontii ("ssp. erikssonii"), B. lanestris, and Letharia spp. Foliose lichens formed a parmelioid-cetrarioid community: Hypogymnia enteromorpha group (probably at least including H. imshauaii); Platismatia slauca; T. merrillii; T. platyphylla; Vulpicida canadensis. Most of these species have also been found on Pinus Donderosa or other conifers at many other sites in E. Slope of Cascades, WA that are presumed to be in this association.

3.1.4.3.1.2. Pinus ponderosa/Symphoricarpos albus Association.

3.1.4.3.1.2.1. Habitat: Cooke's plots were in moderately open climax forests; the northern plot was in a shallow valley, the central one was on a N-facing slope.

3.1.4.3.1.2.2. Distribution: Lichens were studied by. Cooke (1955) in Columbia Plateau, WA (northern plot, 600 m, Spokane co., and central plot, 750 m, Whitman Co.).

3.1.4.3.1.2.3. Representative species:

On rotten wood (northern plot): A community consisting of Cladonia coniocraea, C. diuitata, and C. fimbriata occurred;

On smooth trunk bark of Crataegus douslasii (northern plot):' There was a mixed community of appressed-foliose and crustose species: Candelaria concolor; Lepraria sp. (L. incana group); Lecanora spp. (L. "subrugosa", L. "rugosa"), Lecidella elaeochroma, and Phvscia tenella.

On bark of branches and twigs in the crown of Pinus ponderosa:

In the northern plot there were three communities: The first was a fruticose (Brvoria-Letharia) community: Brvoria lanestris; Letharia spp. The second was a foliose (parmelioid-cetrarioid) community: Hypogymnia enteromorpha group (probably at least including H. imshausii), H. tubulosa, Melanelia elesantula, Platismatia slauca, Tuckermannopsis chlorophylla, and Vulpicida canadensis. The third was a crustose/squamulose (Biatora-Hypocenomyce) community: Biatora varians; Hypocenomyce scalaris.

In the central plot, there were again three communities: First was the fruticose (Letharia) community: Letharia columbiana and L. vulpina. There were two foliose communities:'the parmelioid-cetrarioid community: Hypogymnia enteromorpha group (probably at least including H. imshauaii), Melanelia elesantula, Platismatia slauca, P. stenophylla, Tuckermannopsis chlorophylla,

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T. merrillii, T. platyphylla, and Vulpicida canadensis, and in additiqn a Xanthoria community: Xanthoria polycarpa.

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3.1.4.4. MONTANE FOREST ZONES (Lyons, 1971)

3.1.4.4.1. GENERAL

Habitat:, Precipitation: Snowfallsof 30 cm are not uncommon. Temperature: Summer temperatures are moderate, and are alleviated by dense forest shade,. the coolness of mountain creeks, and a considerable drop in temperature each night. Winter temperatures average below freezing.

Distribution: Other coniferous trees that occur in east side montane forests include Abies procera (E. Slope of Cascades of WA and OR) and Taxus brevifolia (Northeast WA Mountains, Northeast O R Mountains).

Role(s): Brvoria spp. (especially species such as B. oreqana and B. fremontii, .which usually contain no lichen substances,) are also used for food and nesting material by northern flying squirrels (Glaucomys sabrinus), as-discussed in detail by (Hayward & Rosentreter, 1994). The range of these squirrels includes NE Mountains, WA, the Blue Mountains in Columbia Plateau, WA, and Northeast Mountains, OR.

Sensitivity: Logging and fire are major threats.

3.1.4.4.2. MONTANE FORESTS, UNSPECIFIED (probably Abies srandis or Pseudotsuqa menziesii zones):

3.1.4.4.2. Representative species: Most of the corticolous/lignicolous macrolichens are listed under particular zones or communities. A few additional species have been, found on unspecified conifers in mixed or unspecified montane forests in the WA/OR part of the Columbia Basin. Several additional macrolichens occur only rarely in this region, in moister areas, but are common elsewhere (including the west side and the north half of Idaho). These include Esslincferiana idahoensis (E. Slope of Cascades, OR: 1050 m, Jefferson Co.), Nephroma resupinatum and Sphaerophorus slobosus . Slope of Cascades, WA, ca. 60-500 m, Klickitat Co.), and Tuckermannoosis orbata (NE Mountains, WA: 930 m, Ferry Co.).

Little information on crustose species'on conifers in east side montane forests (except the Abies concolor Zone) is available. Lecidea Daddensis has been found on Larix occidentalis and Picea enaelmannii (E. Slope of.Cascades, WA: Mt. Adams, 1200-1500 m, Yakima' Co.).. Crustose species.growing-on unspecified conifers in'moist areas in E. Slope of Cascades, WA (mostly at 60-500 m, Klickitat Co.) include Arthonia carneorufa, Buellia lauri-cassiae, B. mvriocarpa, and Placvnthiella uliainosa (all on wood), 'and Bacidia rubella, Diplotommma Denichrum, Japewia tornoensis, Lecidea turaidula, and Pyrrhospora cinnabarina. Ochrolechia subathallina has been found at several localities in E. Slope of Cascades, OR (1300 m, Deschutes Co.; 1050 m, Jefferson Co.; 1800 m, Klamath Co.).

In the'order Caliciales, Cyphelium inquinans has'been found on an unspecified Abies sp. in E. Slope of Cascades, OR (1050 m,

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Jefferson Co.). Calicium abietinum has been found on unspecified wood in mixed forest in E. Slope of Cascades, OR (1050 m, Jefferson Co.), Calicium lenticulare (on wood) and Calicium viride have been found on unspecified'conifers in E. Slope of Cascades, WA (60 m and ca. -500 m, Klickitat Co.), and C. viride is likely to'occur on Picea enselmannii and Thuia plicata (Vitt, et al., 1988j.

3.1.4.4.3. MONTANE FORESTS; UNSPECIFIED (probably with Pinus contorta and/or Picea engelmanii-Abies lasiocarpa) [Roger Lake, Okanogan Co., WA]

Representative species:

On' conifers. (mostly on branches): Dominant-macrolichens were Brvoria spp. (especially B. trichodes ssp. americana, but B. fremontii, B. glabra., and others were also common). Parmeliopsis ambioua and P. hyperopta were also common on both bark and on ecorticate logs in open meadowy areas, where they were fertile (which is very rare in these species). Alectoria sarmentosa, Hypogymnia spp. (H. austerodes, H. imshausii, H. occidentalis, and H. ohvsodes), Letharia vulpina, Parmelia sulcata, and Platismatia glauca occurred only. occasionally. Lecanora circumborealis and Calicium viride (Caliciales) were common crustose species on branches or twigs; Xylographa abietina and X. vitilago were common on wood in the same area as the-Parmeliopsis species.

3.1.4.4.4. MISCELLANEOUS MONTANE FORESTS WITH PARTICULAR CONIFERS

3.1.4.4.4.1. Forests with Larix occidentalis

Distribution: E. Slope of Cascades, WA (lichens collected at 1200-1500 m, Yakima Co.); NE Mountains, WA (lichens colleced at 960 m, Okanogan Co.; 795-960 m, Pend Oreille Co.); E. Slope of Cascades, OR (northern part;- lichens collected at unknown elevation in Deschutes Co., and at 900-910 m in Jefferson Co.); NE Mountains; OR.

Representative species: The macrolichens found on L. occidentalis are similarto the ones common on Pinus Donderosa in fairly dry sites: Brvoria abbreviata, B. fremontii, B. fuscescens; Hypogymnia imshausii, Letharia vulpina, Parmeliopsis ambioua, Tuckermannopsis merrillii, T. platyphylla, Vulpicida canadensis. .A member of the Caliciales, Thelomma ocellatum, has been found on wood of L. occidentalis (fencepost). One other crustose species, Lecidea paddensis, has been found.

3.1.4.4.4.2. Forests with Pinus monticola

Distribution: E. Slope of Cascades, WA (lichens collected at ca. 700 m, Kittitas Co.); NE Mountains WA (1410 m, Pend Oreille Co.); E. Slope of Cascades, OR (lichens collected at 1710 m, Klamath Co.); NE Mountains, OR.

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Representative species: Alectoria sarmentosa', Hypogymnia imshausii, H. sp. (H. enteromorpha group), Letharia vulpina

3.1.4.4.4.3. Forests with Picea engelmanii

Distribution: E. Slope of Cascades, WA (lichens collected at 1200-1500 m, Yakima Co.); NE Mountains, WA; E. Slope of Cascades, OR (northern part); NE Mountains, OR. Representative species: Alectoria sarmentosa, Bryoria abbreviata, B. fremontii, B. fuscescens, B. Pseudofuscescens, Caloplaca sp. (C. holocarpa group), Hypogymnia austerodes, H. metaphysodes, Lecidea paddensis, L. sp., Letharia vulpina, and Platismatia glauca have been found on P. engelmanii. Bryoria fremontii and B. lanestris have been found on Picea sp. (identified as "P. sitchensis", which is probably erroneous since the locality is near the west edge of NE Mountains of WA).

3.1.4.4.4.4. Forests with Thuia plicata

Distribution: E. Slope of Cascades, WA (lichens collected at ca. 700 m, Kittitas Co.; ca. 1000 m, Yakima Co.); Northeast Mountains, WA (lichens collected at 1040 m, Pend Oreille Co.); E. Slope of Cascades, OR (northern part).

Representative species: Cyphelium inquinans was found on T. plicata at the Yakima Co. site, and another member of the Caliciales, Calicium viride, is expected to occur on T. plicata. Xanthoria "candelaria" was found on bark of red cedar at the Kittitas Co. site. Cladonia spp. (not positively identified) were found on rotten logs of T. plicata at the Pend Oreille Co. site.

3.1.4.4.4.4. Forests with Abies amabilis:

Distribution: Lichens were collected on A. amabilis in E. Slope of Cascades, OR (1050 m, Jefferson Co.)

Representative species: Tuckermannopsis platyphylla was found on this tree species.

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3.1.4.4.5. **PINUS CONTORTA ZONE** (Franklin & Dyrness, 1973)

3.1.4.4.5.1. Habitat: Low summer rainfall (56-66 mm); wide diurnal temperature fluctuations, especially during the summer (average in July ca. -15 degrees C, maxima in high 20's C); average annual precipitation is 350-700 mm; average winter temperatures below freezing (Franklin & Dyrness, 1973).

3.1.4.4.5.2. Distribution: The zone is limited to the pumice plateau of the southern parts of E. Slope of Cascades, OR (collections at 1050 m, Deschutes Co.;. 1500 m, Klamath Co;) and adjacent E. Plateaus and Hills (1745-2000 m, Lake Co.); it occurs at 1200-1525 m (Franklin & Dyrness, 1973). The tree also occurs in E. Slope of Cascades of WA (collections at 1100 m, Yakima Co.), west edge of Columbia Plateau, WA (collections at 300 m, Klickitat Co.); NE Mountains, WA; NE Mountains, OR.

3.1.4.4.5.3. Representative species: Few collections have been made in the area clearly dominated by P. contorta: All of the macrolichen species that have been collected on pines recorded as P. contorta, except perhaps Bryoria fuscescens and B. trichodes ssp. americana (both of which were found in riparian areas), and B. oreaana and B. pseudofuscescens (both found in a mixed conifer subalpine forest) are also common on P. ponderosa in drier areas. The communities appear to be similar, but those on P. contorta, especially the foliose groups, are less diverse (Hypogymnia imshaugii, Tuckermannopsis merrillii, Vulpicida canadensis, or Parmeliopsis spp., or rarely Melanelia subolivacea, in various combinations). As with P. ponderosa, few crustose species occur on P. contorta; Hypocenomyce scalaris has been found at one site (2000 m, Lake Co.), and Calicium viride is expected on P. contorta (Vitt, et al., 1988).

a dry forest at high elevations for lichens?

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3.1.4.4.6. PSEUDOTSUGA MENZIESII SERIES: PSEUDOTSUGA MENZIESII ZONE (Franklin & Dyrness, 1973)

3.1.4.4.6.1. GENERAL

3.1.4.4.6.1.1. Habitat: Pseudotsuqa menziesii occurs in a wide variety of sites, including some very dry ones, but growth is best on moist, rich soils. Temperatures.average cooler and annual precipitation higher than in Pinus ponderosa Zone (Franklin & Dyrness, 1973).

3.1.4.4.6.1.2. Distribution: Pseudotsuqa menziesii is a major tree speciesin the E. Slope of.Cascades (WA, OR), NE Mountains (WA), from low to moderate elevations (up to 1350 m in WA--Lyons, 1971), and in NE Mountains. (OR). Calocedrus decurrens' is another tree that is likely to occur with P. mehziesii.

3.1.4.4.6.1.3. Role(i): In contrast to the situation on the west side,' nitrogen fixing lichens appear to be very rare on bark and wood in Pseudotsuqa forests between the Cascades and the Rockies, except perhaps in moist areas 'in the Columbia Gorge. However, one nitrogen fixer (Neohroma parile) has been found on exposed roots of Pseudotsuqa in a mixed conifer forest in E. Slope of Cascades, OR (1050 m, Jefferson Co.).

3.1.4.4.6.1.4. Representative species: On standing trees of Pseudotsuqa, the dominant fruticose lichens are Brvoria spp. (B. abbreviata, B. caoillaris, B. fremontii, B. fuscescens, B. implexa, B. lanestris, B. oreqana, B. oseudofuscescens) and Letharia spp., although Alectoria spp. (A. imshauqii and A. sarmentosa) may occur occasionally. Several of'these (e.g., Brvoria fremontii and B. pseudofuscescens) also occur on Picea enqelmannii in mixed forests in NE Mountains of OR.

-The main foliose lichens are Hypoqymnia imshauqii, Parmelioosis 'spp., Platismatia spp. (P. qlauca, and in the moistest forests, also P. stenophylla), Tuckermannopsis spp. (T. chlorophylla and T. platyphylla, T. merrillii, and probably T. pallidula), and Vulpicida canadensis. Other foliose species found on Pseudotsuqa, include Parmelia saxatilis (on a 1.3 m dbh tree) and Xanthoria "candelaria" in NE Mountains, OR (1510-1800 m, Walllowa Co.).

The few crustose species 'growing on Pseudotsuqa in the region that have been identified include Caloplaca sp. (C. holocarpa group), Lepraria / Lecidea (overprinted) ...ospoda (usually low on trunks)-; L. sp., Lecidella qlomerulosa, and Protoparmelia ochrococca (on trunks), and probably Lecanora circumborealis (on branches or twigs). In moist areas at the east edge of the Columbia Gorge of WA, Arthonia carneorufa, Diplotomma oenichrum, Lopadium disciforme, Melaspilea proximella (on root), and Pvrrhospora cinnabarina have been found on Pseudotsuqa. Crustose members of the Caliciales found on bark or wood in known or presumed Pseudotsuqa forests in the region include Calicium spp. and Chaenotheca furfuracea. On rotting wood (including that of

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hardwoods such as Acer spp.), species of Cladonia (including C. cariosa and C. chloroohaea) are sometimes present.

3.1.4.4.6.1. PARTICULAR ASSOCIATIONS: Pseudotsusa menziesii/Physocarpus malvaceus Association

3.1.4.4.6.1.1. -Habitat: Cooke's plot (Spokane-Co.) was in a dense, near-climax forest, on a level bench at the bottom of an E-facing slope). The other sites are only presumed to be in this association; .

3.1.4.4.6.1.2. Distribution: Lichens were collected-in NE Mountains, WA (Columbia Plateau, WA (1800 m, Pend Oreille Co.; northern plot, 600 m, Spokane Co.--Cooke, 1955; locality not recorded, 'Colville National Forest, 853 m) and NE Mountains, OR (914 m, Union Co.).

3.1.4.4.6.1. Representative 'species:

On rotten wood of Acer sp.: Cladonia community, (northern plot of Cooke, 1955): Cladonia cariosa; C. chloroohaea ("f. rapophora")

On Pseudotsuga menziesii v. glauca: Cooke (1955) reported two communities of macrolichens on twigs and branches in the crown of the trees.' The dominant fruticose lichens (Bryoria-Letharia community) were Bryoria "oregana" (probably B. abbreviata); B. lanestris; Letharia dolumbiana; L. vulpina. The major foliose lichens. (parmelioid-cetrarioid community) -were Hypogymnia enteromorpha group (probably at least including H. imshaugii); H. ohysodes; Platismatia glauca; P. stenophylla Tuckermannopsis chloroohylla; T. platyphylla; Vulpicida canadensis. At the 1800 m site in Pend Oreille Co., fruticose lichens found on Pseudotsuga included Alectoria imshaugii '(on the bole and limbs).

On bark or wood (unspecified): At the Colville N.F. site (WA), L. vulpina was apparently the only fruticose lichen found, and H. imshaugii, P. glauca and T. platyphylla were the foliose lichens. At the OR site, fruticose lichens included Bryoria capillaris and B. fuscescens, and two 'crustose members of the Caliciales (Calicium sp. and Chaenotheca furfuracea) were found.

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3.1.4.4.7. TSUGA HETEROPHYLLA SERIES:

3.1.4.4.7.1. ARIES GRANDIS ZONE (Franklin & Dyrness, 1973).

3.1.4.4.7.1.1. Habitat: Most moderate environmental regime of any of'the east-side forest zones (except where Tsuga or Thuia are present). Neither moisture nor temperature conditions are extreme. Precipitation is generally higher (average annual of 632-1157 mm; 43-115 mm in summer) and temperatures lower (mostly below freezing) than in lower forest zones. Less snow (average annual snowfall 231-450 cm) than subalpine zones.

3.1.4.4.7.1.2. Distribution: The zone is the most extensive midslope forest zone in the OR and southern WA Cascades (typically 1100-1500 m) and Northeast OR Mountains (1500-2000 m) (Franklin & Dyrness, 1973). The tree occurs in E. Slope of Cascades (WA, northern OR), Northeast WA Mountains, Northeast OR Mountains. (However, Lyon's map shows A. arandis mostly on the west side, with scattered populations in northeastern fourth of Washington State).

3.1.4.4.7.1.3. Representative species: Mycocalicium subtile occurred on the trunk of A. grandis, and several other Caliciales occurred on various conifer or hardwood trees in a mixed forest in E. Slope of Cascades, OR (1050-m, Jefferson Co.); another Caliciales species, Stenocybe major, was found on A. grandis at two localities in E. Slope of Cascades, WA (ca. 500 m, Klickitat Co.). Other crustose species found on A. randis at the Klickitat Co. sites include "Arthopyrenia punctiformis", Bacidia rubella, and Pertusaria sp.

3.1.4.5.7.2. Particular Associations: Abies grandis/Pachistima myrsinites Association

Habitat: The site studied by Cooke (1955--northern plot, Stevens Co.) was in a dense, near-climax forest on a northeast-facing slope).

Distribution: Lichens were studied in NE Mountains, WA (800 m,'Pend Oreille Co.; 600 m, Stevens Co.)

Representative species:

On rotten wood (Stevens Co. site): A community with Cladonia cenotea and C. coniocraea was found.

On crown branches of "all conifers" (Abies grandis, Larix occidentalis, Pinus ponderosa, P. contorta v. latifolia, and Pseudotsuga menziesii v. glauca) at Stevens Co. site: Dominant fruticose lichens were Alectoria sarmentosa, Bryoria implexa, B. lanestris, B. sp. ("Alectoria iubata v. prolixa"), and Letharia spp. Foliose species included Hypogymnia spp. ("Parmelia enteromorpha"; H. phvsodes), Melanelia exasperatula, Pannelia sulcata, Platismatia glauca, P. stenophylla, Tuckermannoosis chloroohylla, T. platyphylla, and Vulpicida candensis.

On lower dead limbs of Pinus contorta (Pend Oreille Co. site): Platismatia glauca was found.

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On bark of (living) Larix occidentalis (Pend Oreille co. site): Letharia vulpina was found.

3.1.4.4.7.2. ABIES CONCOLOR ZONE

Habitat:- Conditions are generally similar to those in the A. arandis Zone.'

Distribution: The zone occurs in south-central OR, at 1650-2000 m (Franklin & Dyrness, 1973).

3.1.4.4.7.2.1. Unspecified conifer forest (probably Abies concolor), with Populus trichocarpa.

Habitat::-The site was a mature, probably old-growth forest, with very. large trees.

Distribution: Lichens were collected in'one site in the southern part of E. Slope of Cascades, OR (1620 m, Klamath Co.).

Representative species: Fruticose lichens on'conifers. included Alectoria sarmentosa (probably a dominant), A. imshaugii, Brvoria spp. (including B. capillaris .and others), and both Letharia spp. Foliose lichens included Hypogymnia imshauqii, H. occidentalis, Melanelia elesantula, Parmeliopsis ambigua, P. hyperopta, Platismatia qlauca, Tuckermannoosis chloroohvlla, and.-T. platyphylla. Crustose lichens on conifers included Hypocenomyce scalaris and Lecanora circumborealis, plus two members-of the Caliciales: Chaenotheca furfuracea (on roots) and Cyphelium sp.

3.1.4.4.7.2.2. Abies concolor forests (with Pinus ponderosa and sometimes P. contorta in drier areas, and with Alnus ssp. in riparian areas)

3.1.4.4.7.2.2.1. Habitat: Most 'of the sites in this province were in or near'wild and scenic rivers and the Gearhart Widerness,, and were closed canopy, 'mature (probably old-growth)' forests, with very large trees, and lichen communities on conifers were especially rich and luxuriant at such sites.

3.1.4.4.7.2.2.2. Distribution: Lichens were collected at numerous sites -in the. southwest part of E. Plateaus and Hills, OR (1680-2100 m, Klamath Co.; 1680-2000 m, Lake Co.).'

3.1.4.4.7.2.2.3. Representative species:

On Abies concolor: At most of the sites; fruticose lichens included Brvoria spp. (especially B. abbreviata, B. fremontii, and sometimes B. fuscescens) and-Letharia columbiana and L. vulpina. 'Evernia prunastri also occurred rarely at two sites (one riparian, one not). Foliose lichens included Hypogymia imshausii, Melanelia subolivacea, Tuckermannoosis chloroohvlla, T. merrillii, T. platyphylla. Physcia dimidiata, Xanthoria fallax, and the crustose species Candelariella xanthostigma were found only at one, non-riparian, site. Among crustose lichens, Lecanora circumborealis and L. sp. were frequent on twigs, while Lecidea sp. and Ochrolechia androgyna were sometimes common-on trunks. Hvoocenomvce scalariswere found on burnt logs or stumps at a few sites, together with Lepraria sp. and Trapeliopsis granulosa at one non-riparian site.

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In or near.riparian areas, several additional macrolichens lichens were found: The fruticose species Alectoria'imshauaii and A. lata were found at several sites, and Ramalina farinacea' (a species found primarily. in moist deciduous woodlands), Usnea sp., and Brvoria glabra were found at one of the riparian sites (Buckboard Creek, 1600 m, Lake Co.). At the latter site, several additional foliose lichens (Ahtiana sphaerosoorella, Esslingeriana idahoensis, Melanelia exasperatula, Parmelia sulcata, and Xanthoripolycarpa) also occurred.. Cladonia spp., and Parmelioosis ambiaua and P. hyperopta occurred on trees or burnt stumps, only at more or less riparian sites. Xvloaraph a abietina and X. hians (found on rotting wood at Blue Lake Trail, 1900-2100 m, Lake Co.) and two crustose members.of the Caliciales (Mycocalicium sp. at Buckboard Creek, and Calicium viride at S. Fork Sprague River, Gearhart Wilderness, 1800-1850 m, Lake Co.) were also found only in mature forests in or near riparian areas.

In unspecified montane forests in this providence, additional lichens found on unspecified conifers '(probably mostly Abies concolor, since the labels usually specified when species were found on pines). included Alectoria sarmentosa, Brvoria caoillaris, B. pseudofuscescens, and B. simplicior, Melanelia elesantula; Physconia sp., and Tuckermannoosis orbata, and (on wood of dead branches) the crustose species Lecanora saliana. Most of these additional lichens were found in mature forests (some of which were in riparian areas).

3.1.4.4.7.3. TSUGA HETEROPHYLLA ZONE (Franklin & Dyrness, 1973)

Habitat: Precipitation: Average annual is 560-1700 mm. Temperature: Mean annual temperatures 2.5-7.5° C (in British Columbia).

Distribution: Tsuga heterophylla occurs in'limited areas on moist slopes in the northern part of E. Slope of Cascades and NE Mountains of WA, at moderate elevations (600-1350 m in WA) (Lyons, 1971) The zone occurs at 800-1200 m in Eastern WA Cascades,. and becomes rarer southward into northern OR (Franklin & Dyrness, 1973). Absent from eastern Oregon. Thuia plicata is another tree that is likely to occur with T. heteroohvlla.

3.1.4.4.7.3.1. Particular Associations: Tsuaa heterophylla/Pachistima myrsinites Association,

3.1.4.4.7.3.1.1. Distribution: Lichens were collected in NE Mountains,. WA (780-1410 m, Pend Oreille Co.).

3.1.4.4.7.3.1.2. Role(s): Alectoria sarmentosa and Brvoria spp. are important winter foods for caribou (Ransifer tarandus) (Sharnoff, 1993, and many other references), whose range extends into the Columbia Basin only in NE Mountains and adjacent areas in the northern Rocky Mountains. At least one nitrogen fixer (Lobaria nulmonaria) has been found in this association.

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3.1.4.4.7.3.1.3. Sensitivity:. Air pollution (e.g., from the only nearby large city, Spokane) and logging are potentially major threats to the lichens in this:association, especially at higher or moister sites..

3.1.4.4.7.3.1.4. Representative species:

On Tsusa heterophylla (1410 m): The dominant lichen on -boles and limbs of Tsuga was.Alectoria sarmentosa; other macrolichens found (mostly on dead limbs) were Hypogymnia sp. (H. enteromorpha group), Lobaria pulmonaria, and Platismatia glauca.

"On bark of old Pinus monticola (1410 m): Alectoria sarmentosa again was.dominant on boles and lower dead. limbs; Hypogymnia sp. (H. enteromorpha group) was also collected.

'On rotting logs (unspecified logs, 1410 m; Thuja plicata logs, 1040 m): Several' Cladonia ssp. (needing positive identifications to species) were found.

On-lower dead limbs of 20-25 cm dbh Larix occidentalis and Pinus contorta in a 35 year old stand (960 m): Brvoria fuscescens, Hypogymnia imshaugii, Tuckermannoosis platyphylla, and Vulpicida canadensis were collected.

On lower' dead limbs of Pseudotsusa menziesii v. slauca (780 m): Hypogymnia ohvsodes was found.

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3.1.5. SUBALPINE FOREST-TUNDRA (Vitt, et al., 1988). SUBALPINE ZONE (Lyons, 1971) FORESTS, AND TIMBERLINE VEGETATION (Franklin & Dyrness, 1973)

3.i.s.i. 'GENERAL'

Habitat: The following information comes, from Lyons (1971). Precipitation: Heavy spring rains with swirling mists are common. Snow usually arrives by mid-November, and can be as much as 60 cm in WA. Temperature: Summers have sunny days and chilly nights. Winters are long and severe. In the.driest areas, Pseudotsuaa menziesii or Pinus contorta can also occur in the subalpine zone.

Distribution:'. Subalpine areas occur mainly in E. Slope of Cascades, WA, E. Slope of Cascades, OR, and N.E. Mountains, OR.

Representative species: Ahtiana sphaerosoorella (on. conifers).and Tuckermannopsis subalpina (on shrubs or sometimes bases of.krumholz trees) are among the few corticolous or lignicolous species that are probably restricted to this zone. Most of the other lichens are common (often moreso) in lower elevation zones.

3.1.5.2. UNSPECIFIED SUBALPINE COMMUNITIES

3.1.5.2.1. E. Slope of cascades, WA

3.1.5.2.1.1. Unspecified Krumholz areas on the crest or east slope of the North Cascades:

Distribution: Lichens were collected at several sites in E. Slope of Cascades, WA [??--need to check Douglas article] (Joe Mills Mountain [presumably well below the summit, which is at 2354 m] and Snowshoe Mountain [summit is at 2200 m], Okanogan co. --Douglas, 1974), and two along the crest of the Cascades (trails to Harts Pass/Grasshopper Pass and Slate Peak, Okanogan Co./Whatcom Co.--Glew, unpublished data).

Representative species: On Snowshoe Mountain, Brvoria fremontii, B. "oregana" (possibly B. abbreviata), Lecanora fuscescens, and Letharia vulpina occurred on conifer trees, and Icmadoohila ericetorum occurred probably on rotten wood. Letharia vuloina was also found on the trail to Joe Mills Mountain. Along the crest, on krumholz trees, Tuckermannopsis merrillii was found at both sites; Brvoria trichodes and Tuckermannoosis subalpina were found on the trail to Slate Peak, and Ahtiana sphaerosporella, Brvoria abbreviata, B. fremontii, and Letharia vulpina were found at the other site. On the trail to Slate Peak, Trapeliopsis sranulosa was found on rotten wood, and Letharia vulpina, Parmeliopsis ambigua and P. hyperopta were found on unspecified bark or wood.

3.1.5.2.1.2. Unspecified or mixed-zone, presumed subalpine forests or krumholz areas near the east slope of Mt. Adams:

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Distribution: Lichens were collected in the southern part of E. Slope of Cascades, WA (Mt. Adams, Yakima Co.), on unspecified conifers (Bird Creek area, 1890-2079 m). The, locations of one site near Mt. Adams. ("Wodan's Vale", along Hell-Roaring Creek) is uncertain; 'although the creek runs from the base of the glacier at ca. 1600 m, down to ca. 900 m, the locality is described as being at the foot of Mazama Glacier, and the although both specimens of Tuckermannopsis subalpina (in my opinion, probably a very good indicator of subalpine forestsj say "Wodan's Vale", one of these labels also says "Bench Lake", which is at ca. 1500 m.

Representative species:

On unspecified conifers: Letharia vulpina was found at several' sites; including what-isprobably a krumhdlz area (Little Mt. Adams,.2079 m); Tuckermannoosis merrillii 'was found at two probably subalpine sites (1890-1920 m); Bryoria glabra and Letharia columbiana were found in one probably subalpine forest-area ("Wodan's Vale"), with L. vulpina.

On shrubs (probably Vaccinium spp.): Tuckermannoosis subalpina was found.

3.1.5.2.2. E. Slope of Cascades, OR

3.1.5.2.2.1. Unspecified subalpine area

Distribution: Lichens were found 1 mi E of McKenzie Pass, at 2400 m, Deschutes Co.

Representative species: Collema sp. and Trapeliopsis aranulosa were found on old wood; Esslingeriana idahoensis, Letharia vulpina, Phvsconia detersa and Xanthoria fallax were found on unspecified trees or shrubs.

3.1.5.2.3. NE Mountains,-OR

3.1.5.2.3.1. Unspecified presumed subalpine area

Distribution: Lichens were 'collected at Frazer Lake, 2130 m, Wallowa Co . .

Representative species: Bryoria fuscescens and B. . pseudofuscescens were found.

3.1.5.3. SUBALPINE ARE& WITH PARTICULAR CONIFER SPECIES:

3.1.5.3.1. Forests with Picea enqelmannii

Habitat: When this tree occurs in-the subalpine zone;, it is in drier areas than Abies lasiocarpa and Tsuaa mertensiana. Lichens were found on P. enaelmannii in a forest dominated by Abies lasiocarpa, and are discussed in more detail under the Abies lasicocarpa/Menziesia ferrusinea Association. Also see list of species on Picea enselmannii in montane forests, above.

Distribution: Lichens were collected on this tree in a subalpine area in NE Mountains,'WA (1620-1950 m, Pend Oreille Co.).

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Representative species: Alectoria sarmentosa, Bryoria fuscescens, Letharia vulpina, and Platismatia glauca were found.

3.1.5.3.2. "Forests or **krumholz** areas with Larix lyalii
Habitat:- In drier areas than Abies lasiocaroa and Tsuga mertensiana;'only at or near timberline.
Distribution; Larix lyalii occurs in E. Slope of Cascades, WA (eastern half of North Cascades), NE Mountains, WA (Okanogan Mountains), E. Slope of Cascades OR (northernmost part only).
Representative species: At least one lichen, Letharia columbiana; is expected to occur on Larix lyalii (Vitt, et al., 1988).

3.1.5.3.3. Forests or krumholz areas with **Pinus albicaulis**
Distribution: Pinus albicaulis 'occurs at high elevations in E. Slope of Cascades, WA (lichens collected in Yakima Co.); Northeast WA Mountains; E. Slope of Cascades, OR (lichens collected at 2125 m, Deschutes Co.); Northeast OR Mountains (Wallowa Mountains; lichens collected in Baker Co.).
Representative species: Ahtiana sphaerosoorella occurs on bark of Pinus albicaulis, and is strongly associated with this tree species (Goward, 1985; Vitt, et al., 1988); it has been found on krumholz trees at a site in Yakima Co. Another lichen found on P. albicaulis at a different site in Yakima Co. is Bigtarra i a n s . In OR, Hypogymia imshauaii, Parmeliopsis ambigua, and P. hyperopta were found at the Deschutes Co. site; Letharia columbiana and L. vulpina were found at the Baker Co. site.

3.1.5.4. MIXED SUBALPINE FORESTS

Tsuga mertensiana-Pinus contorta-P. monticola-Abies lasiocarpa Forest in E. Plateaus and Hills, OR
Distribution: Lichens were collected at Paulina Lake.Trail, 1605 m, Deschutes Co.
Representative species: Bryoria oregana and B. fuscescens were found on Pinus monticola; Alectoria sarmentosa was found on unspecified conifers.,

3.1.5.5. FOREST Z O N E S :

3.1.5.5.i. ABIES LASIOCARPA SERIES .

3.1.5.5.1.1. ABIES LASIOCARPA ZONE (Franklin & Dyrness, 1973)
Habitat: Coolest and moistest forest zone. Cool summers (mean July temperatures 13-16 degrees C; warmer than T. mertensiana Zone), cold winters (cooler than T. mertensiana Zone), developoment of deep winter snowpacks (but less than T. mertensiana Zone); less precipitation than T. mertensiana Zone

(Franklin & Dyrness, 1973). Abies lasiocarna grows best on moist, porous soils.

Distribution: The-zone usually starts at 1500 m in the Cascades and 1300-1700 m elsewhere (Franklin & Dyrness, 1973). Picea englemannii is a major tree-species in some areas, e.g., WA Cascades and Northeast WA Mountains.

3.1.S.S.l.l.i. Unspecified forests with Abies lasiocarpa:

Distribution: Abies lasiocaroa occurs in E. Slope of Cascades, WA (especially in the northern part, but lichens have been collected on A. lasiocaroa as far south as Mt. Adams in Yakima Co.), in limited areas in NE Mountains, WA, and in the Blue Mountains (NE Mountains of OR and southeasternmost part of Columbia Plateau, WA), and it usually occurs at more or less high elevations (1350-2100 m in WA) (Lyons; 1971).

Representative species: Alectoria sarmentosa and at least two crustose lichens or allied fungi ("Arthopyrenia punctiformis" and "Microthelia micula") have been found on Abies lasiocaroa in Yakima Co. Other species that may be expected to occur on this tree species include Calicium viride and Pvrrhosoora cinnabarina (Vitt, et al., 1988), and Ochrolechia qowardii (Brodo, 1991.)

3.1.5.5.1.1.2. Particular associations: Abies lasiocarpa/Menziesia ferruginea Association

Distribution: Lichens were collected in NE Mountains, WA (1650-1890 m, Pend Oreille Co.).

Role(s): The dominant fruticose lichens in this Association are important sources of food or habitat for animals (see earlier comments).

Representative species: Alectoria sarmentosa was abundant (and in one case apparently the only macrolichen) on both Abies lasiocaroa and Picea enselmanii, at least in two areas (1650 m and 1800+ m), and was also apparently the only macrolichen on both tree species in two other areas; usually it was on lower dead branches, but at the 1620 m site it was also on boles of these trees; while Brvoria fuscescens was abundant (and apparently the only macrolichen) on both kinds of trees at one site (1950 m) and at least on A. lasiocaroa at another (1900 m--on bole and branches of a downed tree, ca. 12-21 m up the tree). At one site (1800 m), Brvoria slabra was abundant (and apparently the only macrolichen) on A. lasiocaroa. Other species found on A. lasiocaroa at some sites include Letharia vulpina (on limbs and bole of A. lasiocarpa at 1800+ m, and lower dead branches of A. lasiocaroa and P. engelmanii at 1860+ m), and at one site (1890 m) Hypogymnia sp. (H. enteromornha group; on a-downed A. lasiocaroa tree) and Platismatia alauca (on the downed fir, and on lower branches of both tree species).

3.1.5.5.2, TSUGA MERTENSIANA ZONE (Franklin & Dyrness, 1973)

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Habitat: The dominant tree grows best in moist, well-drained soils. Other trees include Pinus monticola and ~~Abies lasiocarpa~~.

Distribution: E. Slope of Cascades (WA, OR) and one area in NE Mountains (OR)'; 930-2100 m. Lichens were collected on T. mertensiana in E. Slope of Cascades, WA (Mt. Adams, elevation of site unknown, Yakima Co.) and E. Slope of Cascades, OR (Mt. Hood, 1800 m, Hood River Co.).

3.1.5.5.2.1. **Unspecified** or mixed forests or krumholz areas with Tsuga mertensiana:

Representative species: A crustose species, ~~Lecidea~~ tursidula, was found on T. mertensiana at the Yakima Co. site, and Hypogymnia imshauaii was,found on krumholz trees of that species at the Hood River Co. site.'

Ecogroup corticolous

3.1.6 ALPINE TUNDRA (Vitt, et al., 1988). ALPINE ZONE (Lyons, 1971; Franklin & Dyrness, 1973)

Habitat: Shrubs are the only substrates for corticolous or lignicolous lichens are available in this zone.

Distribution: Alpine areas occur mainly in the northern part of E. Slope of Cascades, WA and on a few high peaks southwards into E. Slope of Cascades,, OR, plus on Steens Mountain in E. Plateaus & Hills, OR.

Representative species: Little or no information on corticolous/lignicolous lichens in the alpine zone of the WA/OR part of the Columbia Basin is available. A few lichens (e.g., species of Lecanora or Lecidea s. lato, and occasionally others that are more common in the subalpine zone) probably occur on shrubs.

Table 1/ Distribution of some major corticolous/lignicolous lichen species by major gymnosperm species on which they occur (underlined ones = major zones).

LICHEN SPECIES	GYMNOSPERM SPECIES											
	JUOC	PIPO	LAOX	PICO	PSME	ABCO	ABGR	PIMO	TSHE	ABLA	PIEN	TSME
Alectoria imshausii		+	+		++	++	++?		+			
A. sarmentosa		+	+	+	+	++	++	+	++	+++	+++	
Bryoria abbreviata		+++	++	++	+	+	+		+			
B. fremontii		+	+	+	++	++	++				++	
B. fuscescens		+	+	++	++				+			
B. pseudo-fuscescens			+		++	++	++?				+	
Hypogymnia imshausii	+	++	++	++	++	++	++	+				+
Letharia columbiana	++	+++	+++	+++	++	+	+	+?				
L. vulpina	++	+++	+++	+++	++	+	+	+		+?	+	+
Melanelia elesantula	++	++			++							
Parmeliopsis ambisua		+	+	+	++	++	++	+		+		
P. hyperopta		+		+	++	++	++			+		
Platismatia glauca		+	+	+	++	++	++		++	+	+	
Tuckerman-opsis chlorophylla	+	+			++	++	++?					
T. merrillii	+-|-	+ + +	+ +	+++	++	+	+?					
T. platyphylla		+	+	+	++	++	+?					
Vuloicida canadensis		++	++	++	++							

Table . Distribution of major corticolous/lignicolous lichen species by hardwood species (underlined ones = major zones; sp. = several species).

LICHEN SPECIES	HARDWOOD SPECIES											
	ACsp	ALsp	POsp	QUGA	ARTR	ARRI	PUTR	CELE	CRDO	ROsp	SYsp	AMsp
Brvoria fremontii							+	+				
Candelaria concolor			+		+++		+++		+	+	+	+
Hypogymnia imshausii								+	+			
Letharia columbiana		+						+				
L. vulpina		+			+	+		+				
Melanelia' elesantula	+		+	+	+	+				+		
M. multispora		+				+			+	+	+	
M. subolivacea					+			+				
Parmelia sulcata	+		+					+	+			+
Phvscia adscendens	+			+						+		
Phvsconia spp.				+	+		+			+		
Xanthoria "candelaria"		+		+	+	+						+
X . fallax			+		++	+	++					
X. polycarpa		+	++		+	+			+	+		+

life zones

Table 7. Distribution of major corticolous/lignicolous lichen species by life zone.

LICHEN SPECIES	LIFE ZONE					
	Sage-brush	Bunch-Grass	Yellow Pine	Montane Forest	Sub alpine	Alpine
Alectoria sarmentosa				+	+	
Brvoria abbreviata			+	+	+	
Brvoria fremontii			+	+	+	
Candelaria concolor	+	+	+			
Hypogymnia imshausii			+	+	+	
Letharia columbiana	+		+	+	+	
Letharia vulpina	+		+	+	+	
Melanelia elesantula	+	+	+	+		
Parmeliopsis ambisua			+	+	+	
Parmeliopsis hyperopta			+	+	+	
Platismatia glauca			+	+	+	
Tuckermannopsis merrillii		+	+	+	+	
Tuckermannopsis platyphylla			+	+	+	
Vuloicida canadensis			+	+	+	
Xanthoria						

life zones				
candelaria	+	+	+	+
Xanthoria polycarpa	+	+	+	

Veg Zones

Table 1. Elevation and climate of major vegetation zones of Franklin & Dyrness (1973).

HABITAT FEATURES	VEGETATION ZONE											
	Shrub-Steppes					Forests						
	ARTR	AGSP/FEID		ARRI	JUOC	PIPO	PICO	PSME	ABGR/ABCO		TSHE	ABLA
Elevation (m)	30 to 1000	30 to 120	450 to 775	450 to 1400	760 to 1400	600 to 2000	1200 to 1525	100 to 1350	1100 to 2000	1650 to 2000	800 to 1200	1300 to 1700
Av. Annual Precip. (mm)	190-389	200-250	360-600	280	200-312	355-760	350-700		632-1157		560-1700	
Av. Summer Precip. (mm)	24-43	23-44	75			41-94	56-66		43-115			
Av. Annual Temp. (°C)	8-12	12	9				6-8	5-6		6-8		3-8
Av. Summer Temp.	19-25	23-24	20			16-20	14-16		18			13-16
Av. Max. Summer Temp.	28-35	31-33	28		26-32	26-32	27-31	27-30		25-29		
Av. Winter Temp.	0 to -5	0	-2			-3 to -5	-3 to -4		-1 to -5			
Av. Min. Winter Temp.	-3 to -10	-3 to -4	-5			-8 to -11	-11		-5 to -10			
Av. Annual Snow (cm)	34-136	34	102	15	15	141-252	417		231-450			500

Veg Zones

Table 2. Distribution of major corticolous/lignicolous lichen species by vegetation zones of Franklin-& Dyrness (1973).

LICHEN SPECIES	VEGETATION ZONE 'Shrub-Steppes'			Forests						
	ARTR	AGSP/FEID	JUOC	PIPO	PICO	PSME	ABGR/ABCO	TSHE	ABLA	Alpine
Alectoria sarmentosa				+	+	+	+	+	+	
Brvoria abbreviata				+		+	+		+	
Brvoria fremontii				+	+	+	+			
Candelaria concolor	+	+		+						
Hypogymnia imshausii				+	+	+	+	+	+	
Letharia columbiana			+	+	+	+	+		+	
Letharia vulpina	(+)		+	+	+	+	+		+	
Melanelia elesantula	+	+	+	+		+				
Parmeliopsis ambisua				+		+	+		+	
Parmelioosis hyperopta				+		+	+			
Platismatia s l a u c a				+	+	+	+	+	+	
Tuckermannopsis merrillii				+	+	+	+		+	
Tuckermannopsis platyphylla				+	+	+	+	+	+	
Vulpicida canadensis				+	+	+		+		
Xanthoria										

Veg Zones										
candelaria	+		+		+	+			+	
Xanthoria polycarpa	+		+		+.	+		+		+

Ecogroup terricolous

3.2. TERRICOLOUS/MUSCICOLOUS

3.2.1. GENERAL

3.2.1.1. Habitat:

Except in the alpine zone, the diversity of lichens growing directly on soil appears to be rather low in most areas, although the cover can be fairly high in some sites. A somewhat more diverse group of lichens occurs on mosses (often over rock), and although individual moss clumps are small, they can can be very numerous, producing high total cover by lichens over a large area.

3.2.1.2. Role(s):

3.2.1.2.1. Modification of soil qualities, and Inhibition of grass germination: Although these functions may be important in a wide range of zones, they are particularly applicable (and most often studied) in steppe and shrub-steppe communities, and are discussed in some detail in the section on those.

3.2.1.2.2. Nitrogen fixation: This is also discussed under steppe and shrub-steppe communities, but it is potentially a major role of lichens in all zones. Species of Leotochidium, Leptogium, and Peltigera are probably the major nitrogen fixers on soil or moss in most communities, although other genera may be important in a few areas.

3.2.1.2.3. Inhibition of mycorrhizal fungi: Several species have been found to show this effect (Brown & Mikula, 1974); although none of the species tested in that study are common in the Columbia Basin (except Cetraria islandica in alpine areas), it is probable that Cladonia spp. or others that are abundant in the region might have similar effects.

3.2.1.3. Sensitivity:

In general, a well developed crust or vegetation of ground-inhabiting lichens is probably a useful indicator of "healthy" ecosystems.

3.2.1.3.1. Tramoling: This is discussed under grassland-Savannah, but is potentially a major threat wherever livestock, humans, or vehicles are abudant.

3.2.1.3.2. Pollution: Air pollution may be a potential threat to some terricolous or muscicolous lichen species (especially to nitrogen-fixing taxa), and might be a problem in moister communities in the relatively few areas in the region where the pollution levels could be extreme. Agricultural chemicals are potentially a problem in some of the drier, lower elevation communities.

3.2.1.3.3. Other: Several other aspects of sensitivity, such as logging and fire, are mentioned or discussed under particular zones or communities below.

Ecogroup terricolous

3.2.2. DECIDUOUS WOODLAND (Vitt, et al., 1988)

3.2.2.1. GENERAL

'3.2.2.1.1. Habitat: This type of ecosystem is usually more moist than other types found in adjacent areas, due to proximity to sources of water, and may also provide moist, shaded microhabitats due to the often more closed canopy or well developed understory. The composition of the soil and humus, and the amounts and types of mosses available as substrates for lichens, are also likely to be different than in other ecosystems.

3.2.2.1.2. Distribution:Although many of the sites where terricolous/muscicolous lichens undoubtedly include various. deciduous woodlands; most of them are adjacent to or mixed with conifer forests, and the label data is unsufficient to allow definite conclusions about which terricolous/muscicolous lichens were associated with which type of plant community.

3.2.2.1.3. Role(s): Nitrogen fixing lichens are abundant in many communities.

3.2.2.1.4. Sensitivity: Pollution, especially from agricultural sources, and clearing of vegetation for human development are potentially important threats.

3.2.2.1.5. Representative species: Lichens that are'likely to occur in the moister parts where hardwood trees dominate, and have been found on soil or moss in areas that are at least partly deciduous woodland, and include Leptochidium albociliatum, Megaspora verrucosa, Polychidium muscicola, and various species species of Cladonia, Lecidea, Lepraria, Leptogium, Nephroma, Mycobilimbia, Peltigera, Stereocaulon, and Trapeliopsis.

Ecogroup terricolous

3.2.3. GRASSLAND-SAVANNAH (Vitt, et al., 1988) STEPPE AND SHRUB-STEPPE (Franklin & Dyrness, 1973)

3.2.3.1. GENERAL

3.2.3.1.1. Habitat:

Conditions are generally dry, with extremes of temperature, in most steppes and shrub-steppes, and terricolous/muscicolous lichens in such communities are usually best developed in areas that are moister-or more protected. However, in-wetland communities, -conditions can be very moist (often to much so for most terricolous/muscicolous lichens, which then are usually confined to hummocks or other raised areas.

3.2.3.1.2. Distribution:

This group of ecosystems. predominates in Columbia Plateau, WA and E. Plateaus and Hills, OR; but penetrates many areas in other provinces.

3.2.3.1.2. Role(s):

3.2.3.1.2.1. Modification of moisture conditions in the soil: Lichens cushion the impact of rain drops and increase soil moisture-infiltration; once moisture is in the soil, microbiotic plants act as an organic mulch by shading, cooling, and decreasing evaporation of soil moisture; thus,' sites with'well developed microbiotic plants will retain more soil moisture within the soil profile (Rosentreter,. 1992).

3.2.3.1.2.2. Nitrogen fixation: Nitrogen is the second most limitng factor after moisture in the sagebrush steppe. Lower plants lack a waxy cuticle for retaining the nitrogen, so it is simply "leaked out" into the surrounding soil (Rosentreter, 1992). Nitrogen fixing lichens occurring in sagebrush-steppe in the region include Collema spp., Leptochidium albociliatum, Leptogium spp., and Peltisera spp. Nitrogen fixation by . . Peltigera spp. in biscuit scablands in E. Plateaus & Hills, OR was studied in detail by Rossman (1993) (unfortunately I do not have a copy of the manuscript at present).

3.2.3.1.2.3. Reduction of soil erosion: Sagebrush steppe is dry during much of the summer and fall; lichens and other cryptogams protect and hold the soil in place, reducing the wind erosion (Rosentreter, 1992).

3.2.3.1.2.4. Inhibition of seed germination of grasses: Several species are known to inhibit grass seed germination: Peltiaera canina s. lato (Pyatt, 1967), P. polydactyla s. lato (Richardson, 19__; the species also affectsroot production and elongation), and Xanthooannelia spp. Microbiotic plants may also serve as a check for invasion by exotic annuals. For example, cheatgrass will invade bare soil sites much more densely than it will a site colonized by cryptogams (Rosentreter, 1992).

3.2.3.1.2.5. Miscellaneous effects on hiaher plants:

Ecogroup terricolous

Although fewer seeds germinate in areas covered by microbiotic plants, more total plants become established compared to bare soil sites (Harper & St. Clair, 1985). Without microbiotic plants, the bare soil sites are harsh, with greater temperature extremes and less moisture retention.

3.2.3.2. Sensitivity:

In addition to Texasnorium sancti-jacobi, other ground-inhabiting lichens that have been found at localities described as having "pristine" or "excellent" range conditions include: Caloplaca sp., Candelariella "citrina", C. terriqena, Catapyrenium lachneum, Diploschistes "muscorum", Leptogium burnettiae v. hirsutum, Psora "rubiformis", Toninia ruginosa, and Xanthoparmelia plittii.

3.2.3.2.1. Trampling: When cryptogams are moist, they are pliable and resistant to livestock trampling. Once the soil surface dries, however, trampling will break apart the plant's network of rootlike rhizine strands, severely damaging the crust they form' Historically, at appears that the native ungulates, such as deer and pronghorn antelope, stayed in the higher country until winter weather drove them down to the sagebrush steppe; they returned to high country in spring. With moist or frozen surface soils;. the animals could walk on, the microbiotic plants with minimal impact. Season of use for livestock should include consideration of cryptogams and soil moisture, for protection of the plants, and ultimately, for protection of the watershed.

3.2.3.2.2. Invasion by annual grasses: Another effect of livestock is' the replacement of native.bunchgrasses by Bromus tectorum or other weedy.annuals. Aside from promoting fire, this results in various changes in the habitat for soil lichens, and in particular is detrimental for species that depend on bunchgrass clumps to'provide a suitable substrate or microhabitat.

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3.2.3.2. ZONAL ASSOCIATIONS

3.2.3.2.1. SAGEBRUSH ZONE (Lyons, 1971)

Habitat: According to Lyons (1971), in WA this zone occupies valley bottoms and plateaus at low elevations (below 430 m; however, some species or'subspecies of sagebrush are abundant up into some subalpine areas of the WA/OR part of the Columbia Basin) in WA. Precipitation: Average annual is less than 250 mm. Temperature: Summer heat is intense, often reaching 38" C; winters see freezing temperatures from November to March.

Distribution: In addition to'the sites referred to below under particular communities or associations, there are several other collecting sites (e.g., E. Plateaus and Hills, OR--Klamath co. and 1290-1350 m, Lake Co.) where the vegetation is only presumed to be dominated by A. tridentata.

3.2.3.2.1.1. Artemisia tridentata communities

3.2.3.2.1.1.1. GENERAL

3.2.3.2.1.1.1.1. Habitat: Information on the ecology of A. tridentata and its subspecies (treated separately below) comes from West, 1988 (in Barbour & Billings) and Rosentreter (1990): Precipitation: Summer precipitation in.sagebrush areas usually is light, and most of the moisture from summer precipitation is lost through evaporation.

3.2.3.2.1.1.1.2. Distribution: Sagebrush steppe is the major vegetation type in the western 2/3 of the Columbia Plateau of WA and most of the E. Plateaus and Hills of OR; the most widespread and important perennial grass associated with Artemisia tridentata is Agropyron spicatum; in the northwestern parts (e.g., Columbia Plateau) and at higher elevations, Festuca idahoensis is also common (West, 1988).

3.2.3.2.1.1.1.3. Role(s): Leptochidium albociliatum and Leptogium spp. are the most common nitrogen fixing lichens in these communities.

3.2.3.2.1.1.1.4. Sensitivity: Destruction or inhibition of the shrub layer (e.g., by fire) can be expected to impact lichens that.depend on the shaded and moist conditions under the shrubs. Grazing of native bunchgrasses, leading to replacement by weedy annual grasses, is likely to negatively affect at least the lichens that tend to grow on decaying bungrass clumps; the changes in vegetation structure (e.g., density of ground cover) may also have various effects (positive or negative, depending on the species) on some lichens growing directly on the.ground. The lichens growing directly.on the ground or on mosses or other vegetation on the ground are directly sensitive to mechanical disturbance (trampling by livestock, motorcycles and off-road vehicles). Lichens growing on moss or soil over rock (at least over larger outcrops or boulders) are less likely to be affected

by distubances. However, all of the lichens are sensitive to at least severe fires, and at least some species are probably sensitive to agricultural chemicals.

3.2.3.2.1.1.5. Representative species: Caloplaca spp., Candelariella spp., Diploschistes spp., Leotochidium albociliatum, Leptogium spp., and Physconia spp. are probably among the more frequent and widely distributed lichens on soil or moss in- Artemisia tridentata communities in WA and OR.-

3.2.3.2.1.1.2. Miscellaneous communities associated with Artemisia tridentata

3.2.3.2.1.1.2.1. Areas with alien annual grasses (usually Bromus tectorum, or sometimes Taeniatherum caput-medusae or others)

Habitat: Bromus tectorum completes its life cycle and produces seeds by late June or early July (West, 1988).

Role(s): Due to the frequency of fires and consequent destruction of native'vegetation in these ecosystems, organic matter and nutrient pools decline,' and if soils are without cover during summer convectional storms, soil erosion is usually severe (West, 1988). Therefore.' cryptogamic crusts are likely to be especially important in such ecosystems.

Sensitivity: Areas with Bromus tectorum are susceptible to earlier and more frequent fires than occurred in sagebrush areas having perennial bunchgrasses (West, 1988).

3.2.3.2.1.1.2.2. Chrysothamnus/Poa community

Habitat: This community is not mentioned by Franklin & Dyrness (1973); they mention Chrysothamnus only as a minor component of the Artemisia tridentata/Agropyron soicatum Association. No data on lichens in this type of community in WA or OR. However, according to a study by Rosentreter (1986), in Idaho, these stands appear to. be favorable for lichens because Chrysothamnus lacks leaves in the winter and early spring, allowing penetration of sunlight to the soil surface, and because the stands collect blowing snow and increase soil surface temperatures and humidity on sunny winter days. Rosentreter also found that "slick spots" in the soil in such communities act as fire refugia for lichen species.

Distribution: Columbia Plateau of WA (Lyons; 1971).

Representative species: Expected species (based on Rosentreter, 1986): Cladonia pyxidata, on weakly saline, often very shallow, soils, associated directly with the shrubs, and with mosses,.and Lecanora muralis; Arthonia alebosa, Caloplaca tominii, and Collema spp. on natric (strongly saline, and fairly shallow) soils, with little or no cover by vascular plants.

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3.2.3.2.1.1.2.3. Artemisia tridentata-Chrysothamnus nauseous/Poa sp. scabflats.

Distribution: Lichens have been collected at one site in E. Plateaus and Hills, OR (1600 m, Lake Co.)

Representative species: A vagrant form of Dermatocarpon sp. was the only lichen collected on soil at this site.

3.2.3.2.1.1.3. Artemisia tridentata ssp. tridentata (basin big sagebrush) Communities

Habitat: ..This subspecies prefers soils that are relatively well drained and rather dry ("aridic" to "xeric"), somewhat cool ("frigid" to "mesic"), and deep.

3.2.3.2.1.1.3.1. Artemisia tridentata ssp. tridentata/Agropyron spicatum Association

Habitat: The association occurs on two major types of soils: Mollic Camborthids and Calcic Haploxerolls (Franklin & Dyrness, 1973).

Distribution: According to Franklin & Dyrness (1973), this is the main vegetation type in the western half of the Columbia Plateau of WA, and along the Okanogan River and northern part of the Columbia River, and it also occurs extensively in E. Plateaus and Hills of OR (including areas near the Columbia River, along the Deschutes River, and large areas in southeast OR). Lichens have been collected on soil or moss in many localities within the distribution of the association (however, in many of these areas, Agropyron spicatum has been partly or entirely replaced by annual grasses, especially Bromus tectorum): E. -Slope of Cascades, WA (Chelan Co.), Columbia Plateau of WA (300 m, Kittitas Co.., 410-630 m, Yakima Co.), and E. Plateaus and Hills of OR (780 m, Malheur Co., 960 m, Grant Co., and 1320 m, Harney Co.; probably also many collections from unspecified "sagebrush" or "juniper-sage" sites, especially in Klamath and Lake counties).

Representative species: Caloplaca spp., Cataovrenium spp., Diploschistes spp., Leptochidium albociliatum, Leptogium spp., Megaspora verrucosa, and Phvsconia spp. are among the more frequent lichens on soil or moss in this association.

3.2.3.2.1.1.3.2. Artemisia tridentata ssp. tridentata/Festuca idahoensis Association

Habitat: The following information is from Franklin & Dyrness (1973): Associated soils are mainly Calcic Haploxerolls or Lithic Mollic Camborthids with one Typic Natrixeroll. On Haploxeroll soils, with higher moisture storage capacities than those supporting adjacent A. tridentata/Agropyron spicatum communities.. The association occurs as a topographic climax on north-facing slopes in the

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Artemisia/Agropyron zone and on south-facing slopes in the adjacent, cooler, moister zones. It is also found in disjunct stands on the northeast slopes of the Blue Mountains, where it is associated with Solodized Solonetz soils.

Distribution: In Washington this association is dominant only in a small area (southwestern Lincoln Co. and central part of, Adams Co.). It also occurs in N.E. Mountains of OR and in at least one area in-the southeast part of E. Plateaus and Hills, OR (lichens were collected at ca. 900 m, in Malheur Co.).

Representative species: Catapyrenium lachneum is the only terricol.ous lichen identified from the one site where collections have been made (a "pristine" area in E. Plateaus and Hills of OR (Malheur Co.).

3.2.3.2.1.1.2. Artemisia tridentata ssp. wyomingensis (Wyoming big sagebrush) Communities--Habitat: This subspecies prefers soils that are drier (aridic-xeric), warmer ("frigid"), only moderately deep, and sometimes slightly saline.

3.2.3.2.1.1.2.1. Artemisia tridentata ssp. wyomingensis/Agropyron spicatum-Festuca idahoensis communities

Distribution: Communities dominated by A. tridentata ssp. wyomingensis and Festuca idahoensis occur in various parts of eastern Oregon, including sites in Baker Co,, Harney Co., and Deschutes Co. (Doescher, et al., 1986). Lichens were collected at a "pristine" site in E. Plateaus and Hills, OR (720 m, Jefferson Co.).

Representative species: In addition to some common and widespread lichens (e.g., Candelariella terrigena and Leptosium lichenoides), there were several unusual species, including Chromatochlamys muscorum v. octospora (an inconspicuous species about which little is known), Collema "xerica" (apparently rare) and Texasporium sancti-iacobi (definitely rare), and Trapeliopsis cf. wallrothii (common in California but apparently rare in the Columbia Basin).

3.2.3.2.1.1.3. Artemisia tridentata ssp. vasevana (mountain big sagebrush)

Habitat: This subspecies occurs at higher elevations (to over 2000 m in Spokane Co., WA--Roché & Busacca, 1987), and prefers soils that are somewhat moist ("udic"), very cold ("cryic"), and moderately deep (to deep in f. spiciformis).

Distribution: N.E. Mountains of WA.

Representative species: To my knowledge, no lichens have been collected in this association at least in WA or OR.

3.2.3.2.2. OTHER ZONAL COMMUNITIES WITH SAGEBRUSH

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1. Artemisia tripartita/Festuca idahoensis Association

Habitat: The site where lichens were collected was in a volcanic scabflat.

Distribution: The association occurs in a wide band along the northern edge of the Columbia Plateau, from Douglas Co. to the northwesternmost corner of Whitman Co. Lichens were found at 750 m, in Lincoln Co.

Representative lichens: One lichen was found on soil in an exposed area: Xanthoparmelia cumberlandia

Ecogroup terricolous

3.2.3.2.3. BUNCHGRASS ZONE (Lyons, 1971). PALOUSE PRAIRIE (Daubenmire, 1992).

3.2.3.2.3.1. GENERAL

3.2.3.2.3.1.1. Habitat:

Lyons (1971) described this zone (actually a group of floral belts intermediate between the sagebrush and yellow pine zones) as occuring at 450-720 m in WA. Daubemire (1992) provides a considerable amount of information on this zone. Precipitation: Total annual precipitation is 330-600 mm; rains tend to be gentle, often mist-like. Summers are dry; winters are wet; snow to a depth of 1 or 2 inches blankets the ground for several weeks or even months. Temperature: Summers are warm ("extremely hot" according to Lyons) but cool at night; winters -alternate between cool and cold, and have below freezing temperatures much of the time. Soil: Zonal soils are derived mainly from thick deposits of Pleistocene loess, locally enriched with volcanic ash; this material becomes thoroughly charged with moisture from winter precipitation; these soils are deep, well drained, and loamy.

3.2.3.2.3.1.2; Distribution:

According to the map in Daubenmire (1992)' the "zonal grasslands" occur mainly in the southeasternmost corner of the Columbia Plateau (WA), and in a small area near the central part of the Columbia River.

Although Daubenmire (1992) referred to the bulk of the bunchgrass areas in eastern WA as "shrub-steppe, undifferentiated", the map in Franklin and Dyrness (1973) shows that these areas consist of several different kinds of communities.

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3.2.3.2.3.1.3. Role(s):

According to Daubenmire (1992), a cryptogam crust (not necessarily always with lichens) covers the soil in, "all virgin stands of Palouse prairie", and prevents dust storms.

3.2.3.2.3.2. PARTICULAR ASSOCIATIONS

3.2.3.2.3.2-i. Festuca idahoensis/Symphoricarpos albus Association.

Habitat: According to Daubenmire (1992), this association has "relatively mild winters", and dry summers (little or no rain from June to October). Soil: Zonal, classified as Argixerolls, Argiudolls, Palexerolls, and Haploxerolls (prairie podzolic, chernozem and planosol).

Distribution: East edge of Columbia Plateau, WA, north of the Snake River (Daubenmire, 1992)'. Lichens were collected at three sites (690-750 m, Whitman Co.).

Role(s): Since soil erosion, long ignored in this area, is

becoming potentially more serious (Daubenmire, 1992), cryptogamic soil crusts potentially have an important function here. Important nitrogen-fixing lichens. in this association are Peltisera spp. (on soil or moss).

Sensitivity: Livestock grazing, with the consequent replacement of native plants by invasive perennial or annual grasses, is a threat, but more importantly, in eastern Washington nearly all the areas where this association might once have occured have beenconverted to cropland (Daubemire, 1992).

Representative species: The dominant lichens at the lower elevations sites are species of Peltiaera and the Cladonia chlorophaea group. In areas where Symphoricarpos predominates (called "Symphoricarpos/Festuca" by Cooke, rather than the other way around), P. canina predominates, although sometimes P. venosa and C. chloronhaea s. lato, and other genera, also occur. In areas where Festuca predominates, P. rufescens co-dominates with C. fimbriata and either C. chloronhaea s. lato, or C. pvxidata), and sometimes also with Dinloschistes "actinostomus".

3.2.3.2.3.2.2. Stipa comata-Poa sandberqii Association

Habitat: Precinitation: Average annual precipitation at the site where lichens were collected is 200-250 mm. Soil: The following information is from Franklin & Dyrness, 1973: Stipa comata associations occur on regosolic soils, that are deep, dominated by gravels or sands, and have low moisture-holding capacity; surprizingly, soils of strongly weathered volcanic ash appear to be ecologically equivalent despite their higher moisture-holding capacity as indicated by comparable communities. Low fertility may be the key factor; e.g., the moisture equivalent, cation exchange capicity, and exchangeable magnesium of soils in Stipa communities differ significantly from those in Aqropyron communities. The S. comata-P. sandberqii Association occurs on sandy soils of the Camborthid, Haploxeroll, and Torriothent groups.

Distribution: Lichens were collected at a "pristine" locality in E. Plateaus and Hills, OR (180 m, Morrow Co.).

Representative species: The only species identified was Candelariella "citrina", which was growing on sandy soil. Due to taxonomic problems the distribution and ecology of this species is not known.

3.2.3.2.3.2.3. Aqropyron spicatum-Poa sandberqii Association

Habitat: This association is basically like the Artemisia/Agropyron except for the absence of Artemisia (Franklin & Dyrness, 1973). Precinitation: Average annual precipitation in the "pristine" site is 200-250 mm. Soil: Camborthids or Haploxerolls.

Distribution: Along the Columbia River between the WA and OR parts of E. Slope of Cascades, and along the Snake River in the southeastern part of the Columbia Plateau (Franklin & Dyrness,

1973).

Representative species: Only three lichens are known to have been'identified from this association in the region treated in this report: Dioloschistes "muscorum" and Psora rubiformis were found on loamy soil with the moss Ceratodon purpureus, in a "pristine" site in E. Plateaus and Hills of OR (Grant Co.). Peltiaera canina was collected on soil in the Columbia Plateau of WA' (Whitman Co.).

3.2.3.2.3.2.4. Agropyron spicatum-Festuca idahoensis Association'

Distribution: Southeast part of Columbia Plateau, WA, and northeast part of E. Plateaus and Hills, OR.

Representative species: Lichens have been collected from at least three sites in this association in the Columbia Plateau of WA: Diploschistes "scruposus" was found on soil at one locality (ca. 700 m, Garfield Co.), and Phvsconia distorta was found at the other two (450-520 m, Columbia Co.).

3.2.3.2.3.2.5. Festuca idahoensis-Hieracium Association

Distribution: Restricted to a very small area in the southwest corner of Columbia Plateau of WA (lichens were collected at.600 m, in Klickitat Co.).

Role(s): Except for Dinloschistes, the terricolous lichens at the one site are nitrogen fixers.

Representative species: Dinloschistes "actinostomus", Leptogium albociliatum, Leptogium californicum, and Peltiaera collina were found on soil.

3.2.3.2.3.2.6. Mixed bunchgrass communities:

3.2.3.2.3.2.6.1. Festuca idahoensis-Agropvron spicatum-Poa sandbersii grassland

Habitat: Precipitation: Average annual'precipitation at the site were lichens collected is 300-350 mm.

Distribution: Lichens were collected in E. Plateaus and Hills of OR. (810 m, Gilliam Co.).

Representative species: Cladonia sp. and Dinloschistes "muscorum", both growing on loamy soil, were identified from a "pristine" site in E. Plateaus and Hills of OR (Gilliam Co;).

3.2.3.2.3.2.6.2. Scabflat/grassland with Festuca idahoensis, Poa sandbergii, Stipa comata; and Bromus tectorum.

Distribution: Lichens were collected in E. Plateaus and Hills of OR (1290 m, Klamath Co.).

Representative species: Dermatocarnon sp. (vagrant form) was abundant on soil among basalt stones. Other lichens, found occasionally, in certain microhabitats, include Cladonia cariosa (associated with decaying Poa

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clumps), and *Collema* sp. and *Diploschistes "muscorum"*.

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3.2.3.3. NONZONAL COMMUNITIES

3.2.3.3.1. COMMUNITIES COMPOSED OF SEVERAL ASSOCIATIONS: BISCUIT SCABLANDS (mound-intermound systems) (Rossman, 1992)

3.2.3.2.3.1.1. Habitat: Semi-arid (average annual precipitation = 280 mm, falling mostly in November to January but with heavy rains in May'and June). Dry summers with high temperatures, average maximum 26-32° C in August to October,, coupled with low daytime humidity of 20-25%, down to 8-10%. Cold winter temperatures average around 0°. C with an average annual snowfall of 150 mm. Freezing temperatures coupled with sunny autumn days result in intense frost action. Winds are usually less than 20 km/hr from west to northwest in summer and from south to southwest in winter. Note : two other vascular plant communities, one dominated by Symphoricarpos oreioohilus, the other by Bromus tectorum, also occur, but no lichens are specifically mentioned for them. Peltigera rufescens is described as "common on soil . . . in all communities, but more commonly on the deep soil of the mound community and north-facing slopes and virtually absent from the heads of ravines."

3.2.3.2.3.1.2. Distribution: Lichens were studied at one site in E. Plateaus and Hills of OR (990-1050 m, Wasco Co.)

3.2.3.2.3.1.3. Mound (deep soil) communities in biscuit scabland, dominated by bunchgrasses (Festuca idahoensis, Agropyron spicatum): Habitat: Circular to ovoid mounds, deepening on-the slope, l-20 m diam. and 100-120 cm, consisting of relatively well-drained, deep loessal soil mixed with volcanic ash and basalt fragments with the basaltic bedrock at ca. 70 cm.

Representative species:

On soil, moss, etc. (unspecified): Common species are. Collema tenax, Leptogium californicum, Megasnora verrucosa, Peltigera rufescens, Polychidium muscicola, and Rinodina mucronatula; others found at the site were Candelariella sp. ("C. aurella"), Leptochidium albociliatum, and Lentogium lichenoides.

On bare soil: Common species are Aspicilia "hispida", Arthonia glebosa, Catanvrenium heoaticum, Cladonia fimbriata, C. pyxidata, Psora luridella, and Toninia sp. Also found were Acarospora schleicheri, Cladonia coniocraea, Lentogium byssinum, Peltigera rufescens, Psora globifera, and Squamrina lentigera.

On stabilized soil at edges of "stone rings" surrounding the mounds, among the moss Tortula ruralis: Diploschistes "muscorum" was common.

On plant debris, cow dung, or mosses: Amandinea (Buellia) punctata and Placynthiella uliginosa were common; Caloplaca jungermanniae and C. stillicidiorum were also found.

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3.2.3.2.3.1.4.. Intermound (shallow soil) communities, dominated by stiff.sage (Artemisia risida) and bunchgrasses (Poa sandbersii) and herbaceous plants (Lomatium coos).

Habitat: Flat, cobbly, brown loam 0-50 cm thick with the bedrock generally at ca. 18 cm.

Representative species: Common lichens on soil, plant debris,-and moss are Collema tenax, Leptogium californicum, Leptochidium albociliatum, Peltigera rufescens, Polychidium muscicola, and Rinodina mucronatula.. Other species include Candelariella'sp. (C. "aurella") and Leptogium lichenoides.

3.2.3.2.h.5. Ravine community (Poa sandbergii-Lomatium coos).

Representative species: Common lichens are Peltisera rufescens' (on soil) and Physcia cascadensis and P. sp. (on moss over basalt cliffs). Other species on mossy cliffs at the site were Buellia papillata (especially on Homalothecium aeneum), Lenraria neglecta (on Grimmia montana and G. ovalis), Ochrolechia unsaliensis, Physcia caesia, P. phaea, and Physconia detersa.

3.2.3.2.3.1.6. Drainage bottom community (Agropyrona spicatum-Poa sandberaii).

Representative species: -The only lichen on soil in this community was Endocarpon pulvinatum.

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3.2.3.3.2. PARTICULAR NON-ZONAL COMMUNITIES

3.2.3.3.2-i; Artemisia risida communities

This type of habitat is not treated specifically under any of the major life zones, and it occurs over a rather wide range of'elevations', from low elevations up to 1200-1500 m or more.

3.2.3.3.2.1-i. Artemisia rigida/Poa sandbergii Association

3.2.3.3.2.1.1.1. Habitat: Artemisia rigida is one of several dwarf sagebrushes characteristic of warmer sites. Soil: This Artemsia prefers soils that are moderately dry (xeric), 'very shallow (ca. 15 cm), and stony (West, 1988; Rossman, 1992); the soil is non-zonal, and soil profiles include Bakeoven loam, Qwin fine.sandy loam, and Licks fine sany'loam (Daubenmire, 1992). Franklin & Dyrness (1973) call the soils lithosolic, and state that the association occurs on basalt. This association characterizes the intermound communities in biscuit scabland, (Rossman, 1992). Other factors: At least in one site (Lincoln Co., WA), according to the collector (Rosentreter); flooding and frost heaving in some areas may be a factor affecting the lichens, possibly explaining the'tendency for Cladonia poccillum and Dinloschistes "muscorum" to form balls or inverted cones rather than the usual flat mats. Another site (Kittitas Co., WA) was described by Rosentreter as "windswept"; this probably applies to at least some of the other sites as well, and is likely to promote dispersal of the loosely attached'lichens (especially Dermatocarnon).

3.2.3.3.2.1.1.2. Distribution: According to Daubenmire (1992), the A. rigida/Poa association occurs in scattered stands from the lowest and driest parts of eastern WA (Columbia Plateau) up into the E. Slopes of the Cascades (WA) and Blue Mountains of WA, as far as the montane (Pseudotsuga menziesii zone), and in Oregon. Artemisia rigida is absent from granitic lithosols, and from a large isodiametric area. in south-central Washington, even though it is well represented in the surrounding area on basaltic lithsols that appear. identical to the eye (Daubenmire, 1992). Lichens were collected in this association in the Columbia Plateau of WA (450 m, Kittitas Co.;. 700 m, Lincoln Co.) and E. Plateaus and Hills of OR (1200 m, Grant Co.; 1200-1400 m, Harney co. ; 900-1050 m, Wasco Co.).

3.2.3.3.2.1.1.3. Role(s): The Artemisia bushes become established on a relatively bare moss-lichen crust (Daubenmire 1992). Several nitrogen fixing lichens (Collema tenax, Lentochidium albociliatum, Leotogium californicum and to a lesser extent L. lichenoides, and Peltigera rufescens) are abundant in this association in biscuit scablands in Wasco Co., OR (Rossman, 1992), but have apparently not been collected (or at least identified) from the other sites. Another. nitrogen fixer found at some sites is Massalongia carnosa.

3.2.3.3.2.1.1.4. Sensitivity: Livestock grazing may be a

problem, but probably mostly in the grassier, less rocky areas; Bromus tectorum invasions are serious only if grazing. is severed; and fire is rarely a problem (Daubenmire, 1992).

3.2.3.3.2.1.1.5. Representative species: Dermatocarnon miniatum "f. vagans" was collected in all but two of the seven sites. Massalonaia carnosa was found at two of the sites, on soil (Lincoln Co.; WA) or moss (Grimmia sp.) (Harney Co., OR). Megaspora verrucosa is common at two sites (Kittitas Co.; WA and Wasco Co. , OR). Several lichens that are apparently uncommon in the -region were'found in this association: Caloplaca tominii -(Lincoln Co., WA), Endocarpon pulvinatum (Harney Co., OR; in Wasco Co. it was instead found in Agropyron spicatum-Poa sandbersii'communities in drainage bottoms). Two lichens described as being common in this association in Wasco Co., OR (Rossman, 1992) have rarely been identified from other parts of the region, but'are easily overlooked: Polychidium muscicola and Rinodina mucronatula.

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3.2.3.3.2.1.2. Purshia tridentata/Bromus tectorum community

-Habitat: The site is an exposed, gravelly,, mostly barren slope, with widely spaced clumbs of mostly herbaceous plants.

Distribution: In pristine.sites,.Purshia tridentata forms a zone with Festuca idahoensis; in Washington that association is restricted to a small area in the southwest part of Columbia Plateau of WA, (northern Klickitat Co. and, southern Yakima.Co.). Purshia tridentata also occurs in various parts of E. Plateaus of OR. Lichens were collected at one site in E. Plateaus and Hills of OR (1500 m, Lake Co.).

Representative species: Leptogium lichenoides and Psora tuckermannii were found on soil.

3.2.3.3.2.1.3. Desert or Salt Desert Shrub Communities

Distribution: These communities predominate in several scattered areas of the southern parts of E. Plateaus-and Hills, OR..

3.2.3.3.2.1.3.1. Artemisia-Atriplex/Grassland

Representative species: One lichen was found, on soil in the open, at 500 m, in Wheeler Co.: Xanthoparmelia cumberlandia

3.2.3.3.2.1.3.2. Shadscale/Winterfat (Atriplex confertifolia-Eurotia lanata) (alkaline community type) habitat.

Representative species: 'One lichen was found, on soil, in Malheur Co.: Multiclavula sp.

3.2.3.3.2.1.3.3. Atriplex confertifolia habitat

Representative species: One lichen was found, on volcanic ash soil, in Malheur Co.: Rhizoplaca melanophthalma (vagrant form).

3.2.3.3.2.1.4. Lava beds with little vascular vegetation but heavy cryptogam cover

Representative species: Acarospora schleicheri, Diploschistes "muscorum" and Psora tuckermannii were found on bare soil; Acarospora schleicheri and Buellia papillata were collected on plant remains, and Candelariella terrigena occurred on dung.

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3.2.4. DRY CONIFEROUS FOREST (Vitt, et'ai., 1988)

3.2.4.1. GENERAL ,

3.2.4.1.1. Habitat:
Conditions-are generally cooler, moister, and more shaded than in grassland-savannas.

3.2.4.1.2. Distribution:
These types of. communities are dominant in most provinces other than Columbia Plateau, WA and E. Plateaus, OR, where they are restricted to moister or higher sites.

3.2.4.1.3. Role(s):
Nitrogen fixation by species of Peltigera or sometimes Ledtogium, and to a much lesser extent other terricolous/muscicolous cyanolichens, is potentially important in a few communities or areas, especially-the moistest ones. Other effects: In some communities, where'lichens are abundant on the soil are abundant, modification of soil qualities, or inhibitory actions on mycorrhizal fungi or grasses, might be important.

3.2.4.1.4. 'Sensitivity:
3.2.4.1.4.1. Logging: Timber harvesting, is likely to have the greatest impacts on the terricolous/muscicolous lichens in all zones, because it radically alters the environmental conditions (e.g., moisture, light, temperature, nutrition), and also results in disturbance of the substrate and direct destruction of the lichens. Except when trees are replaced by croplands or human developments, the long-term effects may be positive for lichens that prefer or tolerate disturbed soil or open areas, as long as sources of propagules for re-colonization are plentiful in the area. However, for-many other lichens,, which require the various conditions that occur in forests,: and especially for.species preferring.old-growth or advanced successional stages, the effects are negative, and will not be easily reversed even where the logging is selective and trees are re-planted. .
3.2.4.1.4.2. Other threats: Especially in,the drier, communities associated with steppes, potential'threats are similar to those discussed under Grassland-Savannah, above (trampling, invasion by annual grasses, and fire). Trampling is also potentially a major problem in moister communities, although the lichens are usually not as brittle in such areas.

3.2.4.1.5. Representative species:
Species of Cladonia and Peltigera are dominant or at least the most abundant macrolichens on soil, moss, or humus, in-all of the forest zones in the region, although in a few localized areas in moister communities (e.g., some Abies grandis forests) or

certain kinds of drier habitats (e.g., Juniper communities), other macrolichens, or sometimes crustose species, may be dominant.

3.2.4.2. JUNIPERUS OCCIDENTALIS ZONE (Franklin & Dyrness, 1973)

3.2.4.2.1. Habitat: Soil: Soil groups include Camborthids, Haplargids, and Haploxerolls; of these, Haplargids are the most common. Surface soils are typically light-colored, coarse textured (sandy loams), low inorganic matter (e.g., 1-4%) and slightly acid. (pH 6.0) to neutral. Subsoils typically have white calcareous or siliceous deposits on peds or rocks.

3.2.4.2.2. Distribution: Juniperus occidentalis is widely distributed in many areas of the E. Plateaus and Hills, OR and edges of adjacent provinces in OR. However, J. occidentalis forms a distinct zone mainly in'some areas of the High Plateau. Lichens were 'collected from several such areas (870-1000 m, Deschutes Co.; 600 m, Grant Co.; ca. 1000-1100 m, Harney Co.). However, many more collections were made from various other areas (Deschutes, Klamath; and Lake Counties) where junipers were an important part of the vegetation, but where Artemisia spp. and often Pinus ponderosa were also abundant, and from several collecting localities where the vegetation was described only as "high desert"could be in areas with either junipers or sagebrush.

3.2.4.2.3. Role(s): Leptochidium'albociliatum, and (at- least in areas where Pinus ponderosa or other conifers are also present), species of Collema, Leptogium, or the Peltiaera canina group (especially P. rufescens and P. ponoiensis) are nitrogen-fixers likely to occur in juniper communities.

3.2.4.2.4. Representative species: Because of the vagueness of the label data, it is difficult to reliably determine which species are actually representive of lichen communities within the zone per se. Many of the species (e.g., Lentochidium albociliatum, species of Caloplaca, Candlariella, Catapyrenium, Cladonia, Dinloschistes, and Physconia, and vagrant forms of Dermatocarnon) are also common in sagebrush areas lacking junipers. However, other species (e.g., Lenraria spp., Ochrolechia upsaliensis, and Phaeophyscia decolor, Psora nipponica, Xanthonarmelia coloradoensis, and Xanthoria elegans), have not been found in pure sagebrush areas, are common at higher elevations, and usually grow (directly or indirectly) on cliffs or outcrops. These lichens are likely to prefer the relatively cool, moist, and rocky sites or microhabitats where junipers (and often conifers) predominate. Additional lichens found at sites where conifers as well as junipers are present include Buellia papillata, Megasoora verrucosa, Psora globifera, P. montana, and Toninia aromatica. An apparently rare undescribed fruticose Aspicilia was found at one site, at the edge-of a Pinus nonderosa stand. Many of the lichens in juniper (or sagebrush) communities at least initially grow on mosses (often over rock on steep north

faces) or on decaying vegetation (e.g. Festuca clumps); in Oregon this includes species of Buellia, Caloplaca, Candelariella, Cladonia, Diploschistes, Leptochidium, Lentosium, Megaspora, and Ochrolechia. Other lichens apparently do occur on bare, sandy or gravelly soil; these include species of Catapyrenium, Collema, Peltiaera, Psora and Toninia. However, at least in the Great Basin of northwestern Nevada (Ryan and McWhorter, unpublished data), Psora spp. (especially P. cerebriformis) appears to always start on saxicolous mosses (Grimmia), which may provide more stability for colonizing, more moisture, or perhaps even organic nutrition during early stages of growth; the moss often becomes obliterated by the lichen, such that the latter appears to be growing on bare soil.

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3.2.4.3. YELLOW PINE ZONE (Lyons, 1971). PINUS PONDEROSA ZONE (Franklin & Dyrness, 1973)

3.2.4.3.1. GENERAL

3.2.4.3.1.1. Habitat: According to Lyons (1971), this zone occurs at 540-960 m in 'WA; the climate is relatively arid with hot summer days and freezing winter temperatures; annual rainfall ranges between 6 and 20 inches. Soil: The following information comes from Franklin & Dyrness (1973): P. oonderosa prefers coarse-textured, sandy soils. At lower elevations, Haplumbrepts are the most common soils; surface soils are generally slightly acid, and reaction often becomes more'neutral with depth. Soils on moister, cooler sites may have moderately thick accumulations of duff and litter; these soils range from slightly to moderately acid, and are generally classified as Haplorthods. There are also large areas of immature regosolic soils, particularly in the pumice plateau of south-central Oregon; thin A horizons have moderate to low organic content; the soils are coarse-textured.

3.2.4.3.1.2. Distribution: E. Slope of Cascades (OR, southern WA), adjacent areas of the Columbia Plateau, WA and E. Plateaus and Hills of OR; southern edge of Northeast WA Mountains; and edges of N.E. Mountains of OR.

3.2.4.3.1.3. Role(s): Species of Leptochidium, Leptosium, and Peltisera, found in this zone, are nitrogen fixers..

3.2.4.3.1.4. Representative species: For the zone as a whole, species of Peltigera and Cladonia, often associated with each other, are the dominant lichens on soil or moss.

3.2.4.3.2. UNSPECIFIED COMMUNITIES (known or presumed to occur in the- Pinus ponderosa Zone)

Distribution: Lichens were collected in unspecified Pinus ponderosa forests (probably with Agropyron, Festuca, or annual grasses), near the border between Columbia Plateau, WA and N.E. Mountains, WA (ca. 700 m, Spokane Co.), E. Plateaus and Hills, OR (1290 m, Klamath Co.), and N.E. Mountains., OR (1005 m, Crook Co.)-. In addition, there are several, other sites that are presumed to be in this zone in E. Slope of Cascades, WA (910 m, Okanogan Co.; 740-1050 m, Chelan Co.), Columbia Plateau, WA (Blue Mountains of Asotin and Garfield counties), and E. Plateaus and Hills, OR (Klamath Co. and Wasco Co.).

Representative species: Peltisera aphthosa occurred in three WA sites (Garfield, Spokane, and Whitman counties, all probably in the Pinus ponderosa/Symphoricarpos association). Diploschistes "muscorum" and Leptochidium albociliatum were found at the Klamath Co. localities and at a presumed ponderosa pine site in WA (Chelan Co.). Leptogium lichenoides and Psora nipponica occurred in two ponderosa pine forests in OR (Crook Co. and Klamath Co.); Psora alobifera occurred at the Crook Co. site. Ochrolechia unsaliensis, and various species of Cladonia (especially the C. chlorophaea group), and Peltigera and

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Phvsconia, occurred at some sites in WA and OR.

3.2.4.3.3. PARTICULAR ASSOCIATIONS

3.2.4.3.3.1. Pinus ponderosa/Agropyron spicatum Association

Habitat: Lichens definitely known to be in this community were found in an open climax forest on a-gravelly till plain (Cooke, 1955).

Distribution: Lichen collections were made in Columbia Plateau, WA (600 m, Spokane Co: and 640-840 m; Kittitas Co.).

Representative species: Peltigera rufescens and Cladonia spp. (C. chloronhaea, C. fimbriata; C. alauca, and C. scabriuscula) form a community at the Spokane Co. site studied by Cooke (1955). Peltiaera collina (and Ochrolechia unsaliensis) occurred at one of the Kittitas Co. sites; Cladonia cariosa occurred at the other.

3.2.4.3.3.2. Pinus ponderosa/Symphoricarpos Association.

Habitat: This association occurs on non-zonal soils, including north-facing loessal slopes or loess-filled basalt rubble, in the least droughty steppe zones (Daubemire, 1992), i.e., in apparently moister sites than the P. ponderosa/Agropyron Association. The sites where lichens were studied by Cooke (1955) were in moderately open climax forests.

Distribution: Columbia Plateau, including the northeast part 'of the Blue Mountains (Daubenmire, 1992). Lichens were studied by Cooke (1955) at two sites in Columbia Plateau (northern plot, 600 m, Spokane Co.; central plot, 750 m, Whitman Co.). Lichens have also been collected in this association at three additional sites in Whitman Co. (one at 750 m, in the same general vicinity as Cooke's plot).

Sensitivity: Grazing by livestock, and consequent invasion by Poa pratensis, may be a problem, but destruction of habitat for agricultural uses is not (Daubenmire, 1992).

Representative species: In both sites studied by Cooke (1955), Peltisera and Cladonia formed communities together (Peltigera canina with Cladonia dioitata in.the central plot, on a north-facing slope; P. rufescens with C. coniocraea, C. disitata, C. fimbriata, and C. simulata in the northern plot, in a shallow valley). Additional species found in the vicinity include Peltiaera venosa and Cladonia. chlorophaea.

3.2.4.3.3. MISCELLANEOUS COMMUNITIES WITH PINUS PONDEROSA

Open Larix occidentalis-Pinus ponderosa forest

Distribution: Lichens were collected in E. Slope of Cascades, OR (910 m, Jefferson Co.).

Representative species: Cladonia polydactyla and C. transcendens were found.

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Pinus ponderosa/CercocarPus ledifolius communities

Distribution: Lichens were collected in E. Plateaus and Hills, OR (1350-1380 m, Klamath Co.).

Representative species: Lichens found at both sites were species of Peltisera (P. didactyla at one site; P. rufescens at the other) and Toninia. Cladonia fimbriata was found at the site with P. rufescens.

3.2.4.3.4. RIPARIAN AND WETLAND COMMUNITIES WITH PINUS PONDEROSA

3.2.4.3.4.1. Pinus ponderosa-Populus tremuloides woodland along creek

Distribution: Lichens were 'found in E. Slope of Cascades,. OR (990 m, Deschutes Co.)

Representative species: Peltigera canina was found on mosses over soil under Populus; Cladonia fimbriata was found on soil over rocks by the creek; Candelariella sp. was found on moss over rock along the creek.

3.2.4.3.4.2. Pinus ponderosa-Populus trichocarpa woodland along river

Distribution: Lichens were collected in E. Plateaus and Hills, OR (1290 m, Klamath Co.).

Representative species: Peltiaera spp. were found on soil (P. canina in moister areas, P. rufescens in drier areas).

3.2.4.3.4.3. Shrub-steppejmeadow at edge of lake

Habitat: The trees in the general area included Pinus ponderosa and Juniperus occidentalis in drier sites further from the lake, and Populus trichocarpa in wetter sites. Shrubs in drier sites included Arctostaphylos patula, Ceanothus spp., Chrysothamnus nauseousus, and Ribes cereum. Grasses included Agropyron trachycaulum, Aarostis alba, Bromus inermis, and Koleria cristata.

Distribution: E. Plateaus'and Hills, OR (1650 m, Lake Co.).

Representative species: Peltigera didactyla occurred on soil in a raised area in the moist meadow next to the lake; P. rufescens occurred in drier areas among- shrubs.

Ecogroup terricolous

3.2.4.4. MOUNTAIN FOREST (CANADIAN) ZONES (Lyons, 1971)

3.2.4.4.1.' GENERAL

3.2.4.4.1.1. Habitat: According to Lyons (1971), this zone occurs at 900-1500 m in Washington; winter temperatures range below freezing and snowfalls of 300 cm are not uncommon;-moderate summer temperatures are alleviated by dense forest shade, the coolness of mountain creeks, and a considerable drop in tmperature each night. . .

3.2.4.4.1.2. **Distribution:** E. Slope of Cascades (WA, OR), Northeast WA Mountains, Northeast OR Mountains; and higher: peaks in Columbia Plateau (WA) and E. Plateaus and Hills (OR). Lichens have been collected,at many localities known or presumed to be in montane forests. Most of these are in E. Slope of Cascades, WA (ca. 700-1775 m; Okanogan.Co.; 350-1500 m, Chelan Co.; 1630 m, Kittitas Co.; 760-1585 m,.Yakima Co.), N.E. Mountains, WA (495-1135 m, Ferry Co.), and E. Slope of Cascades, OR (Wasco-Co.). Sites at low elevations may be in riparian mixed forests; ones at moderate elevations are'likely to be in the Pseudotsuga zone but could be in ponderosa pine forests; ones at high elevations are probably in the Abies srandis zone, but ones at-the highest elevations may be in subalpine forests.

3.2.4.4.1.3. **Role(s):** Major nitrogen. fixers 'include species of Leptogium and Peltiaera, and sometimes others (Neohroma, Pannaria, or Stereocaulon)

3.2.4.4.1.4. Representative species: For montane forests in general, species of Peltiaera (P. rufescens in drier areas, P. didactvla and occasionally others, including P. aphthosa s. lato, P. canina s. lato, P. collina, P. malacea, or P. venosa in wetter areas) and Cladonia (especially c. cariosa, C. chloroohaea, C. ecmocvna, C. fimbriata, and various species in Section Cocciferae) are the most widespread and frequent macrolichens on soil, moss, or humus. At moister or higher elevation sites (Abies grandis and A. concolor zones), Psoroma hypnorum occurred on moss, Neorpriap . and Stereocaulon tomentosum occurred on soil or moss, and Trapeliopsis sranulosa occurred on humus or. rotting wood: At one site (1585 m, Yakima Co.), on the shore of an island in a lake, Cladina ransiferina occurred. In several areas at low to moderate.elevations in N.E..Mountains, WA, the species found (including Acarosnora schleicheri, Dioloschistes spp., and Phvsconia muscigena) are typical of drier,, more open steppes or shrub-steppes, but thelocalities are along rivers in the region completely dominated by the Abies srandis and Pseudotsuaa zones.

3.2.4.4.2. UNSPECIFIED MONTANE FORESTS

3.2.4.4.2.1. (probably **Pinus contorta** and/or **Picea-engelmannii-Abies lasiocarpa**) [E. Slope of.Cascades, WA: Roger Lake Trail, Okanogan Co., WA]

Ecogroup terricolous

Representative species: Solorina crocea (on bare mineral soil) in some areas, and Cladonia ecmocvna in other- areas, were completely dominant in some areas along trail in the forest. Peltisera spp. (P. aphthosa s. lato, P. malacea, P. membranacea, and P. spp.) were also very abundant, mostly on mossy rocks, including ones along a stream in an open area. Other very common species were Caloplaca tiroliensis, Cladonia chloronhaea, C. fimbriata, Peltiaera canina, Solon tomentosum, and Traoeliopsis aranulosa. Additional species included Cladonia cariosa, C. cenotea, C. oleurota, C. sulphurina, Psoroma hypnorum, Rinodina bolanderi, and R. spp. At least one- of the Rinodina species is apparently undescribed, and may be rare.

3.2.4.4.3. **PINUS CONTORTA ZONE (Franklin & Dyrness, 1973)**

"3.2.4.4.3.1. Habitat: The following information comes from Franklin & Dyrness, 1973: Pinus contorta has unusually wide ecological amplitude, thriving on wet, poorly drained sites., as well as coarse-textured, droughty soils, but it tends to occupy the extremes. Climax stands are found on both well and poorly drained pumice soils; Soils: All are Vitrndepts. Poorly drained soils occupy low topography in basinlike depressions or areas adjacent to intermittent streams; these soils have a dark-gray sandy lom or loam Al horizon underlain-by a light-gray to white C horizon composed of pumice gravel and sand. 'On better drained sites, the pumice soil exhibits a thin, dark, grayish-brown, loamy coarse sand Al horizon underlain by a yellowish-brown, gravelly, loamy coarse sand AC horizon which grades, in turn, into relatively fresh, unweathered pumice gravel and sands. The pumice soils of the area under consideration have some distinctive chemical and physical properties (not specified by Franklin & Dyrness--see Cochran, 1969, 1971, and Youngberg & Dyrness, 1965).

3.2.4.4.3.2. Distribution: The zone occurs in central parts of E. Slope of Cascades and adjacent areas in E. Plateaus and Hills, OR.

3.2.4.4.3.3. Representative species: No terricolous or muscicolous lichens are definitely known to have been found in Pinus contorta forests in the region.. Although at one site in E. Plateaus and Hills, OR (1920 m, Klamath Co.) where Pinus contorta was present within the Abies concolor Zone, several kinds of lichens occurred on soil or moss (mostly over rock on steep. faces), they were not necessarily associated with' P. contorta; however, all of them (except Pannaria praetermissa) are also common in juniper, sagebrush, or ponderosa pine communities. In the one Pinus contorta'stand I have studied, on a mudflow (West Slope of Cascades: Skagit co.),, species of Peltiaera and Stereocaulon occurred among mosses in relatively drier, open areas.

Ecogroup terricolous

3.2.4.4.4. PSEUDOTSUGA MENZIESII ZONE (Franklin & Dyrness, 1973)

3.2.4.4.4.1. GENERAL

Habitat: Soil moisture conditions are more favorable than in the Pinus ponderosa zone (Franklin & Dyrness, 1973).

Distribution: E. Slope of Cascades, WA and north and central OR, N.E. Mountains, WA, and N.E. Mountains, CR. In addition to the site mentioned below, lichens were collected in several mixed forests which Pseudotsusa is definitely known to be a major component of the vegetation: Columbia Plateau, WA (1100 m, Whitman Co.) and N.E. Mountains of OR (600 m, Wallowa Co.).

3.2.4.4.4.2. MISCELLANEOUS FORESTS WITH PSEUDOTSUGA MENZIESII

3.2.4.4.4.2.1. Pseudotsuga-Pinus ponderosa forest

"Representative species: On moss over rock at the two sites in Whitman Co.; Leptogium californicum occurred, and may form its own community there, as Leptogium "lichenoides" does in Idaho; at one of these sites Peltigera aphthosa s. lato, P. canina, and Neohroma parile grew and may have formed a community, and Leoraria neslecta also occurred. On disturbed soil at the latter site, P. venosa was also found. Leptogium lichenoides also occurred at the Wallowa Co. site.

3.2.4.4.4.3. PARTICULAR ASSOCIATIONS: Pseudotsuga menziesii/Physocarpus malvaceus Association

Habitat: The site where lichens were collected was a dense, near-climax forest, on a level bench at the botttom of an east-facing slope.

Distribution: Cooke (1955) studied lichens at one site in Columbia Plateau, WA (northern plot; 600 m, Spokane Co.).

Representative species: Once again, species of Peltigera and Cladonia formed a community: P. aphthosa s. lato and P. rufescens were associated with C. chlorophaea, C. diaitata, C. fimbriata, C. ochrochlora, and C. scabriuscula.

Ecogroup terricolous

3.2.4.4.5. TSUGA HETEROPHYLLA SERIES:

3.2.4.4.5.1. ABIES GRANDIS ZONE (Franklin and Dyrness, 1973)

3.2.4.4.5.1. GENERAL

Habitat; The following information comes from Franklin & Dyrness, 1973: Soil: generally.exhibit minimal development but are relatively, deep, largely due to accumulations of volcanic ash throughout much of the zone's range. The dominant soil.processes are podzolic, and typical soil great groups are Haplorthods and Haplumbrepts. Vitrandepts (regosolic soils) with A-C profile sequences in pumice or ash parent materials are also comon.. Thin (2-5 mm), mull-type humus layers are typical along with relaticely thin,- brown or dark-dark-brown, weakly to.moderately acid Al horizons. Continuous bleached A2 horizons are not common. Clay eluviation is minimal in, B horizons which are' distinguished primarily by color.

Distribution: E. Slope of Cascades, WA and north and central OR, N.E. Mountains, WA, and N.E. Mountains, OR.

3.2.4.4.5.2. PARTICULAR ASSOCIATIONS: Abies grandis/Pachistima myrsinites Association

Habitat: The site studied by Cooke-(1955) is a dense, near-climax forest, on a northeast-facing slope.

Distribution: Cooke studied lichens in Columbia Plateau of. WA (northern plot, 660 m, Stevens Co.).

Representative species: Peltiaera aphthosa s. lato was the only lichen on soil.

Ecogroup terricolous

3.2.4.4.6. ABIES CONCOLOR ZONE (Franklin & Dyrness, 1973)

3.2.4.4.6.1. Habitat: Soil: Sites in the pumice region are distinguished from A. grandis Zone by Al-AC-C sequences; A horizons average only 30 cm thick; they are generally slightly acid (pH 6.2) with 8-9% organic matter (Franklin & Dyrness, 1973).

3.2.4.4.6.2. Distribution: E. Slope of Cascades;' southern OR (lichens collected at 1635 m, Klamath Co.) and adjacent.parts of E. Plateaus and OR (lichens collected at many localities, 1600-2100 m, Lake Co.). At the Lake Co. sites, pines recorded as P. contorta, but probably-more likely to be P. ponderosa, were often present or even co-dominant;,many of the lichens on soil or moss -were collected in riparian sites, where hardwood trees or shrubs may have predominated.

3.2.4.4.6.3. Role(s): Leptogium spp. and Peltisera spp. are the major nitrogen-fiyers.

3.2.4.4.6.4. Representative species: In E. Plateaus and Hills of OR, Caloplaca iunoermanniae, Candelariella terriaena, Cladonia chlorophaea, C. fimbriata, Lepraria neglecta, L. spp., Leptoaium lichenoides, Peltigera canina, P. collina, P. rufescens, Phvsconia.detersa, P. musciqena, and Psora nipponica are the most common lichens on soil or.moss; additional species include Cladonia coniocraea, Leptogium saturninum, 'Pannaria praetermissa, Peltisera didactyla, P. iperaisidiosa, Placynthiella uliainosa, Polychidium muscicola, and Toninia sp. Species found at the one site in E. Slope of Cascades, OR (on moss over large rock outcrops in a lava field surrounded by forest) were Cladonia bacillaris, C. fimbriata, Lepraria neglecta, L. sp., and Psoroma hypnorum.

3.2.4.4.7. TSUGA HETEROPHYLLA ZONE (Franklin & Dyrness, 1973)

Habitat: Major soil great groups are Haplorthods, Cryorthods, and Xerochrepts, including some soils with gleyed subsoils (Franklin & Dyrness, 1973).

Distribution: Mostly west of-the Cascades,' and in northern Idaho, but present in the northeast corner of N.E. Mountains of WA

Tsuga heterophylla/Pachistima myrsinites Association

Distribution: Lichens were collected in N.E. Mountains of WA (1000 m, Pend Oreille Co.).

Representative species: Peltigera canina was -found on soil near the mouth of a limestone cave.

Ecogroup terricolous

3.2.5. SUBALPINE FOREST-TUNDRA (Vitt, et al., 1988) SUBALPINE ZONE (Lyons, 1971) FORESTS, AND TIMBERLINE VEGETATION (Franklin & Dyrness, 1973)

3.2.5.1. GENERAL

3.2.5.1-l. Habitat: This zone, according to Lyons (1971), occurs at 1500-2100 m in WA; winters are long and severe with snow depths ranging to 20 inches; heavy spring rains with swirling mists'are common, leaving only a short summer season with its sunny days and chilly nights; snow usually arrives by mid-November.

3.2.5.1.2. Distribution: E. Slope of Cascades, WA (lichens collected in Klickitat and Yakima Co.); E. Slope of Cascades, OR, and to a limited extent on higher peaks in other provinces, including N.E. Mountains of OR (lichens collected at 1575-1800 m, Wallowa Co.).

3.2.5.1.3. Representative species: Too few collections have been made at sites definitely known to be subalpine to draw many conclusions about the lichen communities. Lichens found in presumed subalpine sites, and quite likely to occur in subalpine areas, are listed below, by province and subprovince.

3.2.5.1.3.1. E. Slope of Cascades, WA

North Cascades: In high elevation sites in the North Cascades, the following species, which occur both in alpine areas and in lower elevation communities, have been found, and are ones most likely to'also be present in subalpine areas: Caloplaca iunsermanniae, C. 'stillicidorum, Cladonia cariosa, C. coccifera, C. ecmocvna, C. pvxidata, Lepraria neqlecta, Ochrolechia upsaliensis, Peltiaera aphthosa s. lato, P. canina, P. malacea, P. rufescens, Phvsconia muscioena, Psora nipponica, Psoroma hvonorum, Solorina crocea, and Stereocaulon tomentosum. In addition, Icmadoohila ericetorum (on moss, humus, or rotting wood) and Peltioera venosa (on soil), which are not likely to occur in alpine areas occurred in some presumed subalpine sites.

Central Cascades: At presumed subalpine sites in the central part of E. Slope of 'Cascades, WA, Mycobilimbia sp. ("Lecidea sanguineoatra"), Peltiaera didactvla, and P. venosa were found on soil, Psoroma hypnorum occurred on moss, and Trapelioosis granulosa was found on moss, humus, or rotting wood.

3.2.5.1.3.2. E. Slope of Cascades, OR

Terricolous or muscicolous lichens have apparently not been collected in the few subalpine areas that occur in E. Slope of Cascades, OR. By analogy with the North Cascades, in subalpine areas in the northern and central parts of the province (e.g., east sides, of Mt. Hood, Hood River Co., and Three Sisters, Deschutes Co.), lichens might be expected to occur in Phyllodoce empetriformis dwarf shrub communities,

and further south (e.g., Crater Lake area, Klamath Co.), in Carex breweri snowbed communities.

3.2.5.1.3.3. E. Plateaus and Hills, OR

In this province, lichens have not yet been collected in the few areas that could be considered subalpine (highest elevations in the Gearhart Wilderness and Warner Mountains, and timberline areas on Steens Mountain). However, many of the lichens found on soil, moss, or humus-at low to moderately high elevations in the province are known to be common in alpine and subalpine areas elsewhere, and might be expected to occur in subalpine areas here also.

3.2.5.1.3.4. N.E. Mountains, OR

In N.E. Mountains, OR, in a high elevation mixed conifer forest (with Pidea enaelmannii, and probably Abies lasiocaroa) in Cladonia cariosa occurred on disturbed soil along a trail, Collema sp. was found on soil along a stream, Lecidea sp. and Mvcobilimbia berenseriana were found on humus, and Peltigera aphthosa s. lato and Psoroma hvonorum were found on moss over rocks.

3.2.5.2. FORESTS: ABIES LASIOCARPA SERIES

3.2.4.2.1. ABIES LASIOCARPA ZONE (Franklin & Dyrness, 1973)

3.2.4.2.1.1. GENERAL

Habitat: Zonal soils are generally Cryorthods or Haplorthods with well-developed but relatively thin mor humus layers; regosolic and lithosolic soils are also common in some localities; soils are more acid than in the lower forested zones--typically pH 4.5-5.9 (Franklin & Dyrness; 1973).

3.2.4.2.x.2. Abies lasiocarpa/Menziesia ferruginea Association (Daubenmire & Daubemire, 1968)

Distribution: Lichens were collected in N.E. Mountains, WA (1800+ m, Pend Oreille Co.).

Representative species: Cetraria islandica was found on soil among mosses..

3.2.5.3. SUBALPINE MEADOWS (Franklin and Dyrness, 1973)--No lichens have been identified from soil or moss in areas definitely known to be subalpine meadows, but some of the communities where lichens have been found.in alpine areas also extend into the high subalpine. By analogy with the alpine communities in the North Cascades (see below), lichens might be expected in at least a few subalpine meadow communities, such as the ones below.

Ecogroup terricolous

3.2.5.3.1. Carex breweri Snowbed Communities:
Distribution: These communities have been found on subalpine pumice flats in E. Slope of Cascades, OR (Crater Lake).
Representative species: Cladonia ovxidata and Leoraria neslecta might be expected to occur on soil.

3.2.5.3.2. Phvllodoce empetriformis Dwarf Shrub Communities:
Distribution: These communities have been found in subalpine areas in E. Slope of Cascades, OR (Three Sisters).
Representative species: Leoraria nealecta might be expected to occur.

Ecogroup terricolous

3.2.6. VI. ALPINE TUNDRA (Vitt, et al., 1988) ALPINE ZONE (Lyons, 1971; Franklin & Dyrness, 1973)

3.2.6.1. GENERAL.

3.2.6.1.1. Habitat: According to Lyons (1971), this zone begins anywhere from 1500-2250 m in WA (but mostly 1950-2100 m or higher on the E. Slope, according to Arno, 1984), extending up to the'tops of the mountains; winters are severe, with snowfalls up to 9 m; snow may blanket the ground until early summer and arrive again in October; although summer days may be comparatively warm there is a sudden decrease in temperature once the sun goes down.

3.2.6.1.2. Distribution: E. Slope of Cascades (WA, OR); scattered and restricted in many areas, but a "major life zone" in the North Cascades. In the southern parts of the OR Cascades, nearly barren pumice flats tend to replace the moist meadow and shrub communities found towards the north (Arno, 1984). Alpine areas also occur in the Northeast WA Mountains, the Northeast OR Mountains (Blue Mountains and Wallowa Mountains), and a few areas of the Eastern Plateau of OR (e.g., Gearhart Wilderness, Warner Mountains, and Steens Mountain).

3.2.6.1.3. Role(s): Terricolous and muscicolous lichens are often a relatively major part of the vegetation in alpine areas; modification of soil properties, nitrogen fixation, and other functions are likely to be important.

3.2.6.1.4. Sensitivity: Trampling, and inundation by mud, in heavily used areas, are likely to be serious threats. Air pollution could be a factor in areas in the Cascades where air moves up from major west side urban centers.

3.2.6.2. PARTICULAR PROVINCES

3.2.6.2.1. E. Slope of Cascades, WA (N. Cascades) (Douglas & Bliss, 1977):

3.2.6.2.1.2. Snowbed communities:

Antennaria lanata community: Habitat: Snowbed habitats similar to those of the Carex niaricans type, but becomes snow-free 2-4 weeks earlier (late June to late July), and soils better drained, becoming drier during late summer. 2000-2200 m. All aspects.

Representative species: Lepraria neslecta (dominant); Cetraria islandica (fairly important); smaller amounts of Cladonia ovxidata, Peltigera canina s. lato, Stereocaulon alpinum, Trapeliopsis sranulosa, and others.

Carex breweri community--Habitat: Snowbed, mainly in concave sites; well-drained; snow-free by the latter.part of July; become dry during late summer. 2100-2300 m. All aspects.

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Representative species: Leoraria neglecta (dominant); Cetraria islandica fairly important); smaller amounts of Cladonia pyxidata, Solorina crocea, Thamnolia spp., Cetraria aculeata, Cladina mitis, Flavocetraria nivalis, and traces of others

Carex capitata community--Habitat: Snowbed; at higher elevations (2300-2450 m); level to.slightly concave sites, often-with hummocky topography; least snow accumulation, first to become snow-free. (June); soils, due to drainage from upslope, remain moist well into the summer. All aspects.

Representative species: Cladonia pyxidata and Cetraria ericetorum fairly important; smaller amounts of Peltisera canina s. lato, Thamnolia spp., and others

3.2.6.2.1.3. Dwarf shrub communities:

Phyllodoce empetriformis community--Habitat: In slight snowbank depressions in the lower alpine zone; snow melts in early June to early July. 1750-2150 m. South-facing.

Representative species: Leoraria neglecta and Cladonia squamosa v. subsquamosa fairly important; smaller amounts of others.

Phyllodoce ulanduliflora community--Habitat:, In somewhat protected habitats, on all aspects and soils ranging from well drained, on smooth slopes, to more poorly drained on hummocky terrain; snowmelt occurs in early to late June. 1800-2400 m.

Representative species: Cetraria islandica dominant; Leoraria neglecta fairly important; smaller amounts of Cladina mitis, ~~Cladonia coccifera~~, C. gracilis, Peltiaera canina, and others.

Arctostaphylos uva-ursi community--Habitat: Soils generally poorly developed, but well drained; snowmelt from late May to mid-June. Occurs sporadically, more towards the south. 1750~2250 m. South-facing.

Representative species: Cetraria ericetorum the only reasonably abundant species; minute amounts of several others present

Salix nivalis community--Habitat: On level to moderately steep, exposed, southern slopes; soils are extremely rocky and often show indications, of frost action (i.e., unsorted nets, frost-boils); snowmellt is relatively early, generally occurring between mid-May and early June. 1900-2400 m. South facing.

Representative species: Cetraria aculeata, C.

islandica, Cladonia sp., Leoraria nealecta, and Thamnolia spp. each somewhat important; smaller amounts of Flavocetraria nivalis and others

Salix cascadensis community--Habitat: On gentle slopes or level sites of all aspects; often in snowbeds, which become snow-free later (early June) than those on exposed sites, but have good drainage and become quite dry. 1900-2450 m.

Representative species: Cetraria islandica and Lepraria neslecta fairly important; smaller amounts of Cladonia pvxidata, Peltisera canina s. lato, and others

Dryas octopetala community--Habitat: On slight to moderate slopes of all aspects; soils usually well-drained, poorly developed; snowmelt is relatively early (early to late May). 2100-2450 m. Lichens are frequent but of low importance.

Representative species: Rather small amounts of Stereocaulon alpinum, Cetraria aculeata,' Thamnolia spp., and Cetraria islandica, and others

3.2.6.2.1.4. Dry graminoid communities:

Danthonia intermedia community--Habitat: On moderate to steep slopes in lower alpine; well drained, receive moisture from upslope for much of the summer; snow-melt takes place from mid-May to early June. 2100-2350 m. All aspects.

Representative species: Cetraria islandica and Cladonia pvxidata relatively important; smaller amounts of Thamnolia spp., .Cetraria ericetorum, and others

Calamosrostis purpurascens community--Habitat: At higher elevations (over 2250 m), on moderate to steep slopes; well drained, often rocky; snow accumulation is slight, with snowmelt occurring relatively early (April to early May). .Southwest-facing.

Representative species: Cetraria aculeata, C. ericetorum, C. islandica, and Cladonia pvxidata fairly important; smaller amounts of Flavocetraria cucullata, F. nivalis, Thamnolia spp., Ochrolechia-upsaliensis, and others

Carex phaeocephala community--Habitat: On moderately steep to steep upper slopes, well drained, on southerly or sometimes northerly aspects; snowmelt occurs in May. 1850-2400 m. Rather infrequent; intergrades with the next community.

Representative species: Cetraria ericetorum, Cladonia pvxidata, and Thamnolia spp. are fairly important; smaller

amounts of Stereocaulon alpinum, Cetraria aculeata, C. islandica, and others

Carex scirpoidea 'var. pseudoscirpoidea community--Habitat: On dry, well-drained slopes at all elevations and aspects; become snow-free between mid-April and early May. 2200-2600 m.

Representative species: Cetraria islandica and Trapeliopsis granulosa fairly important; somewhat smaller amounts of Cladonia pyxidata and Peltigera canina; still smaller amounts of Flavocetraria nivalis, Thamnolia spp., Cetraria ericetorum, Cladonia.spp., and others

Carex nardina-commtinity--Habitat: On dry upper slopes of the higher peaks; 'shows no-aspect preference; winter snow cover is thin; snowmelt is relatively early (late April to early May). 2250-2600 m.

Representative species: Cetraria aculeata and Thamnolia spp. fairly important; smaller 'amounts of Candelariella sp., Ochrolechia upsaliensis, Buellia elecrans, Cladonia ovxidata, Lepraria nealecta, and others

Kobresia myosuroides community--Habitat: On high (over 2250 m), well-drained, moderately steep to steep, dry upper slopes; exposed; essentially snow free most of the winter; shallow snow accumulation is found only between the tufts of Kobresia or among lowe earth hummocks. All aspects. Highest total cryptogam cover in the North Cascadian alpine.

Representative species: Cladonia ovxidata and Flavocetraria cucullata, and to a slightly lesser extent Cetraria islandica and C. ericetorum, fairly important; smaller amounts of Flavocetraria nivalis, Thamnolia spp., Cetraria. aculeata, Psorula rufonisra, and others.

3.2.6.2.1.5. Herbfield, fellfiled, boulderfield and vegetation stripe communities. 'Although no details are given, many lichens undoubtedly occur on the ground in these communities. -Habitat: Level or gently sloping summits with accumulations of coarse rock detritus; essentially snow free all winter;.frost has caused extensive breaking of the bedrock. Herbfield community: Habitat: Total vascular plant cover over 50%. (probably few lichens present). Fellfield community: Habitat: Vascular plant cover and rock or boulder cover approximately equal. Boulderfield community: Habitat: Rock or boulder cover over 50%. Vegetation stripe community: Habitat: Vascular vegetation arranged in'long parallel strips, l-2 mm apart; result from downslope soil and rock creep.

3.2.6.2.2. E. Slope Cascades, OR

Ecogroup terricolous

Distribution: Alpine areas are all on the border between this province and the West Slope of the Cascades. Although lichens have been collected at the summit of Mt. Hood (3370 m, Hood River Co.), and around McKenzie Pass (2400 m, Deschutes Co.), the only alpine area in this province from which terricolous or muscicolous taxa have been identified is the summit of Three Sisters (2730 m, Deschutes Co./Lane Co.) (Imshaug, 1957).

Representative species: Cladonia pyxidata, Stereocaulon botryosum, and S. ulareosum were the only macrolichens reported from the summit of Three Sisters. By analogy with the North Cascades of WA, lichens should be expected in Antennaria lanata communities on pumice areas along the crest of the Cascades in south-central OR.

3.2.6.2.3. N.E. Mountains, OR'

Distribution: Imshaug (1957) reported lichens from one alpine area in this province (Summit of Eagle Cap, 2915 m, Union Co./Wallowa Co.).

Representative species: The only macrolichen found on soil or moss was Peltigera canina.

Table 2. Distribution of major terricolous/muscicolous lichen species by soil characteristics.

LICHEN SPECIES	SOIL CHARACTERISTICS					
	Dry Shallow Rocky	Dry Sandy	Dry Deep Loamy	Moist Shallow	Moist Deep	Mosses, etc.
Cetraria aculeata	+	+				+
C. ericetorum	+			+		++
C. islandica	+			+		+
Cladonia cariosa	+		+	+	+	
C. chloroohaea				+	+	+
C. fimbriata				+	+	+
C. pyxidata	+			+		
Diploschistes spp.	+		+	+		+
Leoraria nealecta	+			+		+
Leptochidium albociliatum	+		+	+		++
Leotosium spp.			+	+		++
Mesaspora verrucosa			+	+		+
Ochrolechia upsaliensis	+					+
Peltisera aphthosa				+	+	++
P. canina				+	+	++
P. rufescens	+		+	+		

Veg Zones

Table 1. Elevation and climate of major vegetation zones of Franklin & Dyrness (1973).

HABITAT FEATURES	VEGETATION ZONE											
	Shrub-Steppes					Forests						
	ARTR	AGSP/FEID		ARRI	JUOC	PIPO	PICO	PSME	ABGR/ABCO		TSHE	ABLA
Elevation (m)	30 to 1000	30 to 120	450 to 775	450 to 1400	760 to 1400	600 to 2000	1200 to 1525	100 to 1350	1100 to 2000	1650 to 2000	800 to 1200	1300 to 1700
Av. Annual Precip. (mm)	190-389	200-250	360-600	280	200-312	355-760	350-700		632-1157		560-1700	
Av. Summer Precip. (mm)	24-43	23-44	75			41-94	56-66		43-115			
Av. Annual Temp. (°C)	8-12	12	9				6-8	5-6		6-8		3-8
Av. Summer Temp.	19-25	23-24	20			16-20	14-16		18			13-16
Av. Max. Summer Temp.	28-35	31-33	28		26-32	26-32	27-31	27-30		25-29		
Av. Winter Temp.	0 to -5	0	-2			-3 to -5	-3 to -4		-1 to -5			
Av. Min. Winter Temp.	-3 to -10	-3 to -4	-5			-8 to -11	-11		-5 to -10			
Av. Annual Snow (cm)	34-136	34	102	15	15	141-252	417		231-450			500

life zones

Table 2. Distribution of major. terricolous/muscicolous lichen species by life zone.

LICHEN SPECIES	LIFE ZONE					
Sage-brush — Grass--+	Bunch-Pine	Forest	Yellow alpine	Montane	Sub-alpine	Alpine
Cladonia fimbriata	+	+	+	+++	+	+
Cladonia pyxidata	++	++	+ +	+	+	+
Dinloschistes muscorum	+	+	+	+	+	
Leptochidium albociliatum	+	+	+ +			
Megaspora verrucosa	+	+	+	+		
Ochrolechia uosaliensis	+	+	+	+		+
Peltiaera aphthosa				+	+	?
Peltisera canina			+	+	+	?
Peltisera rufescens	+	+	+	+	?	+

Veg Zones

Table 3. Distribution of major terricolous/muscicolous lichen species by vegetation zones of Franklin & Dyrness (1973).

LICHEN SPECIES	VEGETATION ZONE									
	Shrub-Steppes					Forests				
	ARTR	AGSP/FEID	JUOC	PIPO	PICO	PSME	ABGR/ABCO	TSHE	ABLA	Alpine
Cladonia fimbriata	+	+	+	+		+	+	+	+	+
C. Dvxidata	+	+	+	+	+	+	+	+	+	+
Diploschistes spp.			+	+		+	+	?		
Leptochidium albociliatum	+	+	+	+		+	+	+		
Leptosium spp.	+	+	+	+		+	+	+	?	
Megaspora verrucosa	+	+	+	?		?	?	?	?	
Ochrolechia uosaliensis	+	+	+	+		+				+
Peltiaera aphthosa						+	+	?	?	?
Peltiaera canina				+		+	?	?	?	?
Peltisera rufescens	+	+	+	+	?					?

3.3. SAXICOLOUS LICHENS

3.3.1. GENERAL

3.3.1.1. OVERALL

3.3.1.1.2. Habitat: The ecological factors affecting saxicolous lichens are often inferred from parameters that are more easily observable or'measurable than the actual conditions of moisture, light, and temperature (the effects of which may be difficult to separate).

3.3.1.1.2.i. Slope: Many lichen species show various degrees of preference for the slope of the rock surface. Especially noticeable are species restricted to or.characteristic of steep or vertical, or overhanging surfaces. Species on overhangs (and to some extent on steep or vertical surfaces) are protected from stong heat or light (critical in hot, dry, open areas), but also from precipitation (important for some species in moister areas).

3.3.1.1.2.2. Aspect: In arid or semi-arid areas, and in warm, sunny sites, lichens tend to be more abundant on shaded aspects. Where dew contributes to the moisture source, moisture will be retained longer on the northern and western exposures protected from the morning sun (in the northern hemisphere). In wet or humid areas, and in cool, shaded sites, the reverse of the above is usually true.

3.3.1.1.2.3. Moisture: Saxicolous lichens range from a few that require constant or periodic submersion to those that occur in microhabitats never exposed to direct wetting..

3.3.1.1.2.4. Lisht: Although the effects of light are difficult to separate from those of moisture and temperature, some species are known to have definite requirements or tolerances for various degrees of illumination. Lichens are absent from-extremely shaded areas (e.g., inside caves).

3.3.1.1.2.5. Temperature: Some species can withstand considerable extremes of heat, cold, or both; especially when they are dry; others prefer moderate temperatures.

3.3.1.1.2.6. Nutrients and pH: Many lichens have fairly characteristic or restricted preferences or tolerances for different levels of enrichment from birds, animals, or anthropogenic sources. This often results in distinct zones or mosaics. For some species, requirements for nutrients (whether nitrogen, calcium, phosphorous, or other elements) or lowered pH often seem to override other factors, allowing such species to occur in a very wide range of habitats, wherever enriched (or somewhat alkaline) conditions occur. Other species are intolerant of such conditions.

3.3.1.1.2. Role(s):

3.3.1.1.2.1. Weatherins of rock: The main contribution of most saxicolous lichens, and the best known aspect of their ecology, is in weathering the rock and.forming soil. Organic

acids from lichens etch the rock, and crustose lichen thalli or rootlike structures from them penetrate cracks and help break down the rock because of alternating swelling and contraction of the lichen tissues in response to changing moisture conditions. In the advanced stages of lichen succession on rock, when macrolichens form a thick, loose mat over the rock surface, this mat accumulates plant debris, dust, and moisture, probably occasionally acting directly as a seedbed for vascular plants, and eventually lichens-falling off the rock or falling with parts of the rock contribute nutrients to the soil. The weathering and soil-producing processes also involve various interactions of lichens with bryophytes and occasionally pteridophytes (e.g., Selasinella); e.g., in some cases weathering by lichens may facilitate colonization of these other plants, while in other cases mosses can facilitate establishment by lichens, and all of these kinds of plants modify and contribute to soil properties.

3.3.1.1.2.2. Other physico-chemical effects: Little is known about other ecological functions of saxicolous lichens.. Lichens may affect-the habitat of vascular plants by absorbing moisture and modifying the chemistry and nutrients in water running off the rocks onto the soil. It is also.conceivable that lichens might have other influences on physcial conditions in the ecosystem in some cases (e.g., where light-colored rocks are heavily colonized by dark-colored lichens, or vice-versa). Although various nitrogen-fixing lichens frequently are found on rocks, these species are usually growing on moss or soil rather than directly on the rock.

3.3.1.1.2.3. Biological functions: Lichens on rocks undoubtedly provide nutrition and habitat for invertebrates and microorganisms. Some of the larger foliose lichens (e.g., Umbilicaria ssp.) may be eaten occasionally by mammals, though probably only in desparate circumstances.

3.3.1.1.3. Sensitivity: The nature and degree of sensitivity of saxicolous lichen communities vary with the type of ecosystem and species composition. Lichens on rocks in deciduous woodlands and montane forests are probably the ones most likely to be strongly affected by human activities.

3.3.1.2. SPECIAL HABITATS

3.3.1.2.1. PARTICULAR TYPES OF HABITAT FOR LICHENS (PRIMARILY ON VOLCANIC ROCK), FOUND IN ALL ZONES.

3.3.1.2.1.1. Rocks neriodicallv submerged or exposed to seepage or runoff: Although these kinds of habitats, and some lichen genera found in them (e.g., Dermatocarpon and Staurothele) occur over a very wide range of zones, most of the species, .and ecological considerations (especially for the more truly aquatic communities), are treated under the discussion of Dry Coniferous Forest. Dermatocarnon spp. (D. miniatum, D. reticulatum, and others) occur in a wide variety of microhabitats; ranging from stream beds to cracks in vertical-ledges exposed to seepage, in both wet and dry areas. Lecanora Dseudomellea is common and characteristic in many areas in the lower, drier zones, usually on small rock flows on gently sloping surfaces, but it can also occur on shaded cliffs in some areas, including oak woodlands,, and extends up into open areas in montane forests below the subalpine zone.

3.3.1.2.1.2. Vertical or overhanging surfaces of cliffs or other large rocks (with weak to moderate nutrient enrichment from external sources):
Representative species: The bright greenish yellow Acarosoora "chlorophana" is the most widespread, common, and obvious lichen on relatively exposed cliffs in open areas at all elevations. Species of Caloolaca or Xanthoria are also conspicuously abundant on cliffs, but their distribution is probably determined more by nutrient conditions (see below). Other species that are frequent on steep to overhanging surfaces in a wide range of zones include Lecanora rupicola, Umbilicaria spp., and Rhizoplaca melanophthalma, although.at least the latter species is also quite common on gentle to moderate slopes. Many other species also occur in such habitats, but are less common and conspicuous, and are mostly restricted to certain zones.

3.3.1.2.1.3. Pebbles, gravel, or other small, loose rocks
Representative species: Aspicilia spp., Lecanora polytropa, Lecidea spp., Staurothele spp., and Verrucaria spp. are common crustose lichens. Species of Dermatocaroon and Xanthoparmelia, and sometimes Rhizoplaca melanophthalma are among the foliose lichens that occur.

3.3.1.2.1.4. Rocks nutrient-enriched bv external sources:
Representative species: Species of the "orange lichens" (especially Caloolaca saxicola and Xanthoria spp.) generally show strong preferences for high levels of enrichment, and often occur towards the tops of rocks. Other species, such as Lecanora muralis, and especially species of

Candelariella, Phvscia s. lato (including Phaeophvscia and Phvsconia) and Rhizoplaca, and some 'brown species of Acarospora, prefer more moderate levels of enrichment, and also occur in a very wide range of zones.

3.3.X.2.1.5.: Outcrops or boulders (not notably nutrient-enriched):

Representative species: Species of Aspicilia, Lecidea, (especially the "brown" Lecidea atrobrunnea and L. cascadensis complexes)., and.Rhizocarpon spp. are almost ubiquitous and often completely dominant, in most zones. Label data from one site suggest that Dimelaena species and Xanthoparmelia species, both found mostly in the drier zones or communities, may actually be somewhat intolerant of nutrient enrichment.

3.3.1.2.1.6. Mossy rocks, or crevices or pockets where soil accumulates: Representative species: Species of Cladonia, Leotochidium, Leptogium, Peltiaera, Phvsconia, Stereocaulon, and others often occur indirectly on rock, but are mostly treated in the section on terricolous/muscicolous species. Some species, especially of Parmelia and Xanthooarmelia, can occur directly on indirectly on rock, and where the label data are not explicit, are treated under both categories.

3.3.1.2.2. PARTICULAR ROCK TYPES: Maps and other information on the geology of the region is available in the Atlas of the Pacific Northwest, the Geological Highway Map: Pacific Northwest Region, and other sources. Most of the rocks in all the provinces of the WA/OR part of the Columbia Basin are volcanic (primarily basalt). Therefore the more limited areas of other rock types are likely to have more unusual kinds of lichens.

3.3.1.2.2.1. Siliceous rocks:

3.3.1.2.2.1.1. Volcanic rocks. The ecology of lichens on basalt, andesite, etc., is discussed separately. Basalt or lava are dominant in most provinces, while andesite is abundant in some areas (e.g., central part of E. Slope of Cascades of WA); the differences-among these types are probably negligible in terms of, lichen ecology. On the other hand., pumice (dominant in the south-central part of E. Slope of Cascades, OR, and adjacent E. Plateaus and Hills, OR) can be expected to have a somewhat unusual lichen vegetation. (probably depauperate due to the dry conditions or perhaps the properties of the rock, but with a few species not found on other rock types). Representative species: Few collections have been made on pumice; at least one species, Lecidea Dumicicola, has been positively identified only from this substrate.

3.3.1.2.2.1..2. Metamorphic rocks: Granitic rocks (and other intrusive types) are dominant mainly in large areas of the Northeastern Mountains of WA, but also occur in many. areas in the northern parts of E. Slope of Cascades, WA, and in at least a few areas in N.E. 'Mountains of OR and adjacent parts of other provinces. Representative species: Although the lichen flora on metamorphic rocks are generally similar to those on volcanic rocks, there are also some differences, as evident in one area in Baker Co., OR where lichens were studied on three types of rocks at nearby sites where other conditions were presumably similar (see species lists for those sites, under Sagebrush Zone). Further study is needed before broad'generalizations about the lichen floras of particular kinds of metamorphic or volcanic rocks in the region can be made.

3.3.1.2.2.1.3. Sedimentary rocks: 'These are dominant mainly in large parts of the North Cascades (south to the Wenatchee Mountains) and in the northeasternmost corner of Washington State,' and in scattered patches in south-central Washington, the northeast fourth of Oregon, and the southern half of Oregon east of the Cascades. Representative species: Acarospora americana, A. bullata, A. spp., Aspicilia sp., Caloplaca decipiens, C. fraudans (on boulders), C. sp., Candelariella aurella, C. rosulans, Lecanora muralis, Lecidea sp., Lobothallia sp., Ochrolechia sp.. (on ledges), Phaeophyscia sp., and Rhizoplaca melanophthalma, and Umbilicaria "vellea" have been found on sandstone or conglomerate in the region; Although most of

these species also occur on other-rock types, several (e.g., Candelariella aurella) are usually found only on base-high (calcareous or serpentine) rocks., and many other species that are common on volcanic or metamorphic rocks do not occur on sedimentary rocks (even fairly calcium-poor types). In general the lichen flora on sedimentary rocks tends to have a composition different from that found on other rock types.

3.3i1.2.2.4: **Metal-rich** siliceous rocks: These occur occasionally and locally in various parts throughout the region. Representative species: A few species,'including Acarospora sinopica and Tremolecia atrata; are restricted to iron-rich rocks, and incorporate the iron into themselves, giving them a rusty color.. Other species, including some Lecidea spp., occur facultatively on such rocks, and Lecanora sierrae is known.to sometimes occur on copper-rich rocks, where it absorbs copper, giving the thallus a blue-green color, making it potentially useful in locating copper deposits (Czehura, 19).

3.3.1.2.2. Berpentine or **ultramafic** rocks: These rock types occur in several areas, e.g.; in the north-central parts of E. Slope of Cascades, WA. They are likely to have unusual lichen floras (primarily crustose species), including endemic species and'mixtures of lichens normally found on siliceous‘rocks with ones usually found on calcareous, but in rocks with large amounts of elements such as nickel or chromium, the lichen vegetation may be quite depauperate, especially in dry areas. No collections (or at least identifications) of lichens from these substrates in the Columbia Basin are known. Representative species: Species of Acarospora, Aspicilia, Candelariella, Lecidea, and other crustose genera are to be expected.

3.3.1.2.3. Calcareous substrates: Calcium-high rocks are rare in the region being considered,- but do occur in a few sites in areas where siliceous sedimentary rocks occur (see above). Bones, and man-made structures (cement or concrete, or.marble tombstones) occasionally provide calcareous substrates for lichens. Only a few lichen collections have been made on distinctly calcareous rocks in the region. In -parts of the Columbia Plateau, WA and E. Plateaus and Hills of OR, although the rocks themselves are mostly siliceous, they often have calcareous influences from soil or other sources.

3.3.1.2.3.1. Calcium-containing or **calcium-influenced** rocks: Representative species: Aspicilia spp., Caloplaca spp., Candelariella aurella; Collema spp., Dermatocarpon miniatum, Lecanora muralis, Lecidea spp., Psora globifera (in fissures), 'and Xanthoria spp. are among the at least facultatively calcicolous lichens.

3.3.1.2.3.2. Bone: Representative species: Species of

Caloplaca, Candelariella, Lecanora, and Xanthoria have been found on bone in the region.

3.3.1.2.3.2. Cement or concrete: Represdntative species: Caloplaca spp., Candelariella aurella, Lecanora dispersa, L. muralis, and Lecidea spp. have been found on these substrates in the region.

3.3.1.2.4. Miscellaneous unusual substrates

3.3.1.2.4.1. Human artifacts: Several species have been found occasionally on these substrates in the region. Although their ecological significance is negligible, these occurrences are mentioned here because they may be of archaeological or historic interest to land managers, either for their potential use in dating of structures based on growth rates of lichens, or because of their destructive effects. Xanthoria "candelaria" has been found on tombstones and old bricks. At the Yakima Training Center (Columbia Plateau, WA), several lichens have been found on human artifacts (collected by Reo Boreson, Eastern Washington University; lichens identified by Ryan),' including projectile points composed of cryptocrystalline silica (Lecidea sp. on one estimated to be 1500 to 150 years old, Aspicilia sp. on another, estimated to be 8500 to 6500 years old), and species of Acarosoora, Aspicilia, Lecidea, and Neofuscelia on a ceramic fragment dating'from historic times. Rhizocaroon sp. was found overgrowing a petroglyph in the Okanogan National Forest (Okanogan Co., WA). In Oregon, species of Aspicilia, Lecidea, and others have been found on various archaeological artifacts, and have 'been, ' used to 'date these structures (Pike, unpublished report).

3.3.1.2.4.2. Other unusual substrates: Buellia sp. ("B. disciformis v. saxicola") has been found on petrified wood. Aspicilia desertorum has been found on desert agates.

3.3.2. DECIDUOUS WOODLAND (Vitt, et al., 1988)

3.3.2.1. GENERAL

"3.3.i.l.l. Habitat: Since most deciduous woodlands are adjacent to or mixed with coniferous trees, and label data are usually vague, it is usually impossible to say which saxicolous lichens are really associated with'which communities. Some mixed vegetation'communities found in riparian areas but probably associated more with shrub-steppe,are treated under the discussion of Grassland-Savannah.

3.3.2.1.2; Distribution:. Deciduous woodlands occur especially along the boundary between E. Slope of Cascades! WA and E. Slope of Cascades, OR, but are also common in riparian or wetland areas throughout the region.

3.3.2.1.3. Sensitivity: Clearing of woodlands for agriculture or other development is a threat to saxicolous lichens that require moist or shaded conditions.- Air pollution could be a problem, especially in the-Columbia Gorge and adjacent areas in WA and OR, and in some areas in northeastern WA, because the effects of pollutants (at least sulfur dioxide) are likely to be greater in moist communities; however, agricultural chemicals are more likely to have effects in other areas (fertilizer will promote some species, but it or pesticides could be damaging to others).

'3.3.2.1.4. Representative species: Most of the'saxicolous lichens known or presumed to occur in deciduous woodlands are probably just as common or moreso in other types of ecosystems, although species that prefer wet or shaded conditions are especially likely to occur here, because deciduous woodlands often have closed canopies and frequently occur in moist areas. Lecanora "demissa" is restricted to vertical or overhanging surfaces, in shaded areas (often in deep crevices or under trees) at low to moderate elevations; although it has also been found in steppe areas, it is probably more characteristic of woodlands, where shaded conditions are common.

3.3.2.2. PARTICULAR PROVINCES OR TYPES OF WOODLANDS

3.3.2.2.1. Mixed woodlands/forests near the Columbia Gorge

Representative species: Several moisture-loving species that are common on the west side of the Cascades but are rare in the WA/OR part of the Columbia Basin were found along the-east edge of the Columbia Gorge in E. Slope of Cascades, WA (Klickitat Co.)I including Parmeliella cyanolepra, Placopsis gelida, and Pilophorus acicularis. Additional species found here that are apparently rare or absent elsewhere in the region include Lecanora contigua and Phylliscum demangeonii. Several aquatic or semi-aquatic species were also found in some of these areas (species of Dermatocarpon, Staurothele, and Verrucaria).

3.3.2.2.2. Quercus garryana woodlands

Habitat: The 750 m site was in a community mixed with Pinus

ponderosa.

Distribution: Columbia Plateau, WA (550 m, 'Klickitat Co.; 660 and 750 m, Yakima-Co.)'.'

Representative species: The following species were found at various sites:

On vertical surfaces of basalt cliffs, under oak trees (Rlickitat Co. site): Lecanora "demissa", L. rupicola (in vertical crevice), Phvscia biziana, and Rhizocaroon sp. (gray/brown).

On basalt cliffs (towards the base) (Klickitat Co. site): Leptochidium albociliatum and Psora nipponica and Xanthoparmelia mexicana (all on vertical surfaces only); Lecanora muralis, L. pseudomellea, L. semitensis, L. cf. weberi, and Rhizocarpon bolanderi (including v. sulphurosum).

Onvertical, south- or southeast-facing surface of basalt (sometimes in crevices) (660 m Yakima Co. site): Acarospora "chlorophana", Caloplaca saxicola, Lecanora muralis, L. pseudomellea, Lecidea spp. (brown), and Rhizoplaca melanophthalma.

On vertical, west-facing surface of basalt (660 m Yakima Co. site): Lecanora semitensis, L. sp., Lecidea spp. (brown), and Rhizoplaca melanophthalma.

On horizontal surface under overhang and under oaks (Klickitat Co. site): Rhizoolaca melanophthalma,

On horizontal to moderately sloping basalt outcrops in exposed area in (Yakima Co. sites): Aspicilia spp., Caloplaca saxicola, Dermatocarpon miniatum, Lecanora aarovaalii s. lato, L. muralis, L. phaedrophthalma, L. pseudomellea, L. semitensis, L. sp., Lecidea sp. (brown), Lobothallia oraeradiosa, Lecidea spp. (brown), Rhizocaroon sp., Rhizoplaca chrvsoleuca, and R. melanophthalma.

3.3.2.2.3. Populus trichocarpa woodlands in Pinus ponderosa Zone

Distribution: Lichens were collected in Columbia Plateau, WA (630 m, Yakima Co.).

Representative species:

On vertical surface of B-facing basalt cliff (630 m site): Aspicilia sp., Lecidea sp. (cryptothalline), Neofuscelia verruculifera, and Rhizoolaca peltata.

On vertical surface of W-facing basalt cliff: Aspicilia sp., Dimelaena thvsanota, Lecanora niaromaruinata, Neofuscelia subhosseana, Rhizocarpon sp. (gray/brown), and Rhizoolaca melanophthalma.

On gently sloping surfaces of exposed basalt rocks: Lecanora muralis, L. phaedrophthalma, Rhizoplaca melanophthalma.

3.3.2.2.4. Woodland with Castanopsis chrvsophvlla, patula, aphvlos Amelanchier-alnifolia, and Symphoricarpos sp., adjacent to Pinus ponderosa forest

Distribution: Lichens were collected in E. Plateaus & Hills, OR (1575 m, Lake Co.).

Representative species: Caloplaca 'saxicola and Melanelia

Baxicolious

subarsentifera were found on exposed basalt.

3.3.3. GRASSLAND-SAVANNAH (Vitt, et al., 1988) BTEPPE AND SHRUB-BTEPPE

3.3.3.1. GENERAL

Habitat: Conditions for saxicolous lichens are generally dry, with extremes of temperature, and few sources of protection from these conditions, except in canyons or sometimes under shrubs or large cliffs or boulders.

Distribution: These ecosystems dominate most of Columbia Plateau, WA and E. Plateaus and Hills, OR, and also penetrate other provinces.

Sensitivity: Threats to saxicolous lichens in these habitats are probably minimal; there may be some potential effects from air pollution, agricultural chemicals, dust, or fire. For species that require shelter (or possibly nutrient enrichment) provided by trees or shrubs, loss of those plants could be detrimental.

Representative species: Species of Acarospora, Aspicilia, Buellia, Caloplaca, Candelariella, Dermatocarpon, Dimelaena, Diploschistes, Lecanora (especially L. phaedrophthalma), Lecidea (especially the brown species and L. tessellata), Melanelia, Neofuscelia, Parmelia, Phvscia, Rhizocarpon, Rhizoplaca, Umbilicaria (mainly U. hyperborea and U. phaea), Xanthoparmelia, and Xanthoria are all characteristic.

3.3.3.2. ZONAL ASSOCIATIONS

3.3.3.2.1. BAGEBRUBH ZONE (Lyons, 1971)

3.3.3.2.1.1. GENERAL

Habitat: Conditions are generally dry, with considerable extremes in temperature.,

Distribution: The zone occurs at O-600 m in most parts of WA, but some species or subspecies of sagebrush occur at much higher elevations, especially in OR.

Role(s)': See' general comments.-

sensitivity; In contrast to terricolous lichens, saxicolous taxa'in this zone are probably not likely to be threatened by human activities, except perhaps near some major agricultural areas or a few other major sources of disturbance.

Representative species: Most of the saxicolous lichen taxa found in this zone are also common in other zones, especially the drier, lower ones.,

3.3.3.2.1.2. Unspecified Artemisia communities (presumed to be A. tridentata, but may be A. riqida), in E. Plateaus and Hills, OR

Distribution: Lichens were'collected at 1350-1650 m, Lake Co.,. and 900-1125 m, 'Wheeler Co.

Representative species: The following species were all found on basalt:

On vertical or overhanging surfaces: Acarospora "chlorophana".

On steep, north-facing surfaces: Dimelaená oreina and Lecanora rupicola.

On steep, south- or west-facing surfaces, in nutrient-rich areas (e.g., -around urine deposits of Neotoma): Caloplaca saxicola.

On steep,, southwest-facing surfaces, mostly towards tops of boulders or outcrops: Candelariella vitellina, Dimelaena oreina, Lecanora aarovaalii s. lato, L. muralis, L. oseudomellea, L. sierrae, Phaeoohvscia sp., Phvscia sp., Rhizoplaca chrvsoleuca, R. melanoohthalma, and Xanthoria eleaans

On more or less horizontal surfaces, mostly towards tops of boulders or outcrops: Acarospora sp. (brown), Lecanora qarovaalii s. lato, L. muralis, Lecanora phaedrophthalma, L. pseudomellea, Lecidea tessellata, L. spp. (brown), Neofuscelia verruculifera, Rhizoplaca chrvsoleuca, R. melanoohthalma, and Xanthoria elesans.

On rocks (unspecified, or information insufficient): Neofuscelia loxodes, Rhizocarpon sp. (gray/brown).

3.3.3.2.1.3. Artemisia tridentata Communities

Habitat: See general comments about the Sagebrush Zone.

Distribution: This is the most common type of sagebrush community in the region, occurring over large areas in the southwestern parts of Columbia Plateau, WA and and many areas in E. Plateaus and Hills, OR.

Representative species: In addition to the species: mentioned specifically below, there are others, found in E. Plateaus and Hills, OR, in mixed communities of Juniperus and Artemisia tridentata' (discussed under the J. occidentalis Zone) and in mixed-vegetation riparian communities (discussed under that category).

3.3.3.2.1.3.1. 'Unspecified A. tridentata communities in N.E. Mountains, OR: Northeast Valleys:

Habitat: These sites are treated together here, because although the habitat information is based on the site where lichens were found on granite, the precipitation and temperature data are probably also fairly applicable to the sites with schist and basalt.

3.3.3.2.1.3.1.1. ON GRANITE:

Habitat: The following information'is from Palmer, et al.; 1990. Precipitation is ca. 25 cm per year. There is frequent heavy dew and rather frequent light showers during the spring and autumn. Mean percent of days that water was. available on the rock surface ranged from 30% in mid-summer to 90-100% in the winter; 'moisture was often detected during early morning hours when the air relative humidity was below 95%, even when the rock surface had been dry the previous afternoon. Presumably water was brought to the rock surface by capillary action. Temperature: Maximum daytime rock temperatures usually exceeded air temperatures by 10-20° C during the warmer months and by 5-15°C during the cooler months. The highest rock temperature recorded was 57° C on a day when the air temperature maximum was 36°C. At night the rocks cooled down, but generally remained 5-10° C warmer than the air. Summer air temperatures (weekly averages)' show maxima of 26-34° C and minima of 1-8° C; by November, air temperatures (weekly averages) can drop to maxima below 10° C and minima below freezing. Other factors: Total cover by lichens is less on the south (and east?) exposures than on the north (and west?). Lichens were slow in colonizing rock surfaces recently exposed by spalling.

Distribution: E. Plateaus and Hills, OR (1035 m, Baker Co., OR).

Representative species:

On vertical to overhanging, mostly north-facing surfaces of granite rocks, often near the bottom of a cliff or boulder: Acarospora "chlorophana"

On steep to vertical surfaces (both north; and south-

facing unless specified. otherwise; often near the tops of the rocks, and often on ledges): Acarosoora fuscata; Aspicilia sp. (A. cinerea group); Caloplaca saxicola (vertical relatively sunny surfaces); Dimelaena oreína*; D. thysanota; L. oseudomellea; Umbilicaria hvperborea; U. phaea

On horizontal or gently sloping, exposed surfaces of granite rocks: Lecanora phaedrophthalma; Lecidea cf. atrobrunnea; Rhizoplaca chrysoleuca (near tops of larger, isolated rocks)

On granite rocks (showing no obvious preferences for slope; mostly on south-facing surfaces): Acarosnora sp. (brown); Caloplaca epithallina; Candelaria concolor; Candelariella vitellina; Leciaea sp,; Melanelia substygia; Neofuscelia subhosseana; Phaeophyscia sp.; Rhizocarpon disporum; Rhizocarpon sunerficiale; R. melanophthalma

3.3.3.2.1.3.1.2. ON SCHIST:

Distribution: Northeast OR Mountains: NE Valleys (1100 m, Baker Co., OR).

Representative species: The following lichens were collected.

On vertical to overhanging, mostly north-facing surfaces of schist, often near bases of cliffs or boulders: Acarospora "chlorophana".

On steep to vertical surfaces (both north- and south-facing unless specified otherwise) of schist: Acarospora fuscata, Aspicilia sp. (A. cinerea group), Dimelaena thysanota, Lecanora pseudomellea, Umbilicaria kraschenninikovii, U. phaea, and Xanthoria elegans (on relatively sunny surfaces)..

On horizontal to gently sloping, exposed surfaces of schist: L. phaedrophthalma (near tops of rocks), Lecidea cf. atrobrunnea; and Rhizonlaca chrysoleuca (near tops of larger, isolated rocks)..

On schist (showing no obvious 'preferences for slope, mostly.on south-facing surfaces)': Aspicilia nitida, A. strisata, A. sp. (brown), Caloplaca eoithallina, Lecanora muralis, Neofuscelia sp., Physcia biziana, Rhizocaroon suoerficiale, R. melanophthalma, and Xanthoparmelia plittii.

3.3.3.2.1.3.1.3. ON BASALT:

Distribution: (Flagstaff Hill, 1100 m, Baker Co., OR).

Representative species: The following species were found:

On vertical or overhanging surfaces of basalt,.mostly north-facing, often near the bottom of cliffs: Acarospora "chlorophana".

On steep to vertical surfaces (both north- 'and south-facing): Asoicilia sp. (A; cinerea group), Caloolaca saxicola (on relatively sunny surfaces), Dimelaena thysanota, L. nseudomellea, and Umbilicaria phaea.

On horizontal to gently sloping, exposed surfaces of

basalt: L. phaedrophthalma, Lecidea tessellata, L. sp. (brown), and Rhizoplaca chrysoleuca (near tops of larger, isolated rocks).

On basalt (showing no obvious preferences for slope; mostly on soufh-facing surfaces):. Acarospora sp. (brown), Caloplaca epithallina, Candelariella vitellina, Lecanora muralis, Lecidea sp. (cryptothalline), Physcia sp., Rhizocarpon "disporum", and R. melanophthalma.

3.3.3.2.1.3.2. Artemisia tridentata ssp. tridentata Communities

3.3.3.2.1.3.2.1. Artemisia tridentata ssp. tridentata/Agropyron spicatum Association

Habitat: This is the climatic climax of the driest of the shrub-steppe zones.

Distribution: Lichens were collected on volcanic rocks in Columbia-Plateau of WA (300-825 m, Grant Co.; ca. 200-500 m, Kittitas Co.; 300-480 m, Yakima Co.), and in E. Plateaus and Hills, OR (960 m, Grant Co.; ca. 960-990 m, Umatilla Co.). Lichens were collected on andesitic sandstone, conglomerate, and concrete in Columbia Plateau; WA (480 m, Yakima Co.).

Representative species: The ecology of the species found at various sites is summarized below. Most of the species are common in other kinds of drier communites, but at least one, Parmeliella cvanolepra is characteristic of moister communities.

3.3.3.2.1.3.2.1.1. ON VOLCANIC ROCKS:

On vertical or overhanging surfaces: Acarospora "chlorophana", Acarosoora fuscata (north-facing), Dimelaena oreina, Xanthoria elesans (southeast-facing), and X. fallax.

On gentle to more often steep surfaces mostly towards the tops of larger outcrops: Caloplaca spp., Physcia dubia, P. spp., Rhizoplaca peltata, and Umbilicaria hyperborea.

On tops of larger outcrops, 'or occasionally on smaller rocks (but then away from water channels): Lecanora phaedroohthalma, and Lecidea tessellata.

On pebbles or low outcrops that are often partly buried in soil, on gently sloping areas exposed to occasional flows of water: Acarosoora sp. (brown), Lecanora muralis, L. pseudomellea, and others.

On pebbles or low outcrops in water channels or seepage areas : Dermatocaroon spp. ,

On iron-rich rocks along the sides of canyons or above them: Acarospora sinopica.

On rocks (no obvious preferences, or information insufficient): Acarosnora washinatonenis; A. spp. (brown), Aspicilia . , Candelariella vitellina, Lecanora sarovaslii s. lato, Lecidea spp., Neofuscelia verruculifera, Parmeliella cvanolepra, Rhizocarpon bolanderi, Rhizoplaca melanoohthalma, Umbilicaria phaea, U. polvrrhiza, U. torrefacta, Xanthooarmelia cumberlandia, and X. spp.

3.3.3.2.1.3.2.1.2. ON SEDIMENTARY ROCKS (sandstone or conglomerate; concrete):

On steep to vertical or overhanging surfaces: Acarospora sp., Caloplaca decipiens, Lecanora muralis, Lecidea sp. (brown), Phaeophyscia sp., and Rhizoplaca melanophthalma.

On horizontal surfaces: Lecanora muralis, Rhizoplaca melanophthalma, and others.

On unspecified surfaces: Acarospora bullata,

Candelariella aurella, C. rosulans, Lecidea sp. (cryptothalline), and Lobothallia praeradiosa.

On concrete: Candelariella aurella, Lecanora dispersa, L. muralis, and Lecidea sp. (brown).

3.3.3.2.1.3.2.2. Artemisia tridentata ssp. tridentata/Stipa comata. Association

Habitat: Average annual precipitation at the site is 230-280 mm.

Distribution: Lichens were. collected in E. Plateaus and Hills, OR (Malheur Co.).

Representative species: Dermatocarpon reticulatum was found.

3.3.3.2.1.3.2. Artemisia tridentata spp. wyominsensis communities:

Artemisia tridentata ssp. wyomingensis/Agropyron spicatum-Festuca idahoensis Community

Habitat:

Distribution: Lichens were collected in E. Plateaus .and Hills, OR (720 m, Jefferson Co.).

Representative species: Peltula euploca, which is a species apparently not yet found elsewhere in the region, but'common in arid or semi-arid areas of the southwestern U.S., was found in this community, on basalt cliffs, probably in an area periodically exposed to water seepage or runoff.

3.3.3.2.1.3.3. Artemisia tridentata ssp. vasevana communities

Artemisia tridentata ssp. vaseyana/Festuca idahoensis Association

Habitat:

Distribution: Lichens' were collected in Columbia Plateau, WA (1200 m, Lincoln Co.).

Representative species: Umbilicaria hyperborea was found.

3.3.3.2.1. BUNCHGRASS ZONE (Lyons, 1971); PALOUSE PRAIRIE (Daubenmire, 1992).

3.3.3.2.1.1. GENERAL

Habitat: For saxicolous lichens, in this zone is probably similar'to the Sagebrush Zone, 'except that conditions are often somewhat moister, and on the other hand even less protection from harsh conditions is available.

Distribution: In WA the zone occurs at ca. 540-600 m. In addition-to the sites mentioned specifically below, lichens were collected at several presumed grassland sites in E.' Slope of Cascades, WA (600 m, Chelan Co.; 510 m, Okanogan Co.), and N.E. Mountains, OR (800 m, Grant Co.; 300 m, Wallowa Co.).

Sensitivity: Pollution from agricultural or other human activities may be more important to lichens in this zone than in the mostly sparsely settled shrub-steppe areas.

Representative-species: With.a few possible exceptions (e.g., Rhizocarpon'cookeanum, which so far has apparently been identified only from this zone),.the saxicolous lichen flora in bunchgrass areas is similar to that of the Sagebrush Zone, but appears to be less diverse (probably -because' fewer rocky areas and fewer special'microhabitats are present).

3.3.3.2.1.2. PARTICULAR ASSOCIATIONS

3.3.3.2.1.2.1. Agropyron spicatum/Poa sandbersii Association:

Habitat: The 245 m site was along a river.

Distribution: Lichens were collected in Columbia Plateau, WA (four sites, 245-365 m, Asotin Co.; one site, 60-120 m, Klickitat Co.) and E. Plateaus and Hills, OR ("near confluence of Columbia and John Day Rivers", ca. 1000-1100 m, vicinity of Sherman Co. [label says Wasco Co., but the locality, if correctly recorded, is near the border of Sherman and Gilliam counties]).

Representative species: The following species.were found at the Klickitat Co. site unless noted otherwise:

On shaded, vertical to overhanging surfaces of basalt cliffs (north-facing at Klickitat Co. site, south-facing at one Asotin Co. site): Lecanora demissa.

On vertical surfaces of basalt boulders: Acarosoora "chlorophana", Candelaria- concolor, Diploschistes scruposus, Lecanora muralis, and Rhizoplaca melanophthalma.

On vertical surface of southeast-facing cliff: Rhizoplaca chrvsoleuca and R. peltata.

On more or less exposed, steep to vertical surfaces of 'north-facing cliff: Lecanora muralis, Rhizoplaca melanophthalma, and Xanthoria eleaans.

On ledge of horizontally running crevice in vertical basalt cliff: Lecanora muralis and Rhizoplaca melanophthalma.

On moderately sloping surfaces of basalt: Dimelaena thysanota, Lecanora muralis, L. phaedrophthalma, Neofuscelia verruculifera, Rhizocarpon riparium, R. sphaerosporum, R.

sp. (gray/brown), and Xanthoparmelia cumberlandia.

On horizontal surfaces at base of south-facing basalt cliff (365 m Asotin Co. site): Lecanora muralis, L. cf. weberi', and Xanthoparmelia mexicana.

On more or less exposed rocks near base of cliff (245 m Asotin Co. site): Lecanora garovaglii s. lato, L. muralis, Lecidea spp. (brown).

On unspecified rocks (two 300 m, Asotin Co. sites): Umbilicaria phaea and Xanthooarmelia spp.

'On basalt talus (OR site): Umbilicaria phaea.

3.3.3.2.1.2.2. Agropyron spicatum/Festuca idahoensis Association

Habitat: The 715 m site was on a S-facing hill.

Distribution: Lichens were collected at four sites in Columbia Plateau, WA (365 m, Adams Co./Whitman Co.; ca. 400-600 m, Columbia Co.; 560-715 m, Garfield Co.).

Representative species: The'following species were found at various sites, as indicated.

On basalt (unspecified, mostly gentle slopes) (715 m site): Lecanora muralis, L. phaedrophthalma, L. semitensis, Lecidea spp. (brown), Neofuscelia subhosseana, Rhizocarnon cookeanum, Rhizoplaca chrysoleuca, and R. melanoohthalma.

On vertical face, under boulder (715 m site): Lecanora garovaglii.

On vertical faces of basalt cliff (365 m site): Caloplaca saxicola (under overhang) and Lecanora muralis.

On basalt among grasses, at base of cliff (365 m site): Lecanora muralis and Xanthooarmelia sp.

On basalt (unspecified) (400-600 m site): Umbilicaria phaea.

3.3.3.2.1.2.3. Festuca idahoensis/Symphoricarpos albus Association

Habitat:

Distribution: Lichens were collected in Columbia Plateau, WA (500-765 m, Whitman Co.)

Representative species:

On vertidal or overhanging surfaces (760 m, Whitman Co.): Acarospora "chlorophana".

On rock (unspecified): Dermatocaroon miniatum, Diploschistes scruposus, Lecanora rupicola, Lecidea tessellata, L. sp. (L. atrobrunnea group), Phaeonhvscia decolor, Phvscia caesia, P. dubia, Rhizocaroon cookeanum, R. "disporum", R. geographicum, Rhizoplaca melanophthalma, Umbilicaria phaea

3.3.3.2.1.2.4. Festuca idahoensis/Hieracium Association

Habitat:

Distribution: Lichens were collected in Columbia Plateau, WA (300 m, Rlickitat Co.)

Representative species: Aspicilia sp., Lecanora muralis, L. phaedronhthalma, and Rhizocarpon sp. were collected at the site.

3.3.3.3. NON-ZONAL ASSOCIATIONS

3.3.3.3.1. Artemisia risida communities: Artemisia rigida/Poa sandbercrii communities, 450-2400 m

Distribution: Lichens were collected in Columbia Plateau, WA (ca. 650 m, Lincoln Co.) and E. Plateaus and Hills, OR (1400-2400 m, Harney Co.)

Representative species: Dermatocarpon spp. were found in both provinces; D. miniatum occurred on basalt cliffs and pebbles; D. reticulatum occurred on basalt and rhyolitic cliffs and on partly shaded outcrops. An -additional Dermatocarpon sp. was found on basalt at one Harney Co. site, and Staurothle clonimoides was found on pebbles at another site. Umbilicaria hyperborea was found at the Lincoln Co. site, mostly on individual rocks rather than on cliffs. Many additional species, found in biscuit scablands in Wasco Co.; OR, probably occurred in this association; but since that is not definitely known, they are treated under the discussion of biscuit scablands rather than here.

3.3.3.3.2. Desert Scrub Communities

Distribution: Lichens were collected in E. Plateaus and Hills, OR (41: three localities in or near the Alvord Creek desert, Harney Co.).

Representative species: Acarosnora "chlorophana", Caloplaca saxicola, Lecanora sp., and Lecidea tessellata were found on basalt at one site, in a canyon; Umbilicaria hyperborea, U. kraschennikovii, and U. phaea were found at another, and Asnicilia desertorum was found on desert agates at the third site.

3.3.3.4. MIXED COMMUNITIES:

3.3.3.4.1. BISCUIT- SCABLAND.

Distribution: Lichens were-collected in E. Plateaus and Hills, OR: Deschutes Plateau (40-l) Lawrence Memorial Grassland, Wasco Co.) (Rossman, 1992).

Representative species: The following species were reported (* = "common"):

On basait (unspecified): Buellia sp., Candelariella rosulans, Lecanora ohaedronhthalma, L. rupicola*, Lecidea plana, Neofuscelia subhosseana, Rhizocarpon bolanderi, R. disporum*, R. geographicum, R. srande, and Xanthoparmelia sp.

On "rocks of all sizes": Aspicilia "calcarea"*, Candlelariella vitellina* and Lecanora muralis*, and Lecidea cascadensis*.

On ("large") boulders: Acarospora fuscata*, Aspicilia caesiocinerea* and Lecanora cenisia*, Lecidea atrobrunnea and L. cascadensis*, L. tessellata*, Lecidella carpathica, Dermatocarpon miniatum and Umbilicaria hyperborea, Dermareticulatum* (on "large, exploded boulders"), Umbilicaria phaea, and Lecanora nigromarginata (on "vertical sides of large basalt-boulders").

On "large" rocks:. Buellia retrovertens*, Lecanora. argopholis, Rhizonlaca chrysoleuca and R. melanophthalma*, Xanthoparmelia plittii*, and X. "taractica".

On stone rings: Buellia retrovertens*, Lecanora rupicola* and Rimularia insularis*, Lecidea cascadensis* ("the most common lichen on the preserve covering about half the exposed surface") and Caloplaca epithallina*, Neofuscelia subhosseana*, Lecidella stigmatea (on small stones), and Umbilicaria phaea.

On cliffs or large rocks lining ravines (generally on bedrock): Diploschistes gypsaceus, Parmelia saxatilis, P. sulcata, Pseudephebe oubescens, and Umbilicaria hyperborea*

On small stones at ground level: In the mound and intermound communities: Verrucaria "nigrescens". In the intermound community: Aspicilia "calcarea"*, Catapyrenium plumbeum, and Lecidea lapicida*, and Lecidella stigmatea.

On basalt in bottom of ravines (Juniperus occidentalis Community): Staurothele sp.

On old bones: Caloplaca approximata, Candelariella rosulans, Lecanora "hageni", and L. phaedrophthalma.

3.3.3.5. **RIPARIAN AREAS:**

3.3.3.5.1. Open area with Salix spp., Amelanchier alnifolia, Artemisia tridentata, A. arbuscula, Chrysothamnus nauseosus, and Purshia tridentata; and scattered Pinus ponderosa.

Distribution: Lichens were collected in E. Plateaus and Hills, OR (Sprague River Picnic Area, 1290 m, Klamath Co., OR)-.

Representative species:

On basalt cliffs above river, with bird perch areas:

On vertical to overhanging surfaces: Acarosoora "chlorophana".

On nutrient-enriched vertical to overhanging surfaces: Caloplaca saxicola, Candelaria concolor, Xanthoria elegans, and, X. fallax.

On exposed ledges or projecting areas (mostly horizontal to moderately steep surfaces), moderately nutrient-enriched: Diploschistes scruposus, Lecanora muralis, Phvscia caesia, P. maonussonii, Rhizocaroon "disporum" and Rhizoplaca melanophthalma.

In sheltered niches recessed into the rock: Melanelia subaraentifera.

On other rocks:

On tops of large, exposed outcrops next to river: Xanthonarmelia sp.

On small (under 1 m across) exposed rooks by road, especially on steep surfaces: Candelariella vitellina, Lecanora sierrae, and Umbilicaria phaea.

On cliffs away from river, partly shaded by Pinus ponderosa: Lecanora muralis, L. sierrae, Leoraria spp., and Xanthonarmelia sp.

On rock (unspecified; mostly on exposed lava flow boulders away from river): Aspicilia spp., Dermatocarpon miniatum, D. reticulatum, Lecanora garovaglii s. lato, Lecidea tessellata, L. spp., Parmelia saxatilis, P. sulcata, Phaeoohvscia sciastra, Rhizocarpon bolanderi v. sulphurosa, and Umbilicaria cf. hyperborea.

3.3.3.5.2. Canyon, with various hardwood trees and shrubs, western foothills of the Warner Mountains.

Distributin: Lichens were collected in E. Plateaus & Hills, OR (Bullard Canyon, 1530 m, Lake Co., OR).

Representative species:

On exposed rocks (unspecified): Aspicilia spp., Caloplaca sp., Dermatocarpon miniatum, Lecanora garovaglii s. lato, L. muralis, Lobothallia radiosa, Melanelia elesantula, Rhizoplaca chrysoleuca, R. melanophthalma, R. peltata, Staurothele sp., and Xanthoria elegans were found.'

3.3.3.6. COMMUNTIES INTERMEDIATE BETWEEN SHRUB-STEPPE AND FOREST

3.3.3.6.1. Juniperus occidentalis/Artemisia "High Desert" Communities (unspecified species of Artemisia, not necessarily A, tridentata).

Distribution: Lichens were collected in E. Plateaus and Hills, OR (1350 m, Crook Co., 870-960 m, Deschutes Co.; ca. 800-900 m, Harney Co.; ca. 1000-2040 m, Lake Co.).

Representative species: The following species were found at various sites, as indicated:

On vertical or overhanging surfaces of basalt (870-900 m, Deschutes Co.): Acarosp"chlorophana".

On vertical surfaces of cliffs: Dermatocarnon arnoldianum and Xanthoria fallax (on rimrock 870-900 m, Deschutes Co.); Xanthoria elesans (on vertical rock faces below rimrock, 870-900 m, Deschutes Co.).,

On N-facing vertical walls on N side of high ridge (10 mi S of Burns, .Harney.Co.): Dermatocarpon reticulatum, Leptochidium albociliatum, Phvscia tenella.

On vertical walls in crevices; Dermatocaroon reticulatum, Leotochidium albociliatum, Phaeophvscia decolor, Phvsconia enteroxantha, and P. perisidiosa (all at 1400 m; Lake Co.); Pseudephebe pubescens (870-900 m, Deschutes Co.).

On basalt cliffs, in shade of overhanging rocks: Phvsconia enteroxantha (1400 m, Lake Co.); Acarospora fuscata and Dinloschistes scruposus (1350 m, Crook Co.).

On basalt cliffs, around Neotoma latrines: Calonlaca saxicola (1400 m, Lake Co.).

On exposed tops of basalt dliffs: Candelariella rosulans, Lecanora rupicola, Phvscia callosa (in crevices near urine deposits of Neotroma), and Phvsconia enteroxantha (in cracks) (all at 1400 m, Lake Co.).

On basalt flows: Dermatocarpon reticulatum (exposed NW-facing slope of basalt, 870-900 m, Deschutes Co.); Dimelaena thvsanota (1400 m, Lake Co.).

On base of basalt outcrop (870-900 m, Deschutes Co.): Phaeophvscia decolor.

On rocks in wind-swept gravelly areas (10 mi S of Burns, Harney Co.): Xanthoria elesans.

On gravel and larger rocks (3 mi N of Frenchglen, Harney Co.): Xanthooarmelia plittii.

On basalt boulders along east edge of mesa (Wright's Point, Harney Co.): Umbilicaria hyperborea and Xanthoria elesans:

On basalt'boulders near the road (Wright's Point, Harney Co.): Rhizoplaca chrvsoleuca.

On basalt (unspecified): Aspicilia sp., Calonlaca saxicola, Dimelaena thvsanota, Lecidea tessellata, L. spp. (including L. atrobrunnea group), Neofuscelia subhosseana, Parmelia (s. lato) sp., Phvscia cascadensis, Pseudephebe pubescens, Rhizocar on bolanderi, R. aeminatum, and R. grande (all at 870-900 m, Deschutes Co.); Biatorella hemispherica, Lecidea tessellata, and Rhizoplaca melanoohthalma (all at 1400 m, Lake Co.); Umbilicaria

phaea (960 m, Deschutes Co.); Phvscia biziana (10 mi S of Burns, Harney Co.); Lecidea tessellata (Diamond Craters, Harney Co.).

On other lichens (e.g., Lecidea spp.): Caloolaca eoithallina (several sites).

3.3.3.6.2. Juniperus occidentalis/Artemisia tridentata communities

Distribution: Lichens were collected in E. Plateaus and Hills, OR (1680 m, Klamath Co.);,

Representative species:

On steep sides of larger exposed basalt'outcrops: Phvscia sp. occurred.

On tops and moderately sloping sides of larger (ca. 0.5-0.7 m across, ca. 0.1-0.3 m high) exposed basalt outcrops: Acarospora sp. (brown, lobate), Asnicilia spp.*, Caloolaca sp. (C. ferrusinea group), Candelariella vitellina* (especially under junipers), Lecanora phaedrophthalma (on tops), L. sierrae, L. sp., Lecidea tessellata, L. spp. (brown)*, Rhizocaroon bolanderi V. sulphurosa, Rhizoplaca melanophthalma* (mostly concentrated towards tops), Umbilicaria cf. hyperborea* (mostly on sides), and U. Dhaea were found.

On horizontal tops of small (under 0.3 m across) exposed basalt rocks: Lecidea tessellata was common.

3.3.4. DRY CONIFEROUS FOREST (Vitt, et al.; 1988)

3.3.4.1. GENERAL

Habitat: Forests provide cooler, moister, and more shaded habitats. for' lichens.

Distribution: Forests are dominant in most provinces other than Columbia Plateau, WA and E. Plateaus and Hills, OR, where they are restricted to mountains areas.

Sensitivity: Logging and fire are the factors most likely to affect saxicolous lichens in forests,' although air pollution might be a potential problem in a few areas if it is severe enough.

Representative species: In open areas of forests, especially in the lower, drier zones, the saxicolous lichens are generally similar to those in Grassland-Savannah ecosystems. In more sheltered habitats in these forests, and in the higher or moister forests, many of these species are replaced by others. In particular, the abundance and diversity of macrolichens '(e.g.-, Parmelia and Umbilicaria) and some crustose'lichens (e.g., yellow species.of Rhizocaroon), increases in moister areas. This is also true of. aquatic and.semi-aquatic species, and of species growing on or among mosses.,

3.3.4.2. JUNIPERUS OCCIDENTALIS ZONE (Franklin & Dyrness, 1973)

Habitat: This zone is intermediate in conditions between the shrub-steppe communities and the forests. It is the driest and most open of the gymnosperm-dominated zones.

Distribution: As a zone, it occurs in E. Plateaus and Hills, OR (mostly Deschutes Co., Crook Co., and northwestern Lake Co.). At moderate elevations, to ca. 900(-1350) m.

Sensitivity: Fire is probably the main threat to the lichens.

Representative species: The saxicolous lichens are generally similar to those that are common both in the dry lower zones and the Pinus oonderosa zones.

3.3.4.2.1. Juniperus occidentalis Communities (unspecified)

Distribution: Lichens were collected in E. Plateaus and' hills, OR (41-4: 870 m, Deschutes Co.; 41-2: 1320 m, Wheeler Co.; 41-10: 1620 m, Lake Co.)

Representative species: 'Lecanora muralis, L. cf. niaromarsinata, L. phaedrophthalma, Lecidea spp. (brown), Neofuscelia subhosseana, Rhizocarpon sp.(gray/brown), Rinodina sp., Umbilicaria hyperborea, and Xanthonarmelia plittii were found on andesite at the Deschutes Co. site. The same Lecanora spp., plus L. garovaglii, Neofuscelia verruculifera, Rhizoplaca chrysoleuca, Umbilicaria "vellea" and Xanthonarmelia sp. were found on basalt at the Wheeler Co. site; Lecanora semitensis was found on basalt at the Lake Co. site. Additional species are listed above under Juniperus/Artemisia communities.

3.3.4.2.2. Juniperus occidentalis/Festuca community

Saxicolious

Distribution: Lichens were collected in E. Plateaus and Hills, OR (600 m, Grant Co.).

Representative species: Xanthoparmelia cumberlandia was collected at the site.

3.3.4.3. YELLOW PINE ZONE (Lyons, 1971). PINUS PONDEROSA ZONE (Franklin & Dyrness, 1973)

3.3.4.3.1, GENERAL

Habitat: These forests are relatively dry and open compared to ones in higher zones (except P. contorta zone).

Distribution: In WA the zone occurs at ca. 600-900 m. In addition to sites mentioned below, other presumed Pinus nonderosa sites where lichens were collected are in E. Slope of Cascades, WA (910-990 m, Okanogan Co.; 660-1170 m, Chelan Co.; ca. 800 m, Kittitas Co.; 900 m, Yakima Co.; ca. 500-900 m, Klickitat Co.) and E. Plateaus and Hills, OR (1350 m, Klamath Co.).

3.3.4.3.2. UNSPECIFIED VEGETATION, PRESUMED TO BE IN TEE PINUS PONDEROSA ZONE

Representative species: Some additional species include the following: Acarosoora badiofusca, Bellemerea cinereorufescens, and Melanelia sranulosa on unspecified rocks, and Caloplaca fraudans and Ochrolechia sp. on sandstone, at the 610 m site in Okanogan Co.

3.3.4.3.3. UNSPECIFIED PINUS PONDEROSA FORESTS

Distribution: Lichens were collected in N.E. Mountains, WA (ca. 600 m, Pend Oreille Co.; 590 m, Spokane Co.) and N.E. Mountains', OR (1005 m, Crook Co.; 1620 m, Grant Co.; 1100 m, Union Co.; 780 m, Wallowa Co.), and E. Plateaus and Hills, OR (1200-2000 m, Deschutes Co.; 1525 m, Lake Co.).

Representative species: Rimularia insularis was found on Lecanora rupicola at the Union Co. site. Two species not known elsewhere from the region, Flavoparmelia caperata and Flavopunctelia flaventior, were found at the Wallowa Co. site. Other species found at various sites include Lecanora cenisia, L. laatokkaensis, L. semitensis, L. cf. weberi, and Rhizoplaca cf. subdiscreoans.

3.3.4.3.4. PARTICULAR ASSOCIATIONS

3.3.4.3.4.1. Pinus ponderosa/Agropyron spicatum Association

Habitat:

Distribution: Lichens were collected in E. Slope of Cascades, WA (34: ca. 800 m, Kittitas Co.; 665 m, Yakima Co.)

Representative species: Lichens are from the 665 m site unless specified otherwise.

(Squaw Rock, 665 m, Yakima Co., WA):

On steep surfaces near base of basalt cliff, under pines: Acarosoora "chlorophana", Lecanora muralis, L. nigromarginata, L. aseudomellea, L. cf. weberi, Rhizonlaca melanophthalma, and R. cf. subdiscrepans were found.

On gently sloping surfaces under overhangs and under pines: Lecanora muralis and Rhizoplaca melanophthalma were collected.

On moderately sloping, exposed surfaces: Aspicilia

spp., Lecanora sarovaalii s. lato, L. muralis, L. phaedrophthalma, Lecidea spp. (brown), Neofuscelia verruculifera, and Rhizoplaca melanophthalma were found.

On exposed boulder (800 m site): Dermatocarpon miniatum occurred.

On bone (800 m sife): Xanthoria "candelaria" was found.

3.3.4.3.4.2. Pinus ponderosa/Symphoricarpos albus Association:

Distribution: Lichens were collected in Columbia Plateau, WA (ca. 900 m, Whitman Co.).

Representative species: Phvsconia enteroxantha.

3.3.4.4. MONTANE FOREST ZONES (Lyons, 1971)

3.3.4.4.1. GENERAL

Distribution: In WA these zones occur at ca. 900-1500 m.

Representative species: The following species were found in areas with unspecified vegetation (probably Pseudotsuaa or Abies grandis forests): Umbilicaria "vellea" (Phanessa Grotto, Pend Oreille Co.), Xanthoria elesans (Twisp region, Okanogan Co.)

3.3.4.4.2.' SPECIAL HABITATS

3.3.4.4.2.1. Aquatic/semi-aquatic lichen communities.

Habitat: Usually siliceous rock. Although many of the species are also common in other major zones, and are mentioned in the discussions of them, they are treated together here for convenience.

Distribution: At least some aquatic or semi-aquatic lichens (particularly the crustose ones) are known or presumed to occur in all provinces in the region. Lichens were collected in E. Slope of Cascades, WA (Dewey Lake, ca. 1500 m and Dumbbell Lake, 1650 m, Yakima Co.), E. Plateaus & Hills, OR (Holborok Reservoir, 1650 m,.and Dairy Creek, 1930 m, Lake Co.).

Role(s): Hydrothyria venosa is a nitrogen fixer. It and Dermatocaroon spp. probably provide habitats for invertebrates or possibly even very small fish or frogs. At least some aquatic lichens are probably also eaten by various animals.

Bensitivity: Lichens on rocks in these habitats are probably sensitive to water quantity and quality; as affected by water usage, logging, agriculture, human settlements, and urban or industrial development.

Representative species: The most truly aquatic lichen (Hydrothyria venosa) appears to be restricted to moist foresfs, usually but not always at higher elevations; near the Columbia Gorge it sometimes becomes abundant enough in the water at the Carson Fish Hatchery (Skamania Co.) to clog screens (Davis, pers. comm., 1994). Species of Aspicilia, Dermatocarpon, Staurothele! and Verrucaria occur on at least periodically inundated rocks, in all the major zones, but the species considered to be aquatic'or semi-aquatic (D. arnoldianum, D. luridum, and D. rivulorum; S. fissa, and the V. margacea group) are probably most characteristic of montane forests, and are apparently absent from the warmest and driest zones (steppe and shrub-steppe). Most other semi-aquatic crustose species (e.g., Hymenelia lacustris) also appear to be restricted to the higher elevation zones (montane forest to alpine). However, the crustose aquatic species are often very difficult to collect and identify, making it difficult to reliably describe their distribution and ecology.

A species, of Dermatocarpon was found in Dewey Lake. Hymenelia lacustris was found in Dumbell Lake. Dermatocarpon sp., "Microthelia aterrima", and Staurothele fissa were found in Streams at unspecified elevations near Mt. Adams. Dermatocarpon luridum and Staurothele sp. were found at the Dairy Creek site.

A Staurothele species was also found in creeks at the Holbrook Reservoir site.

3.3.4.4.3. MISCELLANEOUS FORESTS:

3.3.4.4.3.1. Open Pseudotsuga-Pinus ponderosa forests:

Distribution: Lichens were collected in E. Slope of Cascades (760 m, Kittitas Co.; 960 m, Yakima Co.).

Representative species: The lichen floras at the two sites were totally different.

On overhanging surfaces (760 m site): Rhizoplaca melanophthalma

On steep surfaces (760 m site): Collema sp., Dermatocarpon sp., Lecanora muralis, L. rupicola, Lecidea sp. (brown), and Rhizoplaca melanoohthalma.

On gently sloping surfaces (760 m site): Caloplaca sp., Catapyrenium sp., Lecanora muralis, L. nisromaroinata, L. phaedronhthalma, L. rupicola, L. cf. weberi, Lecidea tessellata, Ochrolechia unsaliensis, and Rhizoplaca melanoohthalma.

'On unspecified surfaces (960 m site): Aspicilia sp., Bellemerea alpina, Dioloschistes scruposus, Lecanora laatokkaensis, L. polytropa, L. rupicola, L. sp., Lecidea ssp. (brown), Rhizocarnon sp. (yellow), Umbilicaria sp.

3.3.4.4.4. PINUS'CONTORTA ZONE (Franklin & Dyrness, 1973).

Representative species: Although no lichens have been collected definitely known to be in this zone, species growing on pumice are likely to occur here. Lecidea pumicicola has been collected on pumice at the edge of an obsidian flow in E. Plateaus and Hills, OR (1600 m, Deschutes Co.).

3.3.4.4.5. PSEUDOTSUGA MENZIESII ZONE (Franklin & Dyrness, 1973)

3.3.4.4.5.1. UNSPECIFIED PSEUDOTSUGA FORESTS:

Distribution% Lichens were collected'in E. Slope off Cascades, WA (900 m, Yakima Co.), E. -Plateaus & Hills, OR (1340 m, Klamath Co.), and N.E. Mountains, OR (914 m, Union Co.).

Representative species: Also see list of species found in mixed Pseudotsuga-Pinus ponderosa forests.

On gently sloping basalt (Yakima Co. site): Lecanora muralis, Lecidea sp. (brown), Tremolecia atrata.

On basalt in sheltered canyon (Union Co. site): Neofuscelia verruculifera, Rhizocarpon geographicum.

On andesite (Klamath Co. site): Aspicilia sp., Lecanora muralis, L. cf. niaromaruinata, L. semitensis, L. cf. weberi, Lecidea sp. (brown), Phaeonhvscia decolor, and Rhizoplaca melanophthalma.

3.3.4.4.5.2. PARTICULAR ASSOCIATIONS

3.3.4.4.5.2.1. Pseudotsuua menziesii/Physocarpus malvaceus Association (Cooke, 1955).

Distribution: Lichens were collected in Columbia Plateau, WA

(northern plot, 60 m, Spokane Co.)

Representative species; Cladonia Community: Cladonia fimbriata.

3.3.4.4.5.2.1. Pseudotsuoa menziesii-Picea'enalemanii-Larix occidentalis Community

Distribution: Lichens'were collected in N.E. Mountains, OR (1575-1800 m, Wallowa Co.).

Representative species: Bellemerea alpina, Lecanora ruoicola, Lecidea sp., Leptogium sp., Neohroma parile, Rhizocarnon geographicum were found on rocks in open forest; Collema sp. was explicitly stated to have been found on granite.

3.3.4.4.6. TSUGA HETEROPHYLLA SERIES

3.3.4.4.6.1. **ABIES GRANDIS ZONE** (Franklin & Dyrness, 1973)

Distribution: Although many of the montane sites were lichens have been collected. are probably in this zone, most of them might just as easily be in the Pseudotsuoa Zone, and the label data provide little or no ecological'data. The information on species given below comes from collections at one area.in E. Slope of Cascades, WA (Roger Lake area, 1775-1825 m, Okanogan Co.) that is near the boundary between the montane and subalpine zones.

Representative species (* = "common"):

On outcrops and boulders in forest (1775 m): Aspicilia spp.*, Bellemerea alpina*, Lecanora cenisia*, L. polytropa*, Lecidea leucothallina*, Lecidea spp.*, Lepraria spp.*, Melanelia granulosa*, Protooarmelia badia, Pseudephebe pubescens, Rhizocaroon geographicum*, R. sp. (gray/brown)*, Umbilicaria deusta*, and U. torrefacta were found

On exposed **boulders (1825** m): Aspicilia spp.*, Lecidea spp.*, Lepraria neglecta*, L. sp.*, Melanelia granulosa*, Parmelia saxatilis, Pseudephebe pubescens, Umbilicaria cf. caroliniana, U. hvoerborea, U. torrefacta, U. sp. were found.

3.3.4.4.6.2. ARIES CONCOLOR ZONE (Franklin & Dyrness, 1973)

Habitat: Generally similar to that of the A. arandis zone.

3.3.4.4.6.2.1. Exposed lava flow surrounded by conifer forest (probably Abies concolor).

Habitat: Some of the rocks are quite large, providing many microhabitats (different slopes,- aspects, and surface features), for various lichens. Most of the lichens were found on these larger rocks.

Distribution: Lichens were collected in E. Slope of Cascades,.OR (1620 m, Klamath Co.).

Representative species: Asoicilia sp., Lecidea cf. cascadensis, Pseudeohebe oubescens, Rhizocarnon bolanderi, R. geographicum, R. sp,, and Umbilicaria hyperborea were found,

3.3.4.4.6.2.2. Abies concolor forests with Pinus ponderosa

and/or P. contorta).

Habitat: Some of the localities were in or near riparian areas lined with deciduous woodlands.

Distribution: Lichens were collected at numerous localities in E. Plateausand Hills, OR (1500-1930 m, Klamath Co., 1650-2000 m, Lake Co;).

Representative species: It is noteworthy that Parmelia hygrophila (a species mainly of humid forests) was found at three sites, one riparian, the other two in open, non-riparian areas, including one site where two primarily corticolous lichens, Platismatia glauca and Tuckermannonsis chlorophylla (both also more characteristic of fairly moist areas) were found on rock (T. chlorophvlla also occurred on rock at another dry site. These species were all found only on steep or overhanging surfaces, at the higher elevations (above 1900 m). The lichen flora particularly at one of the higher elevationsites, Palisade Rocks (an open area near timberline, at 1950 m), includes some primarily alpine species (Bellemerea alpina, Pseudeohebe minuscula, Sporastatia testudinea, and Umbilicaria decussata). Pseudephebe pubescens, which has a wide elevational distribution but is most characteristic of the alpine zone, was also found at that site, two other high elevation sites, and two sites at 1500 m.

On vertical or overhanging surfaces: Acarospora "chlorophana"

In shaded crevice on overhanging rock surface: Platismatia alauca was found at one site.

On steep rock faces in open areas: Brvoria sp., Dermatocarpon reticulaturn, Lecanora cenisia, L. sp., Parmelia hygrophila, Physcia sp., Pseudenhebe oubescens, Tuckermannopsis chlorophvlla, and Xanthoria "candelaria" were found at one site.

On rocks in the forest: Dennatocarpon sp., Lecanora muralis, and Leoraria neglecta were found.

On submerged rocks in creeks: Dermatocarnon luridum and Staurothele sp.

On dry rocks (no obvious preferences, or information insufficient): Species found at two or more sites include Aspicilia spp., Candelariella vitellina, Dermatocarnon miniatum, D. reticulatum, Lecanora muralis, L. polytropa, L. 'nseudomellea, L. rupicola, L. semitensis, Lecidea spp. (brown), Lecidella carpathica, Leoraria nealecta, Melanelia elegantula, Phaeophyscia decolor, Physcia dubia, P. macmussonii, Pseudenhebe oubescens, Rhizocaroon lecanorinum, Rhizoplaca melanoohthalma, Umbilicaria hyperborea, U. phaea, U. torrefacta, Xanthoria "candelaria", and X. fallax. Other species that were found include Acarosnora sp. (brown), Bellemerea cinereorufescens, B. sp., Caloplaca cf. cascadensis, C. saxicola, C. sp., Dermatocarnon sp., Lecanora sp., Lecidea tessellata, Leptogium saturninum, Parmelia saxatilis, P. sp., Phvscia biziana, P. cascadensis, P. dimidiata, P. spp., Placvnthium? sp., Psora nipponica, Rhizocarnon geographicum, R. cf. sphaerosporum, R. suoerficiale, R. spp., Staurothele sp., Umbilicaria cf. polyphylla, and U. "vellea".

3.3.4.4.7. TSUGA HETEROPRYLLA ZONE (Franklin 6 Dyrness, 1973)

Habitat: The areas where this zone occurs in the WA part of the Columbia Basin are riparian.

Distribution: Although no'saxicolous lichens are definitely known to have been collected in the few areas in N.E. Mountains of WA where the zone is present, there is no reason not to expect them in this zone;

3.3.5. SUBALPINE FOREST-TUNDRA (vitt, et al., 1988) SUBALPINE ZONE (Lyons, 1971) FORESTS, AND TIMBERLINE VEGETATION (Franklin & Dyrness, 1973)

3.3.5.1. GENERAL

Habitat: Conditions are cold and relatively moist. Sources of nutrient.enrichment are probably minimal.

Distribution: In WA-the zone occurs at ca. 1500-2100 m, although occasional krumholz trees occur somewhat higher. In addition to the sites mentioned below, there are a number of localities from which Howard (1950) and Douglas (1974) reported lichens, in E. Slope of Cascades, WA (North Cascades: Chelan and Okanogan counties); that could be either montane or subalpine..

Sensitivity: Saxicolous lichens are probably not threatened much in this zone:, Trampling, or burying in mud, could be a problem in heavily used areas.

Representative species: In addition to species mentioned specifically below, many others that were collected by Howard, Douglas, or others, that occur both in the alpine zone and in various lower elevation zones are likely to also occur at least occasionally in subalpine areas.

3.3.5.2. AQUATIC COMMUNITIES

Habitat: Water in subalpine areas is cold, and is likely to be relatively clear and pure (not polluted, nor stagnant), except near trails or camping areas.

Distribution: Lichens were collected in E. Slope of Cascades, WA (1920 m, Yakima Co.) and E. Slope of Cascades, OR, (two locations in Deschutes Co., one in Klamath Co.).

Sensitivity: Muddy conditions caused by human activities are a potential threat.

Representative species: Hydrothyria venosa was found in small streams or rills running into lakes, at the three OR sites, Dermatocarpon luridum was found in streams at the WA site.

3.3.5.3. FORESTS (ABIES LASIOCARPA AND TSUGA MERTENSIANA ZONES) (Franklin & Dyrness, 1973)

Habitat: Within the forests, conditions are moist and cold. Heavy snowfalls are not likely to be melted by sunlight or blown away by wind, as they are in krumholz areas or the alpine zone.

Distribution: Although apparently no saxicolous lichens have been identified from definite subalpine forests in the WA/OR part of the Columbia Basin, lichens undoubtedly occur in rocks in these forests.

Representative species: In my experience in other regions (including the west side), the saxicolous'flora in subalpine forests tends to be mostly a continuation of that found in other forests found at moderate to high elevations, with species of Aspicilia, Lecidea, and Rhizocarpon usually dominant, and Umbilicaria spp. (and occasionally others) occurring in more open areas.

3.3.5.4. TIMBERLINE VEGETATION

Habitat: The OR locality was in an area with scattered clumps of Abies lasiocarpa and Tsuga mertensiana. Conditions, are more or less intermediate between those of forests and the alpine zone.

Distribution: Lichens were collected in E. Slope of Cascades, WA (1925 m, Okanogan Co.; 1890 m, Yakima Co.) and E. Slope of Cascades, OR (1800 m, Hood River Co.).

Representative species: Lecidea sp. and Rhizocarpon sp. were found at the OR site. Acarospora "chlorophana", Bellemerea alpina, Lecanora novomexicana, Snorastatia testudinea, and. Tephromela armeniaca were found on vertical (to overhanging in the case of A. "chlorophana" and partly L. novomexicana) surfaces of andesite in open areas. Of these, B. alpina, S. testudinea and T. armeniaca are primarily alpine species, L. novomexicana is primarily-a species of fairly dry, open communities from shrub-desert to alpine in the Rocky Mountains, and in the Pacific Northwest, it is occurs rarely, apparently always in timberline or alpine areas. On exposed outcrops at the 1925 m Okanogan Co. site, Aspicilia spp., Lecanora polytropa, Lecidea spp., Lepraria nealecta, Melanelia sranulosa, Rhizocaroon geographicum, Umbilicaria hwerborea, and U. polyrrhiza were common; other species present included Dermatocarnon moulinsii, Physcia phaea, Pseudenhebe pubescens, Rhizonlaca melanophthalma, R. subdiscrepans s. lato, Rinodina sp., Umbilicaria sp., and a sterile crust were found.

3.3.5.5. SUBALPINE MEADOWS

Habitat: Conditions for lichens are sunnier (and also drier, on larger rocks or ones in drymeadows) than in the forests.

Distribution: Lichens were collected in E. Slope of Cascades, WA (Upper Bird Creek Meadows, Yakima Co.). Other collections have probably been made in other subalpine meadows in the region, but no data on habitat is available for them..

Representative species: Lecidea orotabacina was collected.

3.3.6. ALPINE TUNDRA (Vitt, et al., 1988) ALPINE ZONE (Lyons, 1971, Franklin & Dyrness, 1973)

3.3.6.1. GENERAL

Habitat: Conditions are very cold. Although snowmelt provides water, many rock habitats in this zone are quite dry. At least in moister sites, sunlight is often blocked by clouds. Sources of nutrient enrichment-are probably few in most areas. Rock twe: Rocks in alpine areas of the region are mainly siliceous. Snow: Saxicolous lichens in alpine areas are less abundant with increased snow cover (Flock, 1978). Wind: May be important in dispersing lichens by fragmentation. A few species seem to be characteristic of windy areas; however, this may relate more to dryness or removal of snow than to the wind itself.

Distribution: In WA the zone generally occurs above ca. 2250 m (Lyons, 1971).

Sensitivity: Few if any threats to saxicolous species are likely in this zone. Possibly there could be slight losses in a few areas heavily used.by hikers or climbers, due to abrasion or trampling, or burying by dust, mud, or debris. Lichens that require shelter or nutrients provided by vascular plants might be impacted by loss of those plants. Pollution might be a problem in a few places where air might flow from the bigger urban areas on the west side of the Cascades up into alpine areas on the Cascade crest.

Representative species: Of the macrolichens, Alectoria nioricans, Allantooarmelia alpicola, Brodo oroarctica, Cetraria commixta, C. hepatizon, Cornicularia normoerica, Umiblicaria arctica, U. havasii, U. vellea, U. virsinis, and perhaps others, are restricted to arctic-alpine areas. Crustose species more or less restricted to alpine (or arctic-alpine) areas include Bellemerea subsorediza, Lecanora bicincta, L. intricata, L. melaena, pringlei, Lecidea atromarainata, Ophioparma lapponica, Sporastatia testudinea, and Tephromela anneniaca

3.3.6.2. AQUATIC COMMUNITIES.

Habitat: See under. subalpine aquatic communities.

Distribution: Lichens were collected at Harts Pass/Grasshopper Pass, [ca. 2000 m], Okanogan Co./Whatcom Co.

Sensitivity: See under subalpine aquatic communities.

Representative species: Dermatocarpon luridum was found. Staurothele spp. are also likely to occur in streams in'the alpine zone.

3.3.6.3. COMMUNITIES ON DRY ROCKS, BY PROVINCE OR-SUBPROVINCE.

3.3.6.3.1.' E. Slope of Cascades, WA: North cascades (probably metamorphic rocks)

3.3.6.3.1.1. **Distribution:** Lichens were collected in Chelan co. at Hoodoo Pass, 2200 m (Douglas, 1974); Harts Pass/Grasshopper Pass, [ca. 2000 m], on the border of Okanogan

and Whatcom Co. (Glew, unpublished); and in Okanogan Co. at Haystack Mountain, 2200 m (Douglas, 1974); Snowshoe Mountain, 2200 m; summit of Slate Peak, 2250 m (Imshaug, 1957; Glew, unpublished); Joe Mills Mountain, 2354 m (Douglas, 1974), Chopaka Mountain, 2400 m (Douglas, 1974);' trail to Windy Peak (Douglas, 1974) ; summit of Windy Peak', 2430 m, and summit of Tiffany Mountain, 2482 m (Imshaug, 1957); and McLeod Mountain, 2464 m '(Douglas, 1957).

3.3.6.3.1.2. 'Representative species:

Macroiichens were collected at all of the sites. Pseudenhebe pubescens was found at four of the sites. Phvscia dubia, Umbilicaria hwerborea and Xanthoria eleaans were each collected at three sites. Several species (Alectoria nisricans, Brodoa ororactica, Pseudenhebe minuscula, Umbilicaria decussata, and U. virainis) were found at the summits of Slate Peak, Windy Peak, and Tiffany Mountain, and nowhere else. Allantoparmelia alpicola and Cetraria henatizon were found only at the summits of Windy Peak and Tiffany Mountain.. Umbilicaria oroboscidea was found at McLeod Mountain. Cetraria commixta, Cornicularia normoerica, Melanelia infumata, M. sorediata, Parmelia saxatilis, Physcia aipolia, Umbilicaria arctica, U. cylincrida, U. havasii, U. torrefacta, U. vellea, and U. sp. were found only at Slate Peak. Dermatocarpon reticulatum (on dry rocks) and D. luridum (on wet rocks) were found only at Harts Pass/Grasshopper Pass.

Crustose lichens were collected at all sites, but Imshaug's data on these is not available to me at present. The only crustose species found that is apparently restricted to arctic-alpine areas were Bellemerea subsorediza and Lecidea atromarginata (Slate Peak), Ophioparma lapponica (Hoodo Pass), and Lecanora intricata (Harts Pass/Grasshopper Pass). Other species found that have'broader ecological amplitudes, include Acarosnora "chlorophana", Aspicilia spp., Lecanora polytropa, L. rupicola, Lecidea "atrobrunnea", L. cascadensis, L. confluens, Lecidella stigmatea, Lepraria neglecta, L. spp., Porpidia glaucophaea, Rhizocarpon geographicum, R. macrosporum, Rhizoplaca chrysoleuca, R. melanophthalma, and Staurothele fuscocuorea.

3.3.6.4. E. Slope of Cascades, WA: **Central** Cascades (andesite or other hard, non-porous **volcanic rocks).**

3.3.6.4.1. Distribution: Lichens were collected at Raven's Roost, 1860 m, Timberwolf Lookout and Sourdough Gap, 1950 m, and Mt. Adams, 2400-2700 m, Yakima Co.

3.3.6.4.2. Representative species: Information is from Raven's Roost unless specified otherwise. Although collections were also made at Crystal Peak, 1950 m, that locality is actually in Pierce Co.. The saxicolous flora there was generally similar to that at Raven's Roost, but there were also some additional species found at Crystal Peak: Alectoria niqricans, Bellemerea alpina, Candelariella sp., Brodoa oroarctica, Cetraria hepatizon, C. muricata, Hypogymnia bitteri, Parmelia omphalodes (on steep surfaces), P. saxatilis, Tephromela armeniaca (on vertical surfaces), Umbilicaria virgins (on overhanging surfaces), and

Xanthoparmelia sp.

On overhanging surfaces: Acarospora "chlorophana", Lecanora bicincta, L. novomexicana*, Rhizoplaca melanophthalma, and SDorastatia testudinea.

On vertical surfaces: Allantoparmelia alpicola, Lecanora bicincta, L. melaena, L. Drinslei, L. rupicola, L. sp., RhizocarDon "disporum", RhizocarDon sp. (yellow)*, SDorastatia testudinea (also at Sourdough Gap); Umbilicaria kraschennikovii, and Xanthoria elesans were found. Other species include: Lecanora DolytroDa, RhizocarDon sp. (yellow) *, SDorastatia testudinea, and Tremolecia atrata* (all at Sourdough Gap).

On steep surfaces of exposed boulders: Alectoria lata, AsDicilia sp., Hypogymnia austerodes, Lecanora bicincta; L. prinalei, Ophioparma lapponicum, PseudeDhebe Dubescens, RhizocarDon geographicum, R. sp. (yellow), RhizoDlaca melanophthalma, Umbilicaria kraschenninkovii, and U. sp. were found

On gentle slopes of large, boulders on very exposed, windy points on ridgetops: AsDicilia spp. (A. cinerea/A. aibbosa group), Lecanora bicincta, PseudeDhebe Dubescens, Rhizoplaca melanophthalma, and Thamnolia vermicularis were found.

On moderately sloping surfaces: Acarospora sp., Lecanora polytropa, L. rupicola, Lecanora sp., Lecidea sp. (brown), PseudeDhebe Dubescens, RhizocarDon geographicum, R. riparium, and R. sp. were found.

On exposed rocks: Lecidea sp. (brown) and Umbilicaria kraschenninikovii (at Timberwolf Lookout) were found.

On unspecified rock surfaces: Alectoria lata, AsDicilia spp., Bellemerea sp., Lecanora DolytroDa, Lecidea lactea, L. spp. (brown), PseudeDhebe Dubescens, and RhizocarDon spp. (gray/brown and yellow). At the highest elevation site (Mt. Adams), PseudeDhebe Dubescens and Umbilicaria vircfinis were found.

3.3.6.5. E., Slope of Cascades, OR

Distribution: Collections were made at McKenzie Pass, 2400 m and summit of South Sister, 3157 m, Deschutes Co.; trail from North Sister to Middle Sister; 2760 m, Deschutes Co./Lane Co. (Imshaug, 1957); Mt. Hood, 3370 m, Hood River Co.; and Crater Lake National Park, 1883-2392 m, Klamath Co.

Representative species: Acarospora fuscata and Lecidea pumicicola (both on pumice) and Lecanora Drinslei (on unspecified rock) were found near Crater Lake; Pseudephebe Dubescens and Umbilicaria virsinis were found at the 2760 m site; Ophioparma lapponicum was found at the 2400 m site; and Lecidea spp. were found at the 3175 m and 3370 m sites.

3.3.6.6. N.E. Mountains', OR

Distribution: Lichens were collected at summit of Eagle Cap, 2915 m, Union Co./Wallowa Co. (Imshaug, 1957).

Representative species: Phvscia dubia, Pseudephebe minuscula, P. pubescens, Umbilicaria decussata, U. hwerborea, U. kraschenninikovii, and U. virainis were found on unspecified rocks.

3.3.6.7. E. Plateaus & Hills, OR (41-13/14)

Distribution: Lichens were collected at summit of Steens Mountain, 3000 m, Harney Co.

Representative species: Rhizoplaca melanophhalma and Umbilicaria virginis were found.

Veg Zones

Table 1. Elevation and climate of major vegetation zones of Franklin & Dyrness (1973).

HABITAT FEATURES	VEGETATION ZONE: Shrub-Steppes					Forests					
	ARTR	AGSP/FEID	ARRI	JUOC	PIPO	PICO	PSME	ABGR/ABCO		TSHE	ABLA
Elevation (m)	30 to 1000	30 to 120	450 to 775	450 to 1400	760 to 1400	600 to 2000	1200 to 1525	100 to 1350	1100 to 2000	1650 to 2000	800 to 1200	1300 to 1700
Av. Annual Precip. (mm)	190-389	200-250	360-600	280	200-312	355-760	350-700		632-1157		560-1700	
Av. Summer Precip. (mm)	24-43	23-44	75			41-94	56-66		43-115			
Av. Annual Temp. (°C)	8-12	12	9				6-8	5-6		6-8		3-8
Av. Summer Temp.	19-25	23-24	20			16-20	14-16		18			13-16
Av. Max. Summer Temp.	28-35	31-33	28		26-32	26-32	27-31	27-30		25-29		
Av. Winter Temp.	0 to -5	0	-2			-3 to -5	-3 to -4		-1 to -5			
Av. Min. Winter Temp.	-3 to -10	-3 to -4	-5			-8 to -11	-11		-5 to -10			
Av. Annual Snow (cm)	34-136	34	102	15	15	141-252	417		231-450			500

Table 4 Distribution of major saxicolous lichen species by rock characteristics/position on rock.

LICHEN SPECIES	ROCK CHARACTERISTICS;POSITION ON ROCK'					
	Over- hangs	Sides of cliffs	Sides of outcrops	Tops of cliffs	Tops of outcrops	Pebbles/ gravel
Acarospora chlorophana	+++	+++	+			
Caloplaca saxicola	+	++	++	++	++	
Lecanora muralis	+	++	+ +	+ + +	+++	++
L. phaedrophthalma			+	++	+++	
Lecidea tessellata			+	++	+++	+
Pseudephebe pubescens		+	++	+	+	+
Rhizoplaca chrysoleuca			+	++	+++	
R. melanophthalma	+	++	++	+++	+++	+
Umbilicaria hyperborea		+	++	+++	++	+
U. kraschennikovii		++	+++			
U. phaea		+	++	+++	++	
Xanthoria elesans		+	++	+++	++	

life zones

Table 2. Distribution of major saxicolous lichen species by life zone.

LICHEN SPECIES	LIFE ZONE					
	Sage-	Bunch-	Yellow	Montane	Sub-	Alpine
brush. Grass	Pine	Forest	alpine			
Acarosoora chloroohana	+	+	+	+	+	+
Caloplaca saxicola	+	+	+			
Lecanora muralis	+	+	+	+		
Lecanora phaedronhthalma	+	+	+			
Lecidea tessellata	+	+	+			
Pseudephebe pubescens			+	+		
Rhizoalaca chrvsoleuca	+	+	+			
Rhizoolaca melanoohthalma	+	+	+	+	+	+
Umbilicaria hyperborea	+	+	+	+	+	+
Umbilicaria phaea	+	+	+	+		
Xanthoria elesans	+	+	+			+

Veg Zones

Table 4. Distribution' of major saxicolous lichen species by vegetation zone: of Franklin & Dyrness (1973).

LICHEN SPECIES	VEGETATION ZONE									
	Shrub-Steppes					Forests				
	ARTR	AGSP/FEID	JUOC	PIP0	PICO	PSME	ABGR/ABCO	TSHE	ABLA	Alpine
Acarosoora "chlorophana"	+	+	+	+	?	+	+	?	+	+
Caloplaca saxicola	++	?	++	++	?	?	+			
Lecanora muralis	++	+	+	+	+	+	+			
L. phaedro-phthalma	++	++	++	+	+	+				
Lecidea tessellata	++	++	++	+	?	+	+			
Pseudeohebe pubescens			+	+	?	+	+	?	?	+++
Rhizoolaca chrvsoleuca	+	+	+	+						
R. melanophthalma	+	+	+	+	+	+	+	?	?	+
Umbilicaria hyperborea	+	+	+	?	?	+	+	?	?	+
Umbilicaria phaea	+	+	+	+	?	?	+			
Xanthoria elesans	+	+	+					?	?	+

4. SUCCESSIONAL STAGES

Little is known about the preferences of most of the species for particular successional stages. In general lichen succession follows the order of crustose then foliose then fruticose, but there are many exceptions. In most cases, it is only possible to hypothesize the general occurrences or preferences based on studies made in other parts of the country or world, or make educated guesses based on very subjective evaluation of collection data.

My hypotheses are summarized in a series of tables (see introduction for explanation of format and conventions). I have arranged the information in the-text under some of the headings or subheadings roughly in order of decreasing'likelihood of relevance to the region being considered, i.e., starting with information, from eastern WA/OR (or my own opinions based on my experience there), and ending with information from studies in other parts of the country or world.,. My own opinions are generally inserted in the earlier parts of the discussions.

In the discussions below I have used various terms quite loosely (e.g., "late", "climax", "mature", and "old-growth" are used somewhat interchangeably), because the data are insufficient to allow more than the broadest hypothetical generalizations. I have included second-growth forests under intermediate stages, because the species found in them are not necessarily pioneers or colonizers. However, I have treated "secondary succession" as a separate category after the others, because fire or other. disturbances can occur in localized areas within any stage; and the species that are colonizers after disturbance may not necessarily occur in stages where the entire community is young.

1. CORTICOLOUS/LIGNICOLOUS

Many factors are involved in succession of lichens on bark or wood. In general, as the age and size of the trees (and shrubs) increase, there are more time and space for lichen propagules or fragments to land on them, better conditions and more diverse microhabitats due to increasing roughnening, softening or decomposition of the surfaces, and increased complexity of canopy structure. These are primary factors especially in relatively open'communities composed of one or few dominant woody plant species with little or no understory (e.g., most juniper or pine forests); in such communities, probably due to the substrate texture and dry conditions, a rather small group of lichen species (e.g., Candelaria or Xanthoria in nutrient-enriched shrub or hardwood tree communities, or Letharia 'and various.parmelioid-cetrarioid taxa in pine forests) tend to be the colonizers, and mainly increase in abundance as the community ages, until they occupy all or most suitable surfaces. This general trend is likely to be modified mainly by changes in

spacing of the trees or shrubs, with concordant changes in availability of light, and by factors such as fire or logging.

In more complex woody plant communities, changes in species composition of the trees or shrubs, and various other factors, produce more complex lichen communities, and the succession among the lichens becomes too complex and.variable to make many generalizations;

One European study,-by Hilmo (1994), found that Brvoria spp. were present in equal amounts in all successional stages of forests. Many other species, especially crustose species and extremely common macrolichens such as Letharia spp., are probably at least present in all stages.

DECIDUOUS WOODLANDS

'Little information- explicitly dealing with'lichen' succession in in deciduous woodlands is available.' However, it is likely that species that are characteristic of particular stages in coniferous forests but frequently occur on hardwoods will follow a similar'pattern in deciduous woodlands.

Early Stages.

Information from Montana: Some of the species that are more abundant in second-growth forests in Montana (Lesica, et al., 1991), such as Hypogymnia imshausii, Melanelia multisoora, M. subaurifera, Phvscia stellaris, and Ramalina farinacea, commonly occur on hardwoods, as does Xanthoria polycarpa, which is restricted to such forests there.

Information from Europe: Pioneer lichen colonizers of Fraxinus twigs in Europe (Degelius, 1964) include several species known to occur on various hardwoods' in the WA/OR part of the Columbia Basin: Lecanora carpinea, Phaeophvscia orbicularis, Melanelia exasperatula, M. subaurifera, Parmelia sulcata, Phvscia adscendens, Phvscia stellaris, P. tenella, and Xanthoria polycarpa.

Intermediate Stages

Information from Europe: Species present in all stages but more abundant on trees of moderate age include Hypogymnia phvsodes, H. tubulosa, and Tuckermannoosis chlorophylla (Hilmo, 1994), all of which occur, on hardwoods as well as conifers.

Later Stages:

Information from west side of Cascades, and elsewhere: Lichens associated with old-growth conifer forests but frequently found on hardwoods include species of Lobaria, Neohroma, and Pseudocyphellaria, and some members of-the Caliciales.

Succcession after fire:

Information from Minnesota: A study of an oak Savannah, Wetmore (1983) suggests that the abundance of a few species may

be relatively unchanged with increasing fire frequency, or even increased somewhat (e.g., Candelaria concolor), most lichens (including Candelariella xanthostigma, Physconia detersa, and Xanthoria fallax) decreased with increasing fire frequency, and others were absent entirely where fires were frequent.

CONIFEROUS FORESTS

Pioneer stages

Information from eastern WA/OR: The herbarium labels provide almost no data on which species occur in young coniferous forests in the region, except perhaps that Pyrrhosoora cinnabarina was found on "young" trees of an unspecified species of Pinus (locality not specified, Deschutes Co., OR). In my own experience, young forests or plantations in the Columbia Basin (and elsewhere) generally have low diversity and abundance of lichens on the trees, and few if any logs or stumps on which lichens could grow. The species that do occur on young trees are usually either a few crustose kinds or macrolichens that.are extremely abundant in older communities in adjacent areas (e.g., Letharia spp.).

Information from Europe: 'Studies in Europe also provide very little data relevant to the Columbia Basin. Holien (1989) found that Bryoria capillaris occurred in young stages; Hilmo (1994) found various species of Lecidea and Ochrolechia in young stands. Hilmo (1994) found that Vulpicida pinastri was present only in early stages, and Parmeliopsis spp. were more abundant-in early stages, decreasing with tree age.'

Intermediate stages (including second-growth forests)

Information from eastern WA/OR: Label data show that Bryoria fuscescens, Hypogymnia imshauoii, Tuckermannonsis platyphylla, and Vulpicida canadensis were found on lower dead limbs of 20-25 cm dbh Larix occidentalis and Pinus contorta in a 35 year old stand in N.E. Mountains, WA (960 m, Pend Oreille Co.).

Information from Montana: Species that occur in the WA/OR part of Columbia Basin and are restricted to or more abundant in second-growth forests in Montana (Lesica, et al., 1991) include Ahtiana sphaerosporella (restricted), Bryoria fuscescens, B. pseudofuscescens, Esslinaeriana idahoensis, Hypogymnia imshausii, Melanelia multispora, M. subaurifera, Physcia stellaris, Ramalina farinacea, Tuckermannopsis merrilli, T. orbata, T. pallidula, T. platyphylla, Vulpicida canadensis (restricted), V. pinastri, Xanthoria polycarpa (restricted).

Information from Europe: Hilmo (1994) found that species present in all stages but more abundant on trees of moderate age included Hypogymnia physodes, H. tubulosa, and Tuckermannopsis chlorophylla.

Later stages

Succession

Species found on rotting bark or wood, such as many Cladonia spp., are'in a sense colonizers of such substrates, but they may be more abundant in older forests simply because more logs or stumps are available and-more are in advanced stages of rotting (especially where increasing canopy closure produces more moist conditions).

Information from eastern WA/OR: Label data show that Parmeliopsis hyperopta was found on a "huge" Larix occidentalis in a mixed Pseudotsuaa forest in N.E. Mountains, OR (1510-1800 m, Wallowa Co.); Alectoria sarmentosa (common on bole and lower dead limbs) and Hypogymnia sp. (H. enteromorpha group) were found on bark of an "old" Pinus monticola in a mixed Tsuga heteroohvlla forest in N.E. Mountains, WA (1410 m, Pend Oreille Co.). A difficulty with interpreting the label data is that'in many cases. the presumablylater stage forests tend to be at higher elevations, or in or near riparian areas, and in areas protected from both.logging and fire; thus age or successional stage of the forest is probably not the only factor affecting the lichen flora.

Species found in a probable old-growth forest (presumed to be Abies'concolor) in E. Slope of Cascades, OR (1620 m, Klamath Co.) include Alectoria imshauaii, A. sarmentosa, Brvoria. capillaris, B. sp., Chaenotheca furfuracea, Cyphelium sp., Hypocenomyce scalaris, Yp gymnia imshauaii, H. occidentalis, Lecanora circumborealis, Letharia spp., Melanelia elesantula, Parmelionsis spp., Platismatia glauca, Tuckermannoois chlorophvlla, and T. platyphylla. Species found in forests (known or presumed to be A. concolor, and presumed to be old-growth, but known to also be in *or* near riparian areas) in E. Plateaus & Hills, OR (in or near Gearhart Wilderness) include Alectoria imshauoii, A. lata, Brvoria abbreviata, B. capillaris, B. fremontii, B. fuscescens, B. glabra, B. pseudofuscescens, B. simolicior, B. sp., Calicium viride, Candelariella xanthostiama, Hp gymnia imshausii, Lecanora saliana, Lecidea sp., Letharia spp., Melanelia subolivacea, M. sp., Ochrolechia androgyna, Parmelionsis spp., Phvscia dimidiata, Tuckermannoosis chlorophvlla, T. merrillii, T. platyphylla, and Xanthoria fallax.

In the study by Cooke. (1955) in eastern WA, Brvoria implexa (A. arandis only), B. "oregana" (P. menziesii only), B. lanestris, B. sp. (A. grandis only), Hypogymnia "enteromorpha", Physodes, Letharia spp,, Melanelia exasperatula (A. grandis only), Parmelia sulcata (A. grandis only), Platismatia glauca, P. stenophylla, Tuckermannopsis chloroohvlla, T. platvohvlla,' and Vuloicida canadensis were found in "near-climax" montane forests (Pseudotsuga menziesii and Abies srandis).

Information from Montana: Species more abundant in old. growth than in younger forests in Montana (Lesica, et al.; 1991) include Alectoria imshauoii, A. sarmentosa, Brvoria capillaris , Cladonia spp., Yp gymnia enteromorpha, H. rugosa (restricted to old growth), Lobaria pulmonaria (restricted to old growth),

NeDhroma spp. (restricted to old growth), Parmelia hygrophila, Peltisera spp. (restricted to old growth), Platismatia glauca, TuckermannoDsis orbata (restricted to old growth).

Data from west side of WA/OR: Other species present in old growth forests on the West Side of Oregon or Washington that may also be in old growth forests in the Columbia Basin (especially in montane forests and in extensions of the "West Side" flora along the Columbia Basin.

The following species were listed in Appendix 5-H ("Species With Risk to Viability") in "Report of the Scientific Analysis Team" (1993) in connection with spotted owl habitat: Alectoria sarmentosa, Brvoria capillaris, B. tortuosa, Calicium abietinum, C. adaeauatum, C. adspersum, C. slaucellum; C. viride, Lobaria hallii, L. linita, L. oreqana, L. Dulmonaria, Pseudocyphellaria anthraspis, and Spherophorus slobosus. Species listed in the "Final Environmental Impact Statement" for spotted owl habitat are: Brvoria'tortuosa, Calicium abietinum, C. adaeauatum, C. adspersum, C. viride, Chaenotheca furfuracea, Collema niqrescens, Cyphelium inquinans, Lobaria hallii, L. linita, L. oreqana, L. pulmonaria, Mycocalicium subtile, NeDhroma helveticum, N. parile, Peltigera collina, Pseudocyphellaria anthraspis, and Stenocybe major.

Species listed in Appendix 5-J ("Species for Which Information is Most Limited") in "Report of the Scientific Analysis Team" (1993) are: Collema nisrescens, Hypocenomyce friesii, Hypogymnia ruaosa, and Lopadium disciforme (as L. pezizoides).

Species listed by Pike, et al., 1975 as being present in old-growth forests (though not necessarily particularly associated with them) include Alectoria sarmentosa, Bacidia herrei, B. naeselii, Brvoria fremontii, B. slabra, B. oreaana, Calicium abietinum, Chaenotheca furfuracea, Cladonia spp. (most are widespread "weeds"), Diplotomma penichrum, Esslingeriana idahoensis, Hypocenomyce friesii, Hypogymnia enteromorpha, H. imshauaii, H. tubulosa, Letharia columbiana, Lobaria oreqana, L. pulmonaria, Lopadium pezizoideum, NeDhroma helveticum, N. Darile, Normandina Dulchella, Ochrolechia androgvna, 0. oreaonensis, Parmeliopsis ambiaua, Peltisera collina, Platismatia alauca, Pseudocyphellaria anthraspis, Pyrrhospora cinnabarina, Sphaerophorus globosus, Stenocybe major, Tuckermannopsis chlorophylla, T. orbata, T. Dallidula, T. platyphylla, Xylographa abietina, and X. hians.

Additional species noted by other authors in old-growth forests on the west side include Alectoria lata (Ryan, collection in West Slope of Cascades, OR), Cladonia transcendens, Cyphelium sp., Hypocenomyce scalaris, Hypogymnia metaphysodes, H. occidentalis, Letharia vulpina, Parmelia hygrophila, and Parmeliopsis hyperopta, (Rhoades, 19 --Olympic National Park,. WA). Vitt, et al. (1988) mention Xylographa abietina as occurring in "mature" forest stands in the Pacific Northwest in

Succession

general.

Information from eastern United States: According to Selva (1988), in Maine the diversity and abundance of the order Caliciales (including Calicium, Chaenotheca, Cyphelium, Mycocalicium, Stenocybe, and others) is greater in old growth forests than elsewhere. Species found in old-growth stands in . . Wisconsin (Thomson, 1990) included Cladonia coniocraea, Flavonarmelia caperata, Graphis scripta, Hypogymnia physodes, Lobaria pulmonaria, Pertusaria ophthalmiza, Physconia detersa, Usnea subfloridana

Information from the United Kingdom: Rose (1976) considered Catinaria atropurpurea, Biatora sphaeroides, Pyrrhospora cinnabarina, Lopadium pezizoideum, Peltisera collina, and P. horizontalis to be "faithful" to "old forests" in Britain, and Alectoria sarmentosa; Bryoria capillaris, B. lanestris, Hypocenomyce friesii, L. pulmonaria, Neohroma parile, Peltigera collina, and Pyrrhosoora cinnabarina'to be possible "old forest" indicators in Britain.

Information from Europe: In the study by Hilmo (1994), Alectoria sarmentosa was absent in pioneer stages, and present in intermediate stages, but more abundant on older trees; Ochrolechia androsyna and Usnea spp. were present in pioneer stages, but more abundant in intermediate to climax stages; and Lopadium disciforme, Mycoblastus spp., Parmelia sulcata, and Platismatia alauca were present in all stages but with increasing abundance with tree age.

Succession after fire

My own collections from various localities in the Columbia Basin and elsewhere, show that species of Hypocenomyce, Parmeliopsis, and Traoeliopsis frequently occur.on burnt bark or wood.

Table . Predicted occurrence of corticolous/lignicolous lichens on conifers in different successional stages of forests.

LICHEN SPECIES	SUCCESSIONAL STAGES		
	Early	Intermediate	Later
Alectoria imshaugii			+
A. lata			+
A. sarmentosa		+	+++
Bacidia herrei			+
B. naegelii			+
Bryoria abbreviata		+	+
B. capillaris	+	+	+
B. fremontii			+
B. fuscescens	++	++	+
B. glabra			+
B. implexa		+	+
B. lanestris			++
B. oregana		+	+
B. tortuosa			+
B. pseudofuscescens	++	++	+
B. simplicior			+
B. spp.		+	+
Calicium abietinum			++
C. adaequatum			++
C. adspersum			++
C. viride			++
Catinaria atropurpurea			++
Chaenotheca furfuracea			++
C. spp.			++
Cladonia coniocraea			++
C. transcendens			+
C. spp.		++	++
Collema nigrescens			+
Cyphelium inquinans			++
C. spp.			++
Diplotomma penichrum			+
Esslingeriana idahoensis	++	++	+
Hypocenomyce friesii			++
H. scalaris	+	+	+
Hypogymnia enteromorpha		+	+
H. imshaugii	++	++	+
H. metaphysodes			+
H. occidentalis			+
H. physodes	+	+++	++
H. rugosa			+
H. tubulosa	+	++	+
Lecanora circumborealis			+
L. saligna			+
Lecidea spp.	+	+	+

Succession			
Letharia columbiana	+	+	+
L. vulpina	+	+	+
Lobaria hallii			+
L. linita			+
L. oregana			++
L. pulmonaria			++
Lopadium disciforme	+	++	++
Melanelia elegantula			+
M. exasperatula		+	+
M. subolivacea			+
Mycoblastus sanguinarius	+	++	++
Mycocalicium subtile			++
Nephroma helveticum			++
N. parile			++
N. resupinatum			++
Normandina pulchella			+
Ochrolechia androgyna	+	++	++
O. oregonensis			+
O. spp.	+		
Parmelia hygrophila			+
P. sulcata	+	++	++
Parmeliopsis ambigua	+++	++	+
Parmeliopsis hyperopta	+++	++	+
Pertusaria ophthalmiza			+
Peltigera collina			++
Physcia dimidiata			+
Physconia detersa			++
Platismatia glauca	+	++	++
P. stenophylla		+	+
Pseudocyphellaria anthraspis			++
Pyrrhospora cinnabarina	+	+	++
Sphaerophorus globosus			+
Stenocybe major			++
Tuckermannopsis chlorophylla	+	++	+
T. merrillii	++	++	+
T. orbata	+	+++	++
T. pallidula	++	++	+
T. platyphylla	++	++	+
Usnea subfloridana			++
Vulpicida canadensis		++	+
V. pinastri	+		
Xanthoria polycarpa	++	++	+
Xylographa abietina,			+
X. hians			+

Succession

Table . Predicted occurrence of corticolous/lignicolous lichens on hardwoods in different successional stages of forests.,

LICHEN SPECIES	SUCCESSIONAL STAGES		
	Early.	Moderate	Later
Candelariella xanthostigma			+
Flavonarmelia caperata			+
Graphis scripta			+
Hypogymnia imshaugii	++	++	+
H . physodes	+	++	+
H. tubulosa	+	++	+
Lecanora carpinea	+		
Lobaria hallii			+++
L. linita			+++
L. oreaana			+++
L. pulmonaria			+++
Melanelia exasperatula	+		
M. multispora	++	+ +	+
M. subaurifera	++	+ +	+
Nephroma helveticum			+++
N. parile			+++
N . resupinatum			+++
Parmelia sulcata	+	+	+
Phaeophyscia orbicularis	+		
Physcia adscendens	+		
P. stellaris'	++	++	+
P. tenella	+		
Pseudocyphellaria anthraspis			+++
Ramalina farinacea	++	++	+
Tuckermannopsis chlorophylla	+	++	+
T. orbata	++	++	+
Xanthoria fallax	+	+	+
X. polycarpa	++	++	+

Succession

2. TERRICOLOUS/MUSCICOLOUS

Successional processes in terricolous/muscicolous lichens in open community types (in which the climax state is dominated by grasses, herbs, shrubs, or more or less widely spaced trees) are rather different than in more closed-canopy ecosystems. Although there are of course many intermediates, and many species that occur in both, these two main kinds of ecosystems are discussed under separate headings below.

In many forests or scrublands in the Columbia Basin, microclimatic conditions at the ground surface are severe during early stages (i.e.; before closed canopy develops, if it ever does), with wide diurnal temperature fluctuations and hot'daytime conditions in summer. In drier communities with non-existant, sparse, or widely spaced areas of vascular plant cover (e.g., on lava beds or pumice flats, intermound communities in biscuit scabland, and some kinds of alpine communities), the lichens have to first colonize either bare, rocky or unconsolidated soil, or else moss cushions growing on the soil or rock. In areas with the harshest conditions, the cover and diversity of the lichen vegetation probably increases up to. a point, but the succession is relatively simple, and may lead to a fairly stable climax community of relatively few lichen species.

However, in most ecosystems the pioneer lichens affect the succession of other lichens and also of vascular plants, by consolidating and enriching the soil. -When these successional processes lead to considerable changes in the vascular vegetation, the abundance and composition of the lichen flora also change in complex ways that vary with the particular type of ecosystem.

OPEN AREAS

Pioneer stages

Important pioneers on arid, mineral or rocky soils (often starting on mosses, or sometimes on dung, decaying bunchgrass clumps, or wood) include Psora cerebriformis (Ryan, unpublished data from studies in the Great Basin in northwestern.Nevada) and probably many other sguamulose or crustose kinds, such as other Psora spp., and species of Aspicilia, Caloplaca, Candelariella, Cladonia (especially C. pyxidata), Diploschistes, Lepraria (L. nealecta), and Meaaspora.

Colonizers of soil or moss in dry, rocky areas, and also of all kinds of nitrogen-poor soils (Topham, 1977) include Collema spp., Lentochidium albociliatum, Leptogium spp., Peltiaera spp., and Stereocaulon spp. Some species of Peltiaera are also capable of colonizing sandy soils (Brown & Brown, 1968).

Colonizers in arctic tundras (Topham, 1977), that are also common in alpine areas in the Columbia Basin, include speciés of Cetraria, Flavocetraria, Peltiaera, and Stereocaulon.

Succession

Generally, species that are common in drier, rockier, or more open habitats are probably colonizers, and are absent or less abundant in areas with closed canopies.. However, this is not necessarily a matter of succession, in cases of species that are absent or uncommon in forests, or occur in forests (e.g., Pinus nonderosa) in which conditions for terricolous lichens in the climax stage are probably not much different from those in the early stages,. Some examples of such 'lichens are Acarosoora schleicheri, Candelariella spp., Cataovrenium spp., Chromatochlamys muscorum, Cladonia poccillum, most Collema spp., Dermatocaroon spp. (vagrant forms), Endocaroon oulvinatum, Ochrolechia upsaliensis, Peltigera ponoiensis, Squamarina lentisera, Texasporium sancti-iacobi, Toninia spp., and Xanthooarmelia spp.

Later stages

Cooke (1955) reported that Cladonia chloroohaea, C. fimbriata, C. pvxidata, Diploschistes "actinostomus", Peltiaera canina, P. rufescens, and Physconia "grisea" occurred in "climax prairies" in Columbia Plateau; WA (690 and 750 m, Whitman Co.).

FORESTS AND WOODLANDS

Due to the vagueness of most of the information related to lichens on soil or moss, deciduous and gymnosperm communities are treated together here. Some of the information given below is actually based on studies of lichens growing on bark or wood, but is presumably also applicable for species that grow both on those substrates and on soil or moss.

Early Stages

Generally, species that are common in drier, rockier, or more open habitats are probably colonizers, and become less abundant or disappear with increased canopy or understory cover. Examples include, Cladonia ovxidata, Dioloschistes spp., Lepraria neglecta, Megaspora verrucosa, P. rufescens, Psora spp. and Trapeliopsis cf. wallrothii.

Species restricted to younger (second growth) forests in Montana (Lesica, et al.; 1991) include Cladonia bacillaris, C. carneola, C. cornuta, C. multiformis, C. sulphurina, C. verruculosa

Intermediate stages

No definite informaton on this is available, but obviously lichens that occur both in early stages and in later stages (such as many Cladonia spp.) will also occur during the transition.

Later stages

Species growing on humus or moss are likely to increase as these substrates become more 'abundant, especially in moister communities, and as these substrates accumulate over logs,

stumps, or rocks. On the other hand, debris or bryophytes, and small vascular plants, are likely to cover up many terricolous lichens (especially crustose or small kinds) or prevent them from becoming established.

Information from eastern WA/OR: Cooke (1955) provided information on species found in climax or near-climax forests in Columbia Plateau, WA and N.E. Mountains, WA. Cladonia chlorophaea, C. coniocraea, C. diuitata, C. fimbriata, C. glauca, C. scabriuscula, C. simulata, Peltisera canina, and P. rufescens occurred in. moderately open climax Pinus ponderosa forests (600 m, Spokane Co., 750 m, Whitman Co.). Cladonia chloroohaea, C. diaitata, C. fimbriata, C. ochrochlora, C. scabriuscula, Peltigera aphthosa s. lato, and P. rufescens occurred in a near-climax Pseudotsusa forest (600 m, Spokane Co.). Peltisera aphthosa s. lato occurred in a dense, near-climax Abies srandis forest in (660 m, Stevens Co.).

Information from west side of WA/OR:

Species listed in "Final Environmental Impact Statement" for spotted owl habitat include Leotosium hirsutum, L. saturninum, and Peltiaera collina (all nitrogen fixers).

Pike, et al., 1975 found the following species in 'old-growth forests in western OR: Cladonia rei, C. squamosa ssp. subsquamosa, Leptogium corniculatum, L. lichenoides, Mycobilimbia berengeriana, Nephroma parile, Peltiaera aohthosa, P. canina, P. collina, 'P. horizontalis, P. membranacea, P. polydactyla, P. praetextata, Psoroma hvonorum, and Stereocaulon spp. Other species, found in old growth forests on the Olympic peninsula, WA include Cladonia transcendens (Rhoades, 19) and Peltiaera venosa (Nash collection in ASU herbarium).

Information from Montana: Lesica, et al. (1988) found the following species in old-growth forests: Cladonia cenotea (restricted), C. ochrochlora (restricted), Leotosium spp., Neohroma spp., Peltiaera aphthosa (more abundant), P. collina (restricted), and P. membranacea (more abundant)..

Information from United Kingdom: Rose (1976) included Peltiaera collina and P. horizontalis as possible "old forest" indicators in Britain.

Secondary succession:

Important colonizers in all types of secondary succession are Cladonia spp. (Topham, 1977).

Colonizers of mechanically disturbed soil include Peltiaera spp. (Topham, 1977), in my experience 'especially P. didactyla (Hale, 1979), P. ponoiensis, P. rufescens, P. venosa, and often others.

Several species are colonizers of soil after burning. Topham, (1977) includes Placynthiella uliainosa and Trapeliopsis sranulosa; according to Foster,' (1985) granulosa is one of the earliest colonizers, but it disappears after ca. 30 years. Johansen, et al. (1984), working in Utah, list Collema tenax and

Succession

Caloplaca sp. ("*C. citrina*"--possibly a misidentification of *C. tominii*, which does occur in the Columbia Basin)..

Table . Predicted occurrence of terricolous/muscicolous lichens in different successional stages of forests.

LICHEN SPECIES	SUCCESSIONAL STAGES		
	Early	Moderate	Later
Biatora sphaeroides			+
Cladonia bacillaris	++	++	
C. carneola	++	++	
C. cenotea			+++
C. chloroohaea		+	+
C. coniocraea		+	+
C. cornuta	++	++	
C. dioitata			+
C. fimbriata	+	+	+
C. slauca			+
C. multiformis	++	++	
C. ochrochlora			+++
C. pvxidata	++	+	+
C. rei			+
C. scabriuscula			+
C. simulata			+
C. suuamosa v. subsquamosa			+
C. sulphurina	++	++	
C. transcendens			+
C. verruculosa	++	++	
Dioloschistes spp.	++	++	+
Lepraria nealecta	++	+	
Leptochidium albociliatum	+	+	
Leptogium corniculatum			+
L. hirsutum	+	+	+
L. lichenoides	+	+	+
L. saturninum			+ +
Megaspora verrucosa	+	+	
Mycobilimbia berenseriana			+
Nephroma parile			++
Physconia spp.	+	+	+
Peltiaera aphthosa s.l.		+	++
P. canina s.l.			+
P. collina	(+)	+	+++
P. didactyla	++	+	
P. horizontalis			++
P. membranacea.			+
P. polydactyla s.l.			+
P. praetextata			+
P. venosa		+	++
Placynthiella ulisinosa	+		
Psoroma hypnorum			+
Stereocaulon spp.	+	+	+

Succession

Trapeliopsis granulosa ++

Table . Predicted occurrence of terricolous/muscicolous lichens in different successional stages in open, non-forest communities.

LICHEN SPECIES	SUCCESSIONAL STAGES		
	Early	Moderate	Later
Caloplaca spp.	+		
Candelariella spp.			
Cetraria s.l. spp.	+		
Cladonia chlorophaea			+
C. fimbriata			+
C. pyxidata	+	+	+
Collema tenax	+		
Diploschistes spp.	+	+	+
Megaspora verrucosa			+
Peltigera canina			
P. didactyla	+		
P. ponojensis	+		
P. rufescens	+	+	+
Physconia spp.			+
Psora cerebriformis	+		
Psora spp.	+		
Stereocaulon spp.	+		
Toninia spp.			

III. Saxicolous

As with terricolous species, 'lichen succession on-rocks varies considerably with the openness of the vascular plant communities, and two major groups of ecosystems are treated -separately. However, some factors, variables, and processes are applicable to varying degrees in almost all ecosystems.,

The species composition 'and successional stages, vary considerably according to rock type. On softer sedimentary' rocks, and especially in moist situations, colonization and succession are relatively rapid; macrolichens (and bryophytes) often appear even in early stages, and the rock decomposes fairly easily into soil.

On harder rocks, and 'in drv situations, colonization may require many years or'even millenia (e.g., in the case of' cryptocrystalline silica). of weathering by abiotic (or possibly microbial) weathering before there are even crustose lichens present, and then'the'latter may be confined to crevices or depressions.. Lichen 'succession on these rocks may involve . . interactions with microbes such as microcolonial fungi, which have also been implicated in processes of weathering and "desert varnish" formation (Palmer, 'et al.,'-1990).

. . In these harsh situations, once' colonization has begun, 'lichen growth may still be extremely slow and occur over very long periods of time, 'as evidenced by the fact that Rhizocarpon spp. have been widely'used to date glacier movement and single lichen thalli have-been estimated to be as much as 6000 or more years old. Colonization on overhanging surfaces is probably especially slow.

The complexity of lichen succession on rocks is illustrated by my attempts to estimate the age of a petroglyph on a-boulder in Okanogan N.F., WA.' The only lichens on the petroglyph, on an overhanging surface,.were numerous very tiny, (young,: not even mature) Rhizocarpon thalli (along an area of occasional water runoff), even though, the upper parts of the rock were completely covered by a luxuriant community of- foliose, species overgrowing a tight mosaic of crustose lichens; Although-the age of 'even'the largest individual crustose thalli on the tops'of-the rock might be estimated to be only'on the'order of 50-100 years the size of each crusose thallus was limited by'its contacts with adjacent thalli, whereas many of the foliose lichens were'more able-to overgrow each other and form thick, crowded mats. . The-state of the lichen communities on the upper parts of the boulder are probably a good indication that'this is'an advanced stage of succession that has probably taken many centuries (not counting. the probably very long pre-colonization and initial colonization periods for lichens 'on-hard granite in a dry area)." Howver, this may. still underestimate the time since the lichen-was 'first-colonized,. because there was evidence that the rock surface had exfoliated' in some areas. (aided'by the lichens growing on it),

necessitating a lengthy new period of succession starting on unweathered'granite. There is no way of knowing how many such cycles of succession occurred over time on this boulder: .

Although the boulder described above is presently in a mostly open area, with moderate-sized trees barely overhanging it on one side, no one knows what changes in the vascular plant community (and even in the climate of the area) may have occurred over the presumably very long period since the first lichen landed on the boulder, and how these changes affected the lichen succession;

On large rocks in persistently open communities (or large areas of solid rock within communities that otherwise become covered with one or more strata of vascular plants); lichen succession is often independent of the succession occurring among vascular plants. However, even in such situations, the surrounding community may affect the lichens by shielding it from wind or. morning or afternoon sunlight, modifying moisture conditions in the general area, or promoting the presence of animals or birds in the area (thus involving factors such as nutrient enrichment, trampling, or even direct use of the lichens).

With smaller rocks, or rocks in areas of increasingly closed canopy, the vascular plant community exerts even more influence on lichen succession. Plants (and in some cases their epiphytic lichens) growing above the rocks affect conditions for saxicolous lichens in many ways: Overhanging trees or shrubs decrease light and heat, increase moisture retention but reduce direct interaction with snow or rain and alter the chemistry and nutrient content of the precipitation, cover the lichens with debris, provide habitat for birds or animals whose exdretions fall on the rocks, and even supply a source of lichen propagules. An example of the complexity'of these effects is a basalt outcrop under a juniper in south-central OR, which had abundant cover by a Candelariella species that was abundant on the trees but rare or absent on rocks away from-the trees. Bryophytes, and' sometimes pteridophytes (e.g., Selaginella or some kinds of ferns) also affect lichen succession, to the detriment of saxicolous species but sometimes to the benefit of other groups of lichens.

O P E N AREAS

Numerous studies of lichen succession on rocks in open communities have been made in various parts of North America and Europe. However, the conditions and species compositions in those studies are mostly rather different from those in" the Columbia Basin, and due to time limitations I have chosen to restrict this discussion to a few examples from one review article and generalizations based on my own experience, that should suffice for the purposes of this report.

Succession

Early stages

Colonizers mentioned by Topham (1977) include Lecanora polytropa and Rhizocarpon spp. (e.g., R. geographicum). Other important pioneer lichens include other crustose species, especially in genera such as Acarospora, Aspicilia, Lecanora, and Lecidea.

At least in the arctic (Topham, 1977), Umbilicaria spp. and bird perch species (e.g., Caloplaca saxicola and Xanthoria elegans). precede others, including .the.more common crustose ones.

Small rocks in talus slopes may be especially difficult for lichens to colonize; in an alpine area on the'west side of the Cascades, WA (Chowder Ridge) Lecanora polytropa 'and Staurothele spp. were the only lichens on them.

On calcareous substrates, Candelariella aurella and Lecanora disjersa are among the typical crustose colonizers.

In aquatic or semi-aquatic habitats, species of Staurothele or Verrucaria, or sometimes Aspicilia, are usually the colonizers.

Intermediate stages

The next stages are generally dominated by lobate-crustose, squamulose, umbilicate, or foliose. lichens, such.as species of Melanelia, Neofuscelia, Parmelia, Phaeophyscia, Physcia, Physconia,' Rhizoplaca, Umbilicaria, Xanthoparmelia, and Xanthoria, and additional taxa that. are primarily or'exclusively arctic-alpine (species of Allantoparmelia, Brodoa, Cetraria, etc.), or by the appressed-fruticose genus Pseudephebe.

However, in specialized habitats, the initial colonizers' persist even into the later stages, and merely increase in abundance until all suitable surfaces are covered. Examples are steep 'or overhanging, weakly to moderately enriched surfaces of cliffs (persistently dominated by Acarospora "chlorophana"), strongly nutrient-enriched surfaces (persistently dominated by Caloplaca or Xanthoria), or special 'rock types, especially strongly calcareous, metal-rich, or ultramafic kinds (mostly persistently dominated by various crustose species).

In aquatic or semi-aquatic habitats, Dermatocarpon spp. probably become established during the intermediate stages, and become increasingly dominant until they form the climax community. 'However, in some 'areas, the original crustose pioneer species'probably either persist, or are replaced by algae, cyanobacteria, or bryophytes.

Later stages

By these stages the lichens are often actually growing on soil, humus, moss, or other lichens, rather than directly.on the rock.

In alpine areas, generally the last stratum to develop is dominated.by mostly loosely attached fruticose lichens (species of Alectoria, Cetraria, Cladonia, Stereocaulon, and Thamnolia).

Succession

Species of Cladonia and Stereocaulon may also dominate the climax stages in moist communities at lower elevations.

In drier areas at low to moderate elevations, the climax stage is usually dominated either by the groups that became abundant in the intermediate stages, or, in specialized habitats, by the original colonizers.

On periodically inundated rocks or seepage areas, the original colonizers or species of Dermatocaroon may form the climax communities; or they may be replaced by other organisms, including vascular plants.

FORESTS AND WOODLANDS

Eariy Stages

Pioneer lichens while the canopy is still open are generally the same as the ones found in open areas in the same geological, elevational, and climatic region.

Intermediate Stages

The lichen flora on rocks in drier, fairly open forests, or partially'exposed areas or edges in moister communities generally develops along lines similar in broad outline to what occurs in open areas, although the composition of taxa may be rather different, and probably somewhat richer in forests.

In contrast, in the shade of moister, denser forests, during intermediate (and sometimes also later) stages, the saxicolous flora may be dominated by a few crustose species (mostly Asoicilia, Lecidea,, or Rhizocarpon), to depauperate or even lacking, due to the shaded, moist conditions, and to being covered by debris, bryophytes, or sometimes algae or cyanobacteria. Except where canopy closure is extremely desne, surfaces on or under overhangs, or otherwise sheltered from rain, are generally covered by Lepraria species

Later Stages

Again, the development of the lichen flora growing directly on rock is richer in drier or more open areas; however, the number of trees that are rotting-(and thus more susceptible to falling down); or (especially in drier communities), the increased chance of fire, mean that new open areas become available, and rocks in such areas may develop especially rich, luxuriant, or special lichen communities.

In Montana, Lesica, et al. (1991) found that Leptogium saturninum (usually growing on moss rather than directly on rock) was restricted to old growth.

The following species have been found in old growth forests in western OR, and may also occur in old growth forests on 'in eastern WA/OR: Candelariella vitellina, Hydrothyria venosa (aquatic), Lecanora rupicola, Lecidea atrobrunnea, Pilophorus acicularis, Placopsis selida, Pseudeohebe oubescens, Rhizocarpon

geographicum, R. srande, Umbilicaria phaea, U. polyphylla, U. torrefacta, U. vellea, and Verrucaria sp. (Pike, 1972, Pike, et al.,- 1975).

Species listed in "Final Environmental Impact Statement" in relation to spotted owl habitat on the west. side include the aquatic species. Dermatocarpon luridum and Hydrothyria venosa.

Secondary succession

Factors involved in secondary succession under natural conditions have already been mentioned in a couple of places above. To those comments it can be added that while logging (or the indirect effects of fire in removing trees or other vegetation) have-little or impact on saxicolous lichens in open communities, they may actually be promote the diversity or abundance of lichens in moist, shaded areas. However, the latter effect is probably greatest when removal of vegetation is selective, such that the beneficial contributions of the vascular plant communities to saxicolous lichens (nutrient enrichment, moderation of harsh conditions, etc.) are not lost, and a mosaic of microhabitats for a wide variety of lichen taxa is present;

Table . Predicted occurrence of saxicolous lichens in different successional stages of forests.

LICHEN SPECIES	SUCCESSIONAL STAGES		
	Early	Moderate	Later
Acarospora spp.	+		
Aspicilia spp.	+	+	+
Candelariella vitellina	+	+	+
Dermatocarpon luridum		+	+
D. spp.		+	+
Diploschistes spp.	+	+	
Hydrothyria venosa		+	++
Lecanora laatokkaensis		+	
L. muralis	++	+	
L. polytropa	+	+	
L. rupicola	+	+	+
L. semitensis		+	
L. spp.	+	+	+
Lecidea atrobrunnea s.l.	+	+	+
L. spp.	+	+	+
Lecidella spp.	+	+	
Parmelia spp.		+	+
Pilophoron acicularis			+
Placopsis gelida	+	+	+
Porpidia spp.	+	+	+
Pseudephebe pubescens		+	+
Rhizocarpon geographicum	+	+	+
R. grande	++	+	+
R. spp.	+	+	+
Staurothele spp.	+	+	+
Stereocaulon spp.	+	+	+
Umbilicaria phaea	+	++	+
U. polyphylla		+	+
U. torrefacta		+	+
U. vellea			+
Verrucaria spp.	+	+	+

Succession

Table . Predicted occurrence of saxicolous lichens in different successional stages in open, non-forest areas.

LICHEN SPECIES	SUCCESSIONAL STAGES		
	Early	Moderate	Later
Acarosoora "chlorophana"	+	+	+
Acarosoora spp.	+	+	
Alectoria spp.			+
Allantoparmelia aloicola		+	
Asoicilia spp.	+	+	+
Bellemerea spp.	+		
Brodoa oroarctica		+	
Brvoria spp.			+
Caloplaca saxicola	+	+	
C. spp.	+		
Candelariella aurella	++		
C. spp.	+	+	
Cetraria spp.		+	
Cornicularia normoerica			+
Dermatocarpon spp.		+	
Dimelaena spp.	+	+	
Diploschistes spp.	+		
Lecanora dispersa	++		
L. muralis	+	+	
L. polytropa	+ +		
L. spp.	+		
Lecidea atrobrunnea s.l.	+		
L. tessellata	+		
L. spp.	+		
Lobothalliia spp.	+	+	
Melanelia spp.		+	
Neofuscelia spp.		+	
Ophioparma lapponicum	+		
Phaeophvscia spp.		+	
Physcia spp.	+	+	
Pseudenhebe spp.		+	+
Rhizocarpon geographicum	+	+	
R. spp.	+	+	
Rhizoplaca spp.		+	
Sporastatia testudinea	+		
Staurothele spp.	++		
Stereocaulon spp.			+
Tephromela armeniaca	+		
Thamnolia spp.			+
Tremolecia atrata	+		
Umbilicaria spp.		+	
Xanthooarmelia spp.		+	
Xanthoria "candelaria"	+	+	+

Succession			
X. elesans	+	+	+
X. fallax	+	+	+