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Lichen ecology and diversity of a sagebrush steppe in Oregon: 1977 to the present

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Abstract: We present a lichen checklist of 141 species from the Lawrence Memorial Grassland Preserve and nearby lands in Wasco County, Oregon, based on collections made in the 1970s and 1990s. Collections include epiphytic, lignicolous, saxicolous, muscicolous, and terricolous species. One of these collections is the type specimen for a recently described species, *Placopyrenium conforme*. To evaluate differences between collections made in the 1970s and 1990s, taxa are placed in six morphological groups: crustose, foliose, fruticose, squamulose, stratified nitrogen-fixers, and gelatinous nitrogen-fixers. We determined that recent visits to the preserve added a greater proportion of terricolous species to the list than species from other substrates, reflecting developments in the taxonomy and understanding of biological soil crusts over recent decades. The trade-off between smaller-scale study plots that capture accurate species abundance and larger plots that capture more complete species richness is amplified in the sagebrush steppe because of the small size and cryptic nature of many lichens. We discuss the benefits of both approaches to lichen monitoring in these ecosystems. This project was possible because voucher specimens were available from the original 1977 survey, which allowed us to address changes in species concepts over recent decades.

Key words: biological soil crusts, Lawrence Memorial Grassland Preserve, lichen floristics, lichen monitoring, *Placopyrenium conforme*, rangeland health, sagebrush steppe, terricolous lichens

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Introduction: Sagebrush (*Artemisia*)-dominated plant communities constitute the largest semiarid vegetation type in North America, covering an area of approximately 628,000 km² (Anderson and Inouye 2001). The integrity of sagebrush ecosystems is currently threatened by livestock grazing, invasive species, changing wildfire regimes, and land development. The threat of widespread ecological degradation underscores the importance of understanding the biodiversity and ecological processes in these communities.

Biological soil crust communities are an integral part of resilient sagebrush ecosystems. Biological soil crusts play important roles in maintaining rangeland health; they reduce exotic plant invasion, regulate soil temperature and water dynamics, reduce erosion by binding soil particles, and support diverse soil microbial communities (Belnap 2001b; McCune and Rosentreter 2007). Additionally, by fixing atmospheric nitrogen, cyanolichens and cyanobacteria in soil crusts provide a source of this often-limiting nutrient for surrounding organisms, including vascular plants (Belnap 2001a). Along with bryophytes, free-living algae, and cyanobacteria, diverse lichens constitute a critical component of biological soil crusts in this region (Belnap et al. 2001).

Lichen communities have been well studied around the world, but the diversity of lichens in sagebrush ecosystems has been overlooked historically, due in part to their small size, cryptic nature, and complex taxonomy. Soil crust lichens in particular are difficult to curate and often lack reproductive structures, presenting challenges to identification. In recent years the ecological functions of these soil surface lichen communities have received increased attention (Belnap 2001a), but diversity and geographic distribution are still poorly understood (Rosentreter and Belnap 2001).

Biological soil crusts are easily disturbed by livestock grazing, which leads to decreased cover and species richness (Ponzetti and McCune 2001). Because of the ubiquity of livestock grazing in the American West, a long-ungrazed area of sagebrush steppe is a significant natural resource that can potentially provide excellent habitat for the development and survival of biological soil crusts. Studying the diversity of soil crust lichens in relatively undisturbed sagebrush steppe allows us to understand what these sagebrush communities may have looked like before the introduction of livestock. This understanding can inform future land management decisions.

Bearing in mind these objectives and the fragility of the sagebrush ecosystems across the American West, we present this comparative lichen checklist and discussion.

Study site: The Lawrence Memorial Grassland Preserve (LMGP) is located in north central Oregon, USA, in Wasco County, about 4 km southwest of Shaniko. It covers a 380 hectare (939 acre) portion of the former Rooper Ranch on the Shaniko Plateau. The highest portion, along Rooper Ranch Road, lies at 1050 m (3445 feet) elevation, and the land slopes generally northward toward Ward Creek to about 990 m (3248 feet). Our study area includes the entire Preserve and similar habitats just to the east of the Preserve.

The area was grazed by sheep until about 100 years ago and was then grazed by cattle until the Preserve was completely fenced in December 1976. The chance placement of earlier partial fencing, conservative management practices, and lack of water prevented intense grazing so that today the LMGP is strikingly different from the surrounding rangeland. A more complete history may be found in Winward and Youtie (1976), Davis and Youtie (1976), and Bohn (1977).

The climate on the LMGP is semi-arid with average annual precipitation of 280 mm measured at Kent, falling mostly from November through January but with heavy rains in May and June. Dry summers with high temperatures, average maximum 26-32˚ C in August to October, are coupled with low daytime humidity of 20-25%, occasionally 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 (Bohn 1977).

At LMGP the peculiar mound-intermound system, also called biscuit scabland, is the most conspicuous geologic feature. The mounds are circular to ovoid, depending on the slope, and measure 10-20 m in diameter and 100-120 cm high. They consist of relatively well-drained, deep loessal soil mixed with volcanic ash and basalt fragments with the basaltic bedrock at about 70 cm. Stone rings, lacking visible soil accumulation, surround the mounds. The flat intermound residual soil surface is cobbly, brown loam 0-50 cm thick with bedrock generally at about 18 cm. Small, north-flowing tributaries to Ward Creek lie near the east and west boundaries of the Preserve. Their associated ravines are walled by basalt bedrock cliffs, slopes and talus.

Native species of bunchgrass (*Festuca idahoensis, Poa secunda, Pseudoroegneria spicata*) dominate the Preserve along with the prevalent shrub, *Artemisia rigida*. *Bromus tectorum* occurs frequently, sometimes forming patches that exclude all other vegetation. *Lomatium cous* is present in rocky areas with shallow soil. The bottoms of the major drainages are home to most of the tree species and several species of grasses and forbs that do not occur elsewhere on the Preserve.

The LMGP site is relatively undisturbed; the greater abundance and vigor of bunchgrasses inside the Preserve than outside is obvious even to the casual observer. The LMGP is one of the few sites in the central Oregon steppe that approximates conditions thought to exist in this region before the arrival of settlers and domestic livestock (Rossman 1977).

Methods: In 1977 the second author conducted an extensive lichen survey at LMGP using plot and linear sampling as well as intuitive surveys. Rossman sent many of her collections to numerous lichenologists; some were identified by experts of specific groups. Two decades later her collections were reexamined by Roger Rosentreter and others; several identifications were changed based on advances in taxonomy. New taxa were also found in mixed collections. Most of Rossman's collections are now housed at the Snake River Plains Herbarium (SRP) at Boise State University, the Oregon State University Herbarium (OSC) and the Smithsonian Institution (US).

Other researchers made additional lichen collections at LMGP in the 1990s. Jeanne Ponzetti studied the effects of fire and herbicide use on soil crust lichens at LMGP and made numerous lichen collections using transects and plots (Ponzetti 2001). Roger Rosentreter and

Bruce McCune collected lichens inside and just east of LMGP; collections made outside the LMGP were from habitats similar to those found within the preserve. Rosentreter's collections are now deposited at SRP; McCune's and Ponzetti's collections are deposited in their personal herbaria and at OSC.

To understand compositional differences between collections made at different times, we divided species into groups by substrate: bark, moss, organic matter, rock, soil, and wood. For simplicity, each species was assigned to only the substrate on which it occurred most commonly in the study area. The muscicolous group is the most general of these substrate groups as it includes species growing on moss over both rock and soil. Although most substrates were recorded at the time of collection or were determined later by inspection of collections, a few species were assigned to a substrate group based on literature and field experience.

To compare patterns in field detection of lichens between surveys in the 1970s and 1990s, all species except saxicolous species were assigned to one of six morphological groups as described by Eldridge and Rosentreter (1999). These groups are crustose, foliose, fruticose, squamulose, gelatinous nitrogen-fixing, and stratified nitrogen-fixing; these groups are similar to those used by McCune and Rosentreter (2007). Saxicolous species were not included in this grouping because the 1990s collections focused on other substrates.

Rossman's original identifications were determined using primary literature and comparisons with herbarium material; many were verified by specialists. More recent collections were identified using McCune and Rosentreter (2007) as well as other resources also used by Rossman. Nomenclature follows Esslinger (2009), except for *Cetraria* which follows McCune and Geiser (2009) and *Placidium imbecillum* (Breuss) Breuss, which was not yet listed by Esslinger (2009) at the time of writing. Vascular plant taxonomy follows the USDA PLANTS database (2010).

Results: In the original survey Rossman (1977) reported 95 lichen species, 33 of which had not previously been reported for Oregon, and one of which, *Rinodina terrestris*, had never before been reported from the USA. Many of these new state records are now known to be fairly common in Oregon. These results were described in an unpublished report to the Nature Conservancy (Rossman 1977).

Re-examination of Rossman's collections revealed 20 additional taxa, and further collections in the 1990s added an additional 26 taxa; the lichen checklist for the study area now includes 141 species (Tables A1 and A2). One specimen from the study area is the type specimen for a recently described species, *Placopyrenium conforme* (Breuss 2009). Additions to the species list from collections made in the 1990s involved primarily terricolous lichens from various morphological groups.

New collections of terricolous and muscicolous species in the 1990s represented increases of 62% and 57%, respectively, over the number of species Rossman collected from the same substrates. New species collected in the 1990s from other substrates (bark, wood, rock, and organic matter) resulted in much smaller increases to the list of 14% or less. Only one new wood-dwelling species and one new epiphyte were added. Six new saxicolous species were found, but these represented an increase of only 11% over the number of saxicolous species previously reported (fig. 1).

New species were found in most morphological groups in the 1990s surveys. The number of squamulose species known from LMGP increased by 83% as a result of these surveys and the number of gelatinous nitrogen-fixers increased by 67%. Known species of stratified nitrogen-fixers and fruticose species increased by 50% and 44%, respectively, and known species of crustose taxa increased by 28%. No additional species of non-saxicolous, non-nitrogen fixing foliose lichens were found in the 1990 collections (fig. 2).

Discussion: This project is the first attempt to fully describe lichen species diversity across a large area of sagebrush steppe in the Pacific Northwest. Other work on sagebrush steppe lichens in the region has used only plots and transects (Ponzetti and McCune 2001; Ponzetti et al. 2007) rather than combining them with landscape-scale intuitive surveys. Trade-offs between these methods are discussed below.

By Substrate

A comparison of Rossman (1977) with more recent literature suggests a significant advance in knowledge of soil crust lichens in the last 33 years (e.g. McCune and Rosentreter 2007). Terricolous lichens were less studied and understood than epiphytes and saxicolous lichens in the 1970s; new research and literature on biological soil crust lichens has emerged (e.g. Nash et al. 2007; McCune and Rosentreter 2007). As a result, more recent surveys have been able to add a greater proportion of terricolous species to the list than species from other substrates. Since the muscicolous group includes some species that are often thought of as terricolous, the large relative increase in this group may be partially explained by the same factors.

Collections from the 1990s brought only small increases in the number of bark- and wood-dwelling species; several expected species have not been collected, indicating that further surveys might increase the number of species for these groups. Since surveys in the 1990s focused more on substrates other than rock, further work might result in more species of saxicolous lichens as well.

By Morphological Group

The significant numbers of gelatinous nitrogen-fixers added to the list in the 1990s probably reflect taxonomic advances in the rather cryptic genus *Leptogium* (Jørgensen and Tønsberg 1999). Similarly, new literature and taxonomic work may also account for the many new squamulose species that were found in 1990s survey.

Importance of voucher specimens

This project comparing a decades-old floristic survey with more recent surveys would not have been possible without good voucher specimens. The most useful vouchers contained high quality, fully developed specimens. Terricolous lichens generally require careful curation to produce lasting voucher specimens; otherwise they are easily degraded through routine handling. This is another factor that may help explain why soil crust lichens have been less studied historically than other types of lichens.

Vouchers are necessary for projects like this because updating lichen floristic surveys involves more than just changing species names, since many species concepts themselves have changed. Since the 1970s, numerous species have been split into two or more taxa, as seen in the genus *Trapeliopsis* (McCune et al. 2002). In another example, some currently recognized *Aspicila* species were not yet described in 1977 and others were placed in the genera *Agrestia* and *Lecanora* in Rossman's original report (Rosentreter 1998; Rossman 1977). Numerous changes have been reported for other soil crust genera such as *Buellia, Candelariella,* and *Lecidea*; recent research indicates that the genus *Leptogium* is still in need of further revision (McCune and Rosentreter 2007).

Sampling methods

With the elimination of grazing by livestock, cover of soil crust lichens may be increasing; however, no attempts have been made to measure changes in relative species abundance. In order to effectively monitor changes in species abundance at this site over time, future studies should include a baseline survey of species abundance.

In the field assessments of lichen communities there is a trade-off between assessing species abundance and overall species richness. Larger sample areas more accurately capture species richness, but as sample area increases quantitative assessment of cover or abundance becomes less accurate. This trade-off is amplified in soil crust lichen communities due to the small size of the organisms. Considering the precise goals of a given project is important in these ecosystems in order to ensure that useful data are collected. Research concerning this trade-off in sampling epiphytic macrolichen communities in a forested ecosystem documents that small sample quadrats combined with diversity reconnaissance over a larger area can effectively and accurately represent both species diversity and abundance (McCune and Lessica 1992).

Standard protocols for monitoring/measuring lichen soil crust communities have not been well established. We recommend an approach combining large-scale surveys over the landscape with small plots where species or morphological cover can be easily estimated. This could be an effective approach where data characterizing both species richness and abundance are critical. Plots designed for collection of quantitative abundance data should be small enough that they "can be viewed at one time with individual organisms still easily discernable" (Daubenmire 1968 in McCune and Lessica 1992). As some lichen crust species are barely discernable with the naked eye even at close range, plot sizes of less than one meter square are probably the most useful. Because soil crusts vary greatly among microclimates, numerous small plots are needed to accurately characterize landscape-scale effects such as disturbance.

Identifying soil crust taxa to species, while useful and necessary for some purposes, generally requires technical expertise. Since there appear to be strong correlations between the structure and ecological function of terricolous lichens, grouping lichens by morphology and function for abundance assessments can provide useful management information regarding rangeland health. This approach is rapid, easily repeatable and can be performed by technicians with minimal training (Eldridge and Rosentreter 1999).

Conclusions
The lichens of the sagebrush steppe will persist only as long as their habitat remains intact. Sagebrush lands have been destroyed at an alarming rate; for example, virtually no pristine sagebrush habitats remain in Canyon County, Idaho, west of Boise (Eric Yensen, pers. comm., 2010). Natural preserves such as the Lawrence Memorial Grassland Preserve, along with conservative management practices on other lands, provide important ecological functions such as preserving watershed integrity. Furthermore, they allow the great biodiversity of lichens and other smaller organisms in sagebrush ecosystems to persist for future generations.

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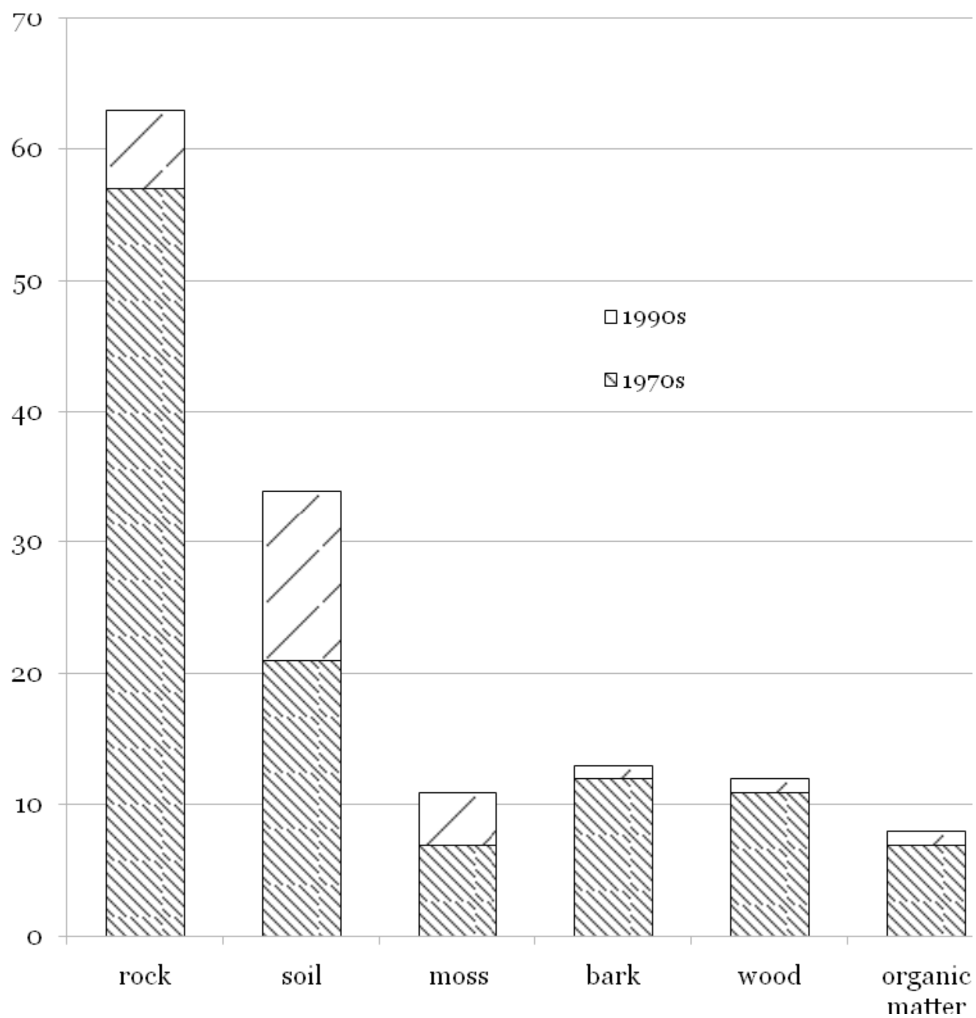

Figure 1: Number of species collected in the 1970s and 1990s by substrate.

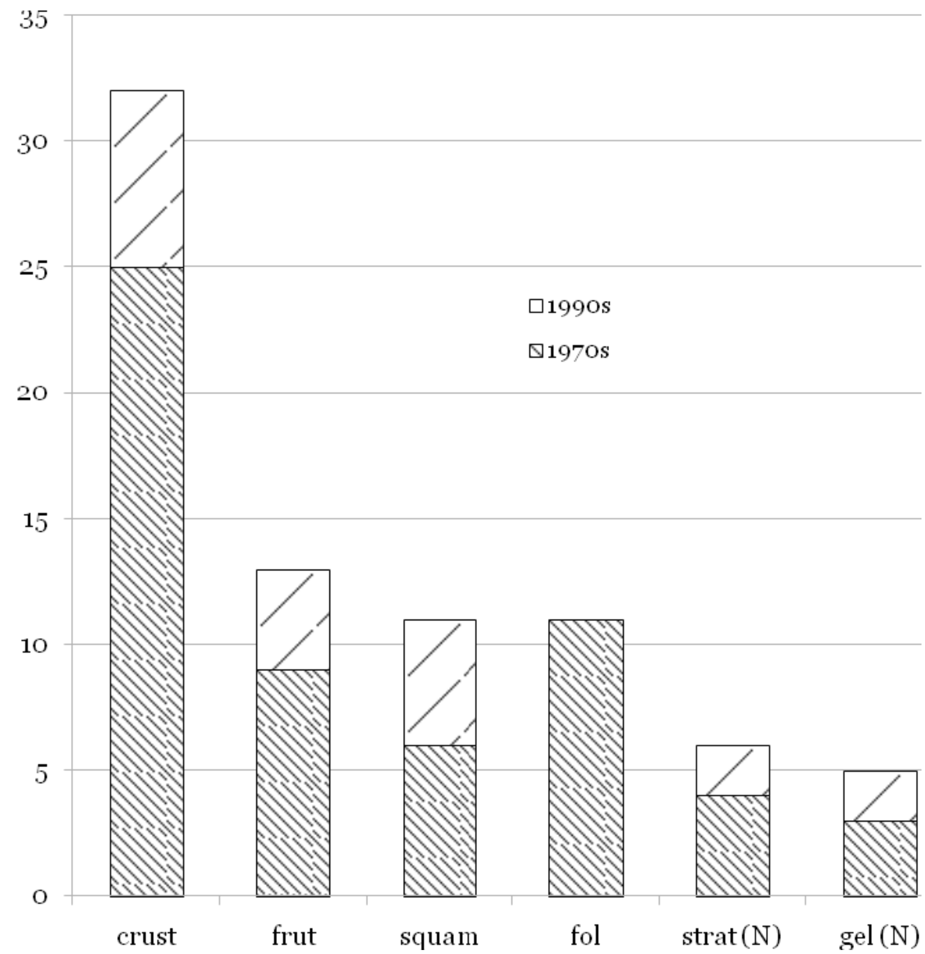

Figure 2: Number of species collected from non-rock substrates in the 1970s and 1990s by morphological group ["crust"=crustose, "frut"=fruticose, "squam"=squamulose, "fol"=foliose, "strat (N)"= stratified nitrogen fixers, and "gel (N)"=gelatinous nitrogen fixers.]

Photo 1: The landscape at the study site is shown with Mt. Hood in the background.

Photo 2: This view of the fence line shows that the greater abundance and vigor of bunchgrasses inside the Preserve than outside is obvious even to the casual observer.

APPENDIX

Table A1: Saxicolous lichens of the LMGP area

Species	**Added in 1990s**	**Collection Number**
Acarospora fuscata (Schrader) Arnold		LL 148
Aspicilia caesiocinerea (Nyl. ex Malbr.) Arnold		LL 776b, 768
Aspicilia calcarea (L.) Mudd		LL 508
Aspicilia cinerea (L.) Körber		LL 776a, 791
Aspicilia contorta (Hoffm.) Kremp.	X	RR 10649
Aspicilia desertorum (Kremp.) Mereschk.		LL 838
Buellia dispersa A. Massal.		LL 209, 211, 210
Caloplaca atroalba (Tuck.) Zahlbr.	X	JP 764
Caloplaca citrina (Hoffm.) Th. Fr.	X	BM 26343
Candelariella aurella (Hoffm.) Zahlbr.		LL 181
Candelariella vitellina (Hoffm.) Müll. Arg.		LL 177
Dermatocarpon miniatum var. *complicatum* (L.) W. Mann		LL 325
Dermatocarpon miniatum var. *miniatum* (L.) W. Mann		LL 326
Dermatocarpon reticulatum H. Magn.		LL 330, 329, 777
Dimelaena thysanota Hale & Culb.		LL 755
Diploschistes scruposus (Schreber) Norman		LL 187, 188
Lecanora argopholis (Ach.) Ach.		UNK
Lecanora cenisia Ach.		UNK
Lecanora hagenii (Ach.) Ach.		LL 518
Lecanora muralis (Schreber) Rabenh.		LL 122, 514, etc.
Lecanora nigromarginata H. Magn.		UNK
Lecanora phaedrophthalma var. *christoi* (W. A. Weber) B. D. Ryan		LL 108, 110, etc.
Lecanora rupicola (L.) Zahlbr.		LL 820, 523, 804
Lecidea atrobrunnea (Lam. & DC.) Schaerer		LL 742, 418, 426
Lecidea fuscoatra (L.) Ach.		LL 678
Lecidea fuscoatrina Hertel & Leuckert		LL 707
Lecidea lapicida (Ach.) Ach.		LL 401, 402
Lecidea lithophila (Ach.) Ach.		LL 766
Lecidea plana (J. Lahm) Nyl.		LL 438
Lecidea tessellata Flörke		LL 451
Lecidea truckeei Herre		LL 639
Lecidea sp. nov., in edit—McCune		LL 722
Lecidella carpathica Körber		LL 760
Lecidella stigmatea (Ach.) Hertel & Leuckert		LL 740, 437, 407
Leprocaulon subalbicans (I. M. Lamb) I. M. Lamb & Ward		LL 771, 163, 165
Leptogium gelatinosum (With.) J. R. Laundon	X	BM 26346
Lobothallia alphoplaca (Wahlenb.) Hafellner		LL 399
Lobothallia praeradiosa (Ach.) Hafellner		LL 832
Melanelia disjuncta (Erichsen) Essl.		LL 338, 344
Ochrolechia upsaliensis (L.) A. Massal.		LL 157
Parmelia saxatilis (L.) Ach.		LL 749, 353, 354
Parmelia sulcata Taylor		LL 331
Physcia biziana (A. Massal.) Zahlbr.		LL 305, 302, 719

Physcia phaea (Tuck.) J. W. Thomson		LL 303
Physcia tribacia (Ach.) Nyl.		LL 730
Placopyrenium conforme Breuss	X	JP 758, RR 10627
Pseudephebe pubescens (L.) M. Choisy		LL 385
Rhizocarpon bolanderi (Tuck.) Herre		LL 130, 131
Rhizocarpon disporum (Nägeli ex Hepp) Müll. Arg.		LL 135
Rhizocarpon geographicum (L.) DC.		LL 141
Rhizocarpon grande (Flörke ex Flotow) Arnold		LL 826
Rhizocarpon viridiatrum (Wulfen) Körber	X	BM 26350
Rhizoplaca chrysoleuca (Sm.) Zopf		LL 102
Rhizoplaca melanopthalma (DC.) Leuckert & Poelt		LL 117, 126, 770
Rimularia insularis (Nyl.) Rambold & Hertel		LL 445
Staurothele areolata (Ach.) Lettau		LL 333
Staurothele drummondii (Tuck.) Tuck.		LL 733
Staurothele fissa (Taylor) Zwackh		LL 712
Umbilicaria hyperborea (Ach.) Hoffm.		LL 169, 734
Umbilicaria phaea Tuck.		LL 174
Xanthoparmelia wyomingica (Gyelnik) Hale		LL 361, 360, etc.
Xanthoparmelia cumberlandia (Gyelnik) Hale		LL 358
Xanthoparmelia plittii (Gyelnk) Hale		LL 725
Xanthoparmelia subhosseana (Essl.) Blanco et al.		LL 776

Tabe A2: Non-saxicolous lichens from the LMGP area

Species Names	**Substrate**	**Morpho-Group**	**Added in 1990s**	**Collection #**
Acarospora schleicheri (Ach.) A. Massal.	soil	crustose		LL 153
Arthonia glebosa Tuck.	soil	crustose		LL 781, 414, 787
Amandinea punctata (Hoffm.) Coppins & Scheid.	organic matter	crustose		LL 222, 219, 223
Aspicilia filiformis Rosentreter	soil	fruticose		LL 387
Aspicilia hispida Mereschk.	soil	fruticose	X	JP observed
Aspicilia mastrucata (Wahlenb.) Th. Fr.	moss	crustose	X	JP 821
Bryoria fremontii (Tuck.) Brodo & D. Hawksw.	bark	fruticose		LL 818
Bryoria simplicior (Vainio) Brodo & D. Hawksw.	wood	fruticose		LL 353A
Buellia papillata (Sommerf.) Tuck.	organic matter	crustose		LL 226, 408, etc.
Buellia terricola A. Nordin	moss over rock	crustose	X	BM 26358, 26348
Buellia triphragmioides Anzi	bark	crustose		LL 237, 837, 234
Buellia triseptata A. Nordin	wood	crustose		LL 527
Caloplaca ammiospila (Wahlenb.) H. Olivier	organic matter	crustose		LL 370, 371
Caloplaca cerina (Ehrh. ex Hedwig) Th. Fr.	organic matter	crustose		LL 375, 807, etc.

Caloplaca epithallina Lynge	organic matter	crustose		LL 364, 368, etc.
Caloplaca jungermanniae (Vahl) Th. Fr.	moss	crustose		LL 765, 702, 764
Caloplaca tominii (Savicz) Ahlner	soil	crustose		LL 204
Candelariella efflorescens R. C. Harris & W. R. Buck	bark	crustose		LL 161
Cetraria merrillii Du Rietz	wood	fruticose		LL 339
Cladonia coniocraea (Flörke) Sprengel	wood	fruticose		LL 198, 199
Cladonia dahliana Kristinsson	organic matter	fruticose	X	JP 1376
Cladonia fimbriata (L.) Fr.	soil	fruticose		LL 773
Cladonia verruculosa (Vainio) Ahti	soil	fruticose	X	JP 770, 775, RR 10620
Collema tenax (Sw.) Ach.	soil	gelatinous		LL 703, L552
Cyphelium inquinans (Sm.) Trevisan	wood	crustose		LL 146
Diploschistes muscorum (Scop.) R. Sant.	soil	crustose		LL 185, 814
Endocarpon pulvinatum Th. Fr.	soil	squamulose		LL 318
Fuscopannaria cyanolepra (Tuck.) P. M. Jørg.	soil	stratified		LL 549, 460
Hypogymnia imshaugii Krog	bark	fruticose		LL 539
Lecanora densa (Śliwa & Wetmore) Printzen	bark	crustose		LL 527
Lecanora hypoptoides (Nyl.) Nyl.	moss	crustose		LL 502
Lecanora laxa (Śliwa & Wetmore) Printzen	wood	squamulose		LL 527, 524, 281
Lecanora saligna (Schrader) Zahlbr.	wood	crustose		LL 527
Lecanora sp. 4 of Śliwa and Wetmore (2000)	bark	crustose		LL 524
Lecidella euphorea (Flörke) Hertel	bark	crustose		LL 458, 457, etc.
Lepraria borealis Lohtander & Tønsberg	moss over rock	crustose	X	BM 26348
Leptochidium albociliatum (Desmaz.) M. Choisy	soil	gelatinous		LL 544, 827
Leptogium lichenoides (L.) Zahlbr.	soil	gelatinous		LL 738, 556, etc.
Leptogium subaridum P. M. Jørg. & Goward	moss over rock	gelatinous	X	BM 26359
Leptogium tenuissimum (Dickson) Körber	soil	gelatinous	X	JP 762
Letharia vulpina (L.) Hue	wood	fruticose		LL 744, 397
Massalongia carnosa (Dickson) Körber	soil	stratified	X	JP 751
Megaspora verrucosa (Ach.) Hafellner & V. Wirth	soil	crustose		LL 535, 789, 314, 532, 534
Melanohalea elegantula (Zahlbr.) O. Blanco et al.	wood	foliose		LL 794, 343
Melanohalea multispora (A. Schneider) O. Blanco et al.	wood	foliose		LL 346, 344a
Ochrolechia inaequatula (Nyl.) Zahlbr.	soil	crustose		LL 772
Peltigera ponojensis Gyelnik	soil	stratified	X	JP 819a
Peltigera rufescens (Weiss) Humb.	soil	stratified		LL 543, 541

Phaeophyscia ciliata (Hoffm.) Moberg	moss	foliose		LL 313
Phaeorrhiza sareptana (Tomin) H. Mayrh. & Poelt	soil	squamulose	X	JP 819b
Physcia aipolia (Ehrh. ex Humb.)	bark	foliose		LL 718
Physcia caesia (Hoffm.) Fürnr.	moss	foliose		LL 726, 316
Physconia enteroxantha (Nyl.) Poelt	moss	foliose		LL 705, 728, 307
Physconia muscigena (Ach.) Poelt	moss	foliose		LL 308, 727
Placidium pilosellum (Breuss) Breuss	soil	squamulose		LL 700
Placidium imbecillum (Breuss) Breuss	soil	squamulose	X	JP 812
Placidium rufescens (Ach.) Breuss	soil	squamulose		LL 700
Placidium squamulosum (Ach.) Breuss	soil	squamulose		LL 323
Placynthiella oligotropha (J. R. Laundon) Coppins & P. James	organic matter	crustose		LL 462, 711
Placynthiella uliginosa (Schrader) Coppins & P. James	organic matter	crustose		LL 811, 462, etc.
Polychidium muscicola (Sw.) Gray	moss	stratified		LL 745, 548, 724
Protopannaria pezizoides (Weber) P. M. Jørg. & S. Ekman	soil	stratified		LL 648
Psora cerebriformis W. A. Weber	soil	squamulose	X	JP 729
Psora globifera (Ach.) A. Massal.	soil	squamulose		LL 433, 775, etc.
Psora montana Timdal	soil	squamulose	X	JP 753a
Rinodina olivaceobrunnea C. W. Dodge & Baker	soil	crustose	X	BM 26345
Rinodina terrestris Tomin	soil	crustose		LL 243, 241
Texosporium sancti-jacobi (Tuck.) Nádv.	soil	crustose	X	JP observed
Thelenella muscorum v. *octospora* (Nyl.) Coppins & Fryday	soil	crustose		LL 698, 743
Thelomma ocellatum (Körber) Tibell	wood	crustose	X	JP 724, etc., RR 10619
Toninia ruginosa (Tuck:) Herre	soil	squamulose	X	JP 750, BM 26351, RR 10623
Trapeliopsis bisorediata McCune & Camacho	soil	crustose	X	JP 766, 1240, 820
Usnea hirta (L.) F. H. Wigg.	bark	fruticose		LL 715
Usnea scabrata Nyl.	bark	fruticose	X	JP 678, 818
Xanthomendoza fallax (Hepp ex Arnold) Søchting, Kärnefelt & S. Kondr.	bark	foliose		LL 201, 203
Xanthomendoza fulva (Hoffm.) Søchting, Kärnefelt & S. Kondr.	bark	foliose		LL 524
Xanthoria candelaria (L.) Th. Fr.	bark	foliose		LL 200
Xanthoria polycarpa (Hoffm.) Th. Fr. ex Rieber	wood	foliose		LL 206