12-1-2001

Lichens of the ponderosa pine forests of Nebraska.

Sara M. Morgan

LICHENS OF THE PONDEROSA PINE FORESTS OF NEBRASKA

A Thesis

Presented to the

Department of Biology

and the

Faculty of the Graduate College

University of Nebraska

In Partial Fulfillment

of the Requirements for the Degree

Master of Arts

University of Nebraska at Omaha

by

Sara Morgan

December, 2001

ProQuest LLC.
789 East Eisenhower Parkway
P.O. Box 1346
Ann Arbor, MI 48106 - 1346

THESIS ACCEPTANCE

Acceptance for the faculty of the Graduate College,
University of Nebraska, in partial fulfillment of the
requirements for the Master of Arts degree,
University of Nebraska at Omaha.

Committee

David M. Sutherland

Jeffrey J Peck

Chairperson R S Egan

Date 12/4/01

LICHENS OF THE PONDEROSA PINE FORESTS OF NEBRASKA

Sara Morgan, MA

University of Nebraska, 2001

Advisor: Dr. Robert Egan

Although generally thought of as a prairie state, Nebraska retains sizeable areas of both eastern deciduous and western pine forests. The state has five main western pine forest regions dominated by *Pinus ponderosa*. Three of these forests are naturally occurring—the northern Niobrara River Valley area of Brown and Cherry counties, the northwestern Pine Ridge region in Dawes, Sioux, and Sheridan counties, and the Wildcat Hills area of Scotts Bluff County. Samuel R. McKelvie National Forest in Cherry County and the Bessey Unit of the Nebraska National Forest in Thomas County were both planted in the early 1900's. From 541 identified lichens, I found 110 species within a total of 47 genera from these pine forest areas. Of these 110 taxa, 39 species and six genera are new state records. Four of the new species records for Nebraska represent significant extensions of their currently known ranges. The lichens of the planted pine forests are less diverse than the naturally-occurring pine forests, but a few lichen species are currently known only from these planted pine systems.

ACKNOWLEDGEMENTS

First I would like to thank Dr. Robert Egan for opening my eyes to the wonderful and interesting world of lichenology. His knowledge and guidance during this project has been invaluable, and the use of his personal library and laboratory was very helpful. Many thanks to Dr. David Sutherland, Dr. Lisa Boucher, and Dr. Jeffrey Peake for being on my committee and putting forth useful suggestions.

I would also like to express thanks to those who have assisted me in identification and/or verification of problematic lichen species. Dr. Irwin Brodo (Canadian Museum of Nature), Dr. Jack Elix (Australian National University), Dr. Theodore Esslinger (North Dakota State University), Dr. Richard Harris (New York Botanical Garden), Mr. Doug Ladd (The Nature Conservancy, St. Louis), Dr. Scott LaGreca (Harvard University), Dr. Anders Nordin (University of Uppsala), and Dr. Clifford Wetmore (University of Minnesota) all were very willing to assist on this project, and for that I am grateful.

Gratitude goes to Jan and Butch Cheatum, The Nature Conservancy, the Nebraska Game and Parks Commission, and the U.S. Forest Service for granting me permission to collect on the various pine forest sites. Grants from the Biology Department, and the UNOmaha Office of Graduate Studies have funded this project.

Lastly, I would like to extend special thanks to my parents, Doug and Mary Brobst, and to my husband Brent, for their love and support during my graduate career.

TABLE OF CONTENTS

INTRODUCTION

Nebraska has five main pine forest regions dominated by *Pinus ponderosa* Laws., with other small naturally forested areas scattered in pockets across the state (Kaul & Rolfsmeier 1993). Three of these main forest areas occur naturally: the Pine Ridge in northwestern Nebraska, the Wildcat Hills south of the city of Scottsbluff, and the Niobrara River Valley in the north-central portion of the state. These three natural coniferous forest communities are similar in having gentle to steep slopes, well-drained sandy soils, and sandstone outcrops (Steinauer & Rolfsmeier 2000). The Pine Ridge area in Dawes, Sheridan, and Sioux counties is the largest pine-dominated forest in the state and is characterized by the Rocky Mountain ponderosa pine, *Pinus ponderosa* (Nixon 1967). This area also contains a variety of understory shrubs, deciduous trees in canyons, and prairie species on exposed ridges and among trees in savannas (Kaul & Rolfsmeier 1993). The Wildcat Hills is a pine woodland and savanna within Scotts Bluff County. A variety of lichen habitats can be observed in this region including canyons, rocky bluffs, and grassland areas. In addition to pine forest, the area is characterized by an understory with sparse woody plants and herbaceous growth typical of western escarpments (Kaul & Rolfsmeier 1993). The Niobrara River joins the Keya Paha River in Boyd County, Nebraska, and continues

westward across the remaining length of the state. The area is unique due to the co-occurrence of three distinctly different forest types. Western coniferous forest, eastern deciduous forest and northern boreal forests are able to exist in a grassland biome due to unique hydrologic and geologic conditions. Because of this, the region has been referred to frequently as a "biological crossroads" (Kaul et al. 1993). Pine forests are common along the south facing slopes on the north, as well as along the upper slopes of canyons on the south side. The herbaceous understory is typical of the sandhills with a bunchgrass community, and the upper canyons have Pine Ridge species (Kaul & Rolfsmeier 1993).

The remaining two extensive pine forest regions were established in the early 1900's by President Theodore Roosevelt: the Bessey Division of the Nebraska National Forest in Thomas County and the Samuel R. McKelvie National Forest in Cherry County. Planting began on the Bessey Division in 1902, and today this area encompasses over 20,000 acres of hand-planted trees on a reserve that covers over 90,000 acres. The major species include ponderosa pine, jack pine and eastern red cedar, and in older sections the forest is well established enough to support considerable undergrowth, as well as some deciduous species (NOHVA 1998). In 1971 President Nixon signed a law designating 115,703 acres of the Niobrara

Division as the Samuel R. McKelvie National Forest, although planting had begun on this site as early as 1915. Today around 2,300 acres have been successfully planted, containing approximately 0.75 million trees. The major species planted are ponderosa pine, eastern red cedar, jack pine and scotch pine (USDAFS undated).

The pine forest areas of Nebraska are many miles south of the closest region of similar vegetation, the Black Hills in South Dakota and Wyoming, which itself is isolated from the larger Rocky Mountain ecosystem. The lichens present in Nebraska's natural pine populations probably represent remnant taxa inhabiting a once larger coniferous forest that occurred after the last Pleistocene glaciation, so it is natural to expect these areas to support lichen taxa typical of the southern Rocky Mountains. However, the planted populations are not only thousands of years younger, but may be too isolated for significant lichen growth and dispersal to have occurred in less than 100 years. Although these areas contain some substrates similar to the natural populations, and thus theoretically could support a similar flora, their isolation and young age could result in a more reduced but distinct species assemblage.

The lichen flora in these pine forest areas of Nebraska is not well-known. Before this study, Sioux and Dawes counties had only six accepted lichen species

reported, Brown County had seven, Thomas County three, Cherry County twelve, and Scotts Bluff and Keya Paha counties had no taxa reported (Egan et al. 1995). Providing documentation of the lichen flora in these areas will be beneficial not only to future researchers, but to various regulatory agencies as well. The benefits of using lichens as air quality indicators has long been established, and these types of studies require a baseline for future comparison. The purposes of this study were two-fold: 1) to document and describe the lichen flora occurring in these five pine-dominated areas in Nebraska, and 2) to compare the lichen species found in the natural pine regions with the lichen species found in the planted populations.

METHODS

Collections for this study were made in the spring and summer of 2000. Additional unidentified collections made in 1988 by Dr. Robert Egan were included. The sites are grouped into the five main pine forest regions, with the numbers on the left side indicating my collection numbers, or those of Egan (13,000 series). The letters in parenthesis indicate the site (Fig. 1).

Collection of lichens followed standard procedures outlined in Hale (1979). Lichens on trees were collected using a wood chisel, while a stone chisel was used for those growing on rock. Lichens were placed in paper bags along with information regarding substrate, locality and habitat. Each site was intensively collected, with a maximum amount of time spent at each site to ensure that all species were collected.

NIOBRARA STUDY SITES

163-197 (A) Long Pine State Recreation Area

Brown County. 8 miles E of Ainsworth on US Route 20; mixed pine/juniper/oak woodlands; 42°32'38" N. Lat., 99°42'34" W. Long.; elevation 700 m. 21 May 2000.

13250-13264 Long Pine State Recreation Area

Brown County. 7 miles E of Ainsworth; T30N R75W; elevation

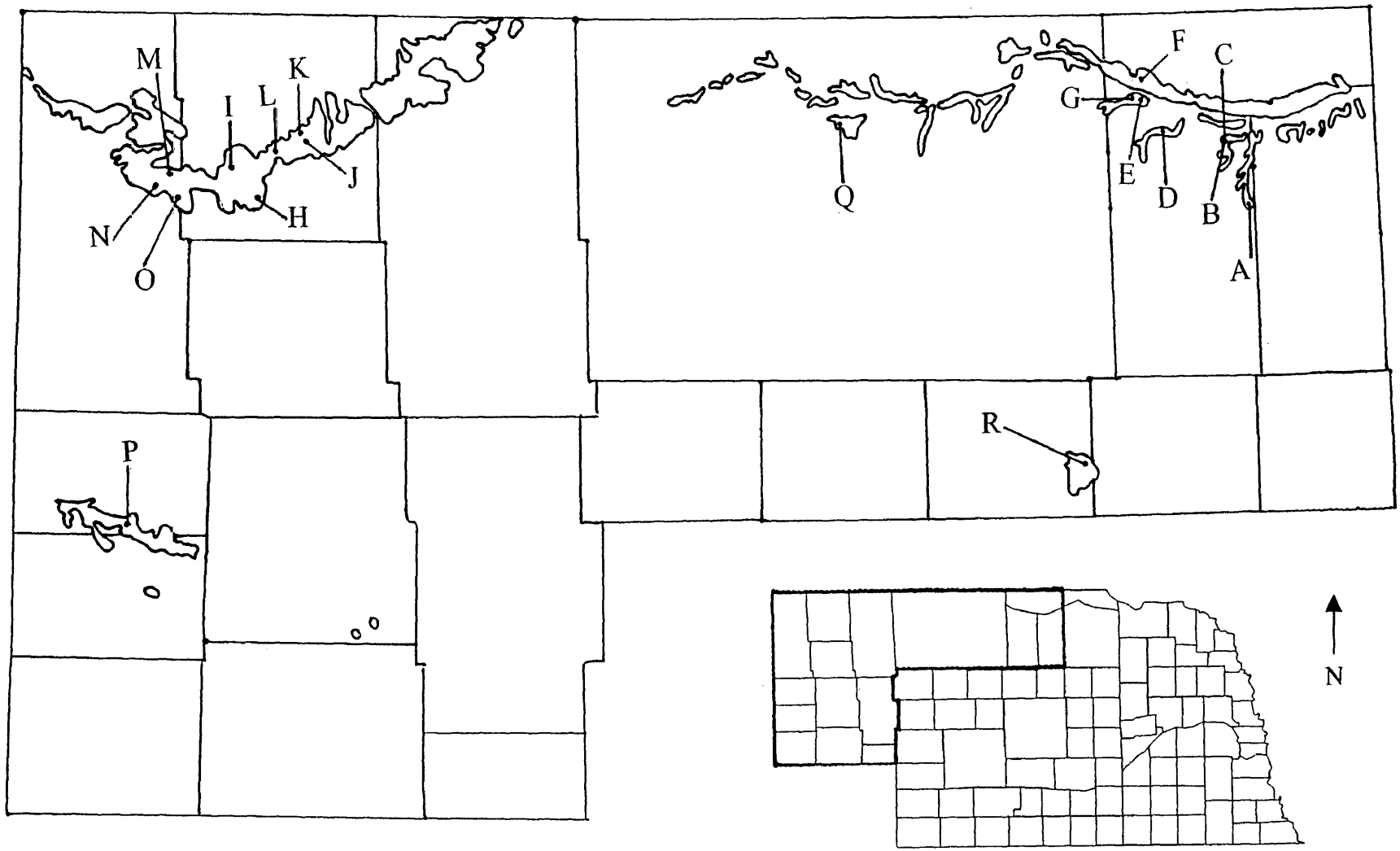

Fig. 1. Map of Collecting Sites. Modified from Kaul & Rolfsmeier, 1993. Areas drawn in indicate pine forest regions in Nebraska. Letters correspond to individual collecting sites (see text). 1 inch = 24.5 miles.

760 m; juniper-pine woods on steep slopes. 26 May 1988.

198-239 (B) Keller Park State Recreation Area

Brown County. 9 miles NE of Ainsworth off US Route 183; mixed pine/juniper/oak woodlands; 42°40'01" N. Lat.; 99°46'07" W. Long.; elevation 670 m; 22 May 2000.

238-250 (C) Cheatum Ranch

Brown County. North on state Hwy 183 along Bone Creek. 9.5 miles NE of Ainsworth; soft sandstone outcrops with some pine/juniper stands; 42°40'32" N. Lat.; 99°46'06" W. Long.; elevation 670 m; 22 May 2000.

251-272 (D) Bobcat State Wildlife Management Area

Brown County. 12 miles N of Ainsworth just W of Meadville Road; Mixed pine/juniper/oak woodlands with steep hillsides. 42°43'28" N. Lat.; 99°51'50" W. Long.; elevation 700 m; 22 May 2000.

273-308 (E) Niobrara Valley Preserve

Brown County. South side of Niobrara River; 6 miles S of Norden off Norden Road; mixed pine/juniper with other deciduous trees in small canyon seeps; 42°47'00" N. Lat.; 100°00'35" W. Long.;

elevation 690 m; 23 May 2000.

309-331 (F) Niobrara Valley Preserve

Keya Paha County. North side of Niobrara River along dirt road towards Sunny Brook and Rocky Ford; about 5 miles SW of Norden; mixed pine/juniper/oak woodland; 42°48'17" N. Lat.; 100°06'16" W. Long.; elevation 700 m; 23 May 2000.

332-337 (G) Niobrara Valley Preserve

Brown County. South side of Niobrara River just E of Fairfield Camp ; 1.5 miles W of the Norden Bridge; N-facing slope with birch/oak/juniper woodlands; 42°47'06" N. Lat.; 100°03'39" W. Long.; elevation 650 m; 23 May 2000.

PINE RIDGE STUDY SITES

365-408 (H) Nebraska National Forest

Dawes County. 18 miles SW of Chadron along East Ash Road (Forest Service road 706); 1.8 road miles N of junction with Table Road (Forest Service road 705) ; pine forest with some deciduous trees and understory; 42°37'39" N. Lat.; 102°11'17" W. Long.; elevation 1260 m; 25 May 2000.

409-425 (I) Nebraska National Forest

Dawes County. 18 miles SW of Chadron along West Ash Road; 4.5 miles S of the junction of Forest Service road 704 and W. Ash Rd; small picnic/camping area with pine/ash/cottonwood trees, grassy understory, along stream; 42°38'50" N. Lat.; 103°15'53" W. Long.; elevation 1100 m; 25 May 2000.

426-444 (J) Chadron State Park

Dawes County. Chadron State Park primitive tent campground; 9 miles S of Chadron off US Route 385; pine woodland; 42°42'43" N. Lat.; 103°01'18" W. Long.; elevation 1200 m; 25 May 2000.

13327-13346 Chadron State Park

Dawes County. Chadron State Park. 8 miles S of Chadron; T32N, R49W; elevation 1220 m; pine forest on steep slopes. 27 May 1988.

521-556 (K) Chadron State Park

Dawes County. Chadron State Park; 9 miles S of Chadron off US Route 385; along Black Hills Overlook Trail towards Lookout Point; pine/juniper forest with many rock outcrops; 42°42'40" N. Lat.;

103°02'04" W. Long.; elevation 1260 m; 24 July 2000.

557-583 (L) Nebraska National Forest

Dawes County. Along Coffee Mill Trail off Dead Horse Road; 11.2 miles SW of Chadron; steep hillsides with mixed pine/juniper forest; 42°40'31" N. Lat.; 103°04'46" W. Long.; elevation 1220 m; 25 July 2000.

13347-13376 (M) Fort Robinson State Park

Sioux County. 2 miles NW of Fort Robinson; T31N, R53W; steep slopes with pines; elevation 1310 m; 28 May 1988.

13377-13404 (N) Smiley Canyon Scenic Drive

Sioux County. 3 miles WNW of Fort Robinson; T31N, R53W; on steep north-facing slope with pines and junipers; elevation 1340 m; 28 May 1988. These specimens were collected prior to the fire of 1989.

13422-13435 (O) Cochran State Wayside Area

Sioux County. 6 miles S of Crawford; T30N, R52W; steep hillside with pines; elevation 1310 m; 28 May 1988.

WILDCAT HILLS STUDY SITES

445-485 (P) Wildcat Hills State Recreation Area

Scotts Bluff County. 12 miles S of Scottsbluff off US Route 71; pine/juniper woodland with steep hillsides; 41°42'41" N. Lat.; 103°40'00" W. Long.; elevation 1380 m; 26 May 2000.

13438-13474 Wildcat Hills State Recreation Area

Scotts Bluff County. 10 miles S of Scottsbluff; steep slopes with pine, juniper and mountain mahogany and rock outcrops; T20N, R55W; elevation 1405 m; 29 May 1988.

MCKELVIE NATIONAL FOREST STUDY SITES

338-364 (Q) Samuel R. McKelvie National Forest

Cherry County. Steer Creek Campground. 15 miles S of Nenzel off US Route S16F; planted pine forest; 42°41'22" N. Lat.; 101°09'14" W. Long.; elevation 940 m; 24 May 2000.

13265-13285 Samuel R. McKelvie National Forest

Cherry County. Steer Creek Campground. 17 miles SSW of Nenzel; T31N, R33W; elevation 945 m; pine forest. 27 May 1988.

NEBRASKA NATIONAL FOREST BESSEY DIVISION STUDY SITES

486-520 (R) Nebraska National Forest, Bessey Division

Thomas County. 4.8 miles SW of Halsey; along Scott Lookout National Recreational Trail; planted pine forest with some juniper, ash and developed understory; 41°53'22" N. Lat.; 100°20'04" W. Long.; elevation 860 m; 2 July 2000.

13477-13491 Nebraska National Forest, Bessey Division

Thomas County. 3 miles W of Halsey; planted pine forest with gentle north-facing slope; T22N, R25W; elevation 550 m; 29 May 1988.

Processing of lichen collections followed Hale (1979). Foliose and fruticose growth forms easily removed from the substrate were rewetted in distilled water, then dried in a plant press. The pressed lichens were placed on cotton wadding on cards. Crustose growth forms were left attached to the substrate and glued to cards. All cards were placed in folded paper packets.

Specimen identifications were made using standard morphological and chemical characteristics. Most morphological features were seen with a dissecting

microscope, with the exception of spore characteristics, which were viewed using a compound light microscope, and measured to the nearest micrometer under 1000x magnification. Problematic specimens were sent to various taxonomic lichenologists for verification or determination. Several specimens remain undetermined, particularly crustose taxa.

Chemical properties were determined by spot tests (10% KOH, Clorox) according to Hale (1979) and/or thin layer chromatography (TLC) using solvent "A" following standard procedures in Culberson (1972) and White & James (1985). Identified lichens were placed in rag paper packets and attached to herbarium sheets. Voucher specimens are deposited in the University of Nebraska at Omaha Herbarium (OMA).

KEY TO GENERA

This key may be used to determine the genera of lichens occurring in the five Nebraska pine forest regions. If more than one species occurs within a genus, a second key to the species is found later within the annotated catalog. If only one species of a particular genus occurs, the species name is given here, and more information will be found within the annotated catalog.

1. Thallus fruticose.....2
1. Thallus foliose, squamulose, crustose, or leprose.....7

2. Thallus pendant, growing downward, bushy or long, primary squamules absent.....3
2. Lichen erect, growing upward from ground, primary squamules present.....*Cladonia*

3. Thallus orange, yellow-green, or green.....4
3. Thallus brown.....6

4. Thallus yellow-green or green.....5
4. Thallus orange and/or apothecia orange.....*Teloschistes chrysophthalmus*

5. Branches round in cross-section, with a central cord.....*Usnea*
5. Branches flattened in cross-section, without a central cord.....*Evernia mesomorpha*

6. Thallus sorediate on margins, lobes flattened.....*Tuckermannopsis chlorophylla*
6. Thallus sorediate in soralia on surface of thallus, lobes round.....*Bryoria fuscescens*

7. Thallus foliose.....8
7. Thallus squamulose, crustose, or leprose.....28

8. Thallus yellow, yellow-green or orange.....9
8. Thallus brown or gray.....14

9. Thallus orange, K+ purple.....*Xanthoria*
9. Thallus yellow or yellow-green, K-.....10

10. Thallus yellow (lacking usnic acid).....11
10. Thallus yellow-green (usnic acid).....11

11. Medulla white, thallus lobes <1.0mm.....*Candelaria concolor*
11. Medulla yellow, thallus lobes >1.0mm.....*Vulpicida pinastri*

12. Pseudocyphellae present on upper cortex of thallus lobes.....*Flavopunctelia*
12. Pseudocyphellae absent.....13

13. Thallus lobes narrow, 1-2 mm wide.....*Parmeliopsis ambigua*
13. Thallus lobes wider, 4 mm or more.....*Flavoparmelia caperata*

14. Thallus with conspicuous veins on the underside.....*Peltigera*
14. No veins on lower surface.....15

15. Thallus with pseudocyphellae on upper surface.....*Punctelia*
15. Thallus with no pseudocyphellae.....16

16. Lichen thallus shades of gray, upper cortex K+ yellow.....17
16. Lichen thallus shades of brown, upper cortex K-.....23

17. Thallus lobes narrow, 1-3 mm wide.....*Physcia*
17. Thallus lobes wider, 4 mm or wider.....18

18. Soredia absent.....*Pseudevernia intensa*
18. Soredia present.....19

19. Thallus lobes inflated at tips, soredia confined to lobe tips.....*Hypogymnia*
19. Thallus lobes not inflated, soredia marginal or laminal.....20

20. Soredia laminal, not at all marginal.....*Hypotrachyna laevigata*
20. Soredia mostly marginal, or on raised ridges.....21

21. Atranorin and norlobaridone present.....*Canomaculina conferenda*
21. Atranorin and salazinic present, norlobaridone absent.....22

22. Lobes linear, soredia marginal and laminal on raised ridges, cilia absent.....*Parmelia sulcata*
22. Lobes broad, rounded, soredia marginal, cilia often present.....*Rimelia reticulata*

23. Thallus lobes narrow, 1 mm wide or less.....24
23. Thallus lobes wider.....26

24. Underside white, rhizines lacking.....*Hyperphyscia*
24. Underside black, rhizines present.....25

25. Lower cortex paraplectenchymatous.....*Phaeophyscia*
25. Lower cortex prosoplectenchymatous.....*Physciella*

26. Underside pale to white.....*Tuckermannopsis*
26. Underside dark brown to black.....27

27. Thallus heavily pruinose.....*Physconia*
27. Thallus not pruinose, or only lightly.....*Melanelia*

28. Thallus crustose.....29
28. Thallus squamulose or leprose.....44

29. Ascoma a perithecium.....*Staurothele elenkinii*
29. Ascoma an apothecium.....30

30. Apothecia mazaedial or biatorine.....31
30. Apothecia lecideine or lecanorine.....32

31. Apothecia mazaedial, spores brown, submuriform.....*Cyphelium notarisii*
31. Apothecia biatorine, spores hyaline.....*Trapeliopsis flexuosa*

32. Apothecia lecideine.....33
32. Apothecia lecanorine.....38

33. Spores 1-celled.....34
33. Spores 2-many celled.....36

34. Spores 16-32/ascus.....*Sarcogyne regularis*
34. Spores 8/ascus.....35

35. Apothecia deeply embedded within thallus.....*Megaspora verrucosa*
35. Apothecia superficial on surface of thallus.....*Lecidella*

36. Apothecia deeply embedded in thallus, perithecia-like.....*Diploschistes*
36. Apothecia superficial on surface of thallus.....37

37. Thallus thick, white areolate, on rock, spores brown
.....*Diplotomma venustum*
37. Thallus green, granular, on moss over soil or soil, spores hyaline
.....*Bacidia sabuletorum*

38. Thallus orange or yellow.....39
38. Thallus white, brown, green or absent.....40

39. Thallus and/or apothecia orange, K+ deep purple.....*Caloplaca*
39. Thallus and/or yellow, K-.....*Candelariella*

40. Spores 1-celled.....41
40. Spores 2-celled.....43

41. Spores 16-32/ascus.....*Acarospora strigata*
41. Spores 8/ascus.....42

42. Spores spherical, 20-25 µm in diameter.....*Aspicilia contorta*
42. Spores ellipsoid, <20 µm.....*Lecanora*

43. Spores brown, 2-celled.....*Rinodina*
43. Spores hyaline, 2-celled.....*Lecania*

44. Apothecia absent, thallus leprose.....*Lepraria/Leproloma*
44. Apothecia present, thallus crustose.....45

45. Apothecia sunken, immersed in thallus.....*Heppia lutosa*
45. Apothecia superficial on squamules.....46

46. Squamules flattened, 3-4 mm wide, spores 1-celled.....*Psora*
46. Squamules convex, 1-2 mm wide, spores 2-celled.....*Toninia*

Annotated Catalog

With the exception of new species reports for Nebraska, details of Nebraska lichen records from the literature can be found in Egan et al. (1995). Many of these lichen taxa were also reported from South Dakota and Wyoming (Wetmore 1968). Frequency designations (rare, occasional, frequent, or common) for each species were based on the overall numbers of specimens collected.

Acarospora strigata (Nyl.) Jatta

This crustose species has a whitish-gray, thick, areolate thallus that is lightly pruinose. Lecanorine apothecia are immersed in the thallus and have hyaline, simple spores, 16-32/ascus. Rare on rock. While Wetmore (1968) and Brodo et al. (2001) report this species from neighboring states (Colorado, South Dakota and Wyoming), this report is a new record for Nebraska.

Chemistry: upper cortex K-, C- ; medulla K-, C-

Pine Ridge: 13362

Aspicilia contorta (Hoffm.) Kremp.

The whitish-gray, areolate thallus on this crustose species is lightly to heavily pruinose. Lecanorine apothecia are immersed in the thallus and have spherical, hyaline spores, 20-25 μm in diameter, 8/ascus. Occasional on rock. Although Brodo

et al. (2001) indicate on a distribution map that this species occurs in Nebraska, there have been no reports of this species from Nebraska within the published primary literature. Therefore, this report is considered a new state record for *A. contorta*.

Chemistry: upper cortex K-, C- ; medulla K-, C-

Niobrara: 271 Pine Ridge: 547, 573

Bacidia sabuletorum (Schreber) Lettau

This crustose species has a greenish thallus that is granular sorediate and has light brown lecideine apothecia that become black with age. Spores are four- or more-celled, transversely septate, hyaline, slender and needle-like. Frequently on moss over soil or on soil. This species has previously been recorded in South Dakota (Wetmore 1968) and Missouri (Ladd et al. 1994).

Niobrara: 230, 262 Pine Ridge: 379, 552, 529, 13433 Wildcat Hills: 478

Bryoria fuscescens (Gyelnik) Brodo & D. Hawksw.

Bryoria fuscescens has a fruticose, brown thallus that grows pendant from its point of attachment. Branches are round in cross-section and have soredia contained in soralia that expand wider than the branch. Found occasionally on pine bark and rotten logs. While Brodo et al. (2001) indicate on a distribution map that this species occurs in Nebraska, as well as Colorado and Wyoming, there have been no reports of

this species from Nebraska within the published primary literature. Therefore, this report is considered a new state record for *B. fuscescens*.

Chemistry: outer cortex K-, C- ; fumarprotocetraric acid

Pine Ridge: 380, 13344, 13374 Wildcat Hills: 13462

Caloplaca

Caloplaca species are crustose lichens with a orange to yellowish upper cortex which have a purple/black K+ cortical reaction and polarilocular ascospores. Dr. Clifford Wetmore assisted in the identification of these specimens.

1. On bark or wood.....2
1. On rock.....5

2. Thallus sorediate.....3
2. Thallus not sorediate.....4

3. Soredia in soralia, thallus yellow-orange.....*Caloplaca chrysophthalma*
3. Soredia diffuse over thallus, thallus dark orange.....*Caloplaca microphyllina*

4. Thallus yellowish, apothecial disks light orange.....*Caloplaca flavorubescens*
4. Thallus very pale, apothecial disks light orange to dark red.....*Caloplaca cerina*

5. Thallus sorediate, with a placoid margin.....*Caloplaca decipiens*
5. Thallus without soredia.....6

6. Thallus present.....7
6. Thallus inconspicuous, only scattered apothecia.....8

7. Thallus deep orange, placoid margin present.....*Caloplaca trachyphylla*
7. Thallus pale, light gray, areolate.....*Caloplaca flavovirescens*

8. Apothecial disk deep orange, margins lighter.....*Caloplaca holocarpa*
8. Apothecial disk deep orange, margins same color or disappearing.....*Caloplaca subsoluta*

Caloplaca cerina (Ehrh. *ex* Hedwig.) Th. Fr.

This species has a pale colored thallus with no soredia. Apothecia are common, with a dark orange to red disk, and margins that are the same color as the thallus. Found occasionally on juniper, oak, ash and willow bark.

Niobrara: 172, 181, 261 Pine Ridge: 416 McKelvie: 345

Caloplaca chrysophthalma Degel.

The light yellow thallus of *C. chrysophthalma* has soredia contained in soralia. Apothecia were not seen in Nebraska specimens. Rare on bark. This report of *C. chrysophthalma* constitutes a new state record for this species. Brodo et al. (2001) describe *C. chrysophthalma* as having a "southern boreal forest" distribution, but it has not been recorded from Nebraska in any published primary literature.

Niobrara: 282

Caloplaca decipiens (Arnold) Blomb. & Forss.

This species has a light orange thallus that radiates in lobes to form a placoid margin, almost appearing foliose. Soredia are granular, diffuse across thallus, and more concentrated in the center. Rare on rock. This species has been recorded from South Dakota (Wetmore 1968), Colorado, Montana, Nebraska (Wetmore & Kärnefelt 1998).

Wildcat Hills: 459

Caloplaca flavorubescens (Hudson) J.R. Laundon

Caloplaca flavorubescens has a pale yellow thallus with many apothecia that have a light orange disk and margins the same color as the thallus. No soredia are present. Found frequently on juniper, oak, ash and birch bark.

Niobrara: 168, 201, 279, 307, 321, 333, 337 Pine Ridge: 404

Caloplaca flavovirescens (Wulfen) Dalle Torre & Sarnth.

This species has a pale, areolate thallus with numerous apothecia that have a dark orange to red disk, and margins slightly lighter in color than the rest of the thallus. No soredia are present. Rare on rock.

Niobrara: 234, 263

Caloplaca holocarpa (Hoffm. *ex* Ach.) M. Wade

There is no visible thallus to *C. holocarpa*, only scattered apothecia that have a deep orange disk and lighter colored margins. Found occasionally on rock and cottonwood bark.

Pine Ridge: 13389 Wildcat Hills: 457 McKelvie: 360

Caloplaca microphyllina (Tuck.) Hasse

Caloplaca microphyllina has a deep orange thallus with granular soredia scattered throughout, very diffuse. Apothecia present, both disk and margin deep orange. Found frequently on wood and pine bark.

Niobrara: 194, 231, 246, 302 Wildcat Hills: 446, 13444

Caloplaca subsoluta (Nyl. *ex* Wedd.) Zahlbr.

This species has no visible thallus, consisting only of scattered apothecia that have a deep orange disk and margins the same color as the thallus. Found frequently on rock. This report of *C. subsoluta* constitutes a new state record. Earlier reports of this species in North America may be found under *C. irrubescens* (Arnold) Zahlbr.

Niobrara: 217 Pine Ridge: 390, 436, 437, 13368, 13389

Wildcat Hills: 456, 460

Caloplaca trachyphylla (Tuck.) Zahlbr.

The deep orange thallus of *C. trachyphylla* radiates in lobes to form a placoid margin and almost appears foliose. No soredia are present. Apothecial disk and margin are both deep orange and occur more frequently towards the center. Found rarely on rock. *Caloplaca trachyphylla* has been reported from Nebraska previously (Egan et al. 1995; Wetmore & Kärnefelt 1998).

Wildcat Hills: 13447, 13449

Candelaria concolor (Dickson) Stein

This foliose species has a bright yellow upper cortex with granular soredia. Soredia are mostly marginal on thallus lobes, although they can become laminal in older sections. Apothecia are rare. Thallus lobes are very small, narrow. Found on pine, juniper, oak, paper birch and ash bark. *Candelaria concolor* is common in Nebraska and has been reported from the Black Hills (Wetmore 1968).

Chemistry: upper cortex K-, C-

Niobrara: 196, 205, 232, 274, 310, 13251, Pine Ridge: 423 McKelvie: 358

Bessey: 504

Candelariella

This crustose genus has a yellow upper cortex. Species collected in Nebraska vary in presence/absence of apothecia and thalli.

1. Thallus composed of soredia-like granules, apothecia rare.....*Candelariella xanthostigma*
1. Thallus absent, dispersed apothecia present.....*Candelariella aurella*

Candelariella aurella (Hoffm.) Zahlbr.

There is no obvious thallus to *C. aurella*, only scattered yellow apothecia containing eight spores per ascus. Morphologically, it is similar to *C. vitellinula* (Nyl.) H. Olivier, which has 16-32 spores per ascus. Found frequently on rock and pine bark. Wetmore (1968) reports this species from neighboring states (South Dakota and Wyoming), and although Brodo et al. (2001) indicate on a distribution map that this species occurs in Nebraska, there have been no reports of this species from Nebraska within the published primary literature. Therefore, this report is considered a new state record for *C. aurella*.

Pine Ridge: 385, 393, 443, 531, 545, 566, 13330, 13367

Candelariella xanthostigma (Ach.) Lettau

This species has a thallus composed of yellow soredia-like granules and no apothecia. Found rarely on oak bark. This species is also a new record for Nebraska, although it is known from South Dakota, Wyoming and Arizona (Wetmore 1968).

Niobrara: 197 Wildcat Hills: 475

Canomaculina conferenda (Hale) Elix

Canomaculina conferenda is a broad-lobed foliose species with a grayish upper cortex that has marginal granular soredia and marginal cilia. The lower cortex is brown throughout with abundant rhizines that extend to the lobe margins and are easily seen from upturned lobe edges. No apothecia were seen on Nebraska specimens. Rare on pine bark. This is the first report of the genus and species in Nebraska, and represents a significant range extension from its previously known western limit in the Ozarks (Harris & Ladd 2001).

Chemistry: upper cortex K+ yellow, C- ; medulla K-, C-, KC+ red

atranorin and norlobaridone

Bessey: 13487

Cladonia

Cladonia is a genus characterized by fruticose, gray-green lichens that grow erect from substrate with podetia that arise from basal squamules (primary thallus). Thin-layer chromatography is often needed to distinguish between morphologically similar species. Dr. Richard Harris assisted in the identification of these specimens.

1. Podetia with well-formed cups.....2
1. Podetia without well-formed cups.....6

2. Podetia tall (5-10 mm), with narrow flaring cups and farinose soredia.....*Cladonia fimbriata*
2. Podetia shorter (4-6 mm), with wider, goblet-shaped cups.....3

3. Very base of podetia corticate, upper part ecorticate, covered in granular soredia; fumarprotocetraric acid only.....*Cladonia chlorophaea*
3. Podetia more corticate, covered in areoles.....4

4. Primary thallus of thick, radiating lobes, closely appressed; fumarprotocetraric acid only.....*Cladonia pocillum*
4. Primary thallus not as above.....5

5. Atranorin and fumarprotocetraric acid present, podetia with some squamules.....*Cladonia humilis*
5. Fumarprotocetraric acid only, podetia without squamules .....*Cladonia pyxidata*

6. Podetia terminating in large brown apothecia.....*Cladonia cariosa*
6. Apothecia absent.....7

7. Thallus UV+, squamatic acid present.....*Cladonia cenotea*
7. Thallus UV-.....8

8. Podetia 10-15 mm tall.....9
8. Podetia <10 mm tall.....10

9. Squamules on lower part of podetia, mostly corticate, homosekikaic acid only.....*Cladonia rei*
9. No squamules on podetia, large ecorticate areas, fumarprotocetraric acid only.....*Cladonia coniocraea*

10. Homosekikaic acid present, podetia mostly 5 mm or shorter, pycnidia brown if present.....*Cladonia ramulosa*
10. Barbatic acid present, podetia mostly over 5 mm, pycnidia red if present.....*Cladonia macilenta* var. *bacillaris*

Cladonia cariosa (Ach.) Sprengel

Podetia are mostly corticate, covered in squamules, branched, and terminating in brown apothecia. Primary squamules are large and ascending so that white undersides are clearly visible. Found occasionally on soil.

Chemistry: atranorin

Niobrara: 215 Pine Ridge: 375, 444, 13357

Cladonia cenotea (Ach.) Schaerer

This species has podetia that do not end in well-formed cups and branch once or twice. The podetia are mostly corticate, although some ecorticate areas occur and are covered in farinose soredia. Squamules occur on the lower half of many podetia. Primary squamules are small, not closely appressed. Rare on rotten wood. This report of *C. cenotea* is a new record for the state.

Chemistry: squamatic acid (UV+)

Pine Ridge: 370

Cladonia chlorophaea (Flörke *ex* Sommerf.) Sprengel

Cladonia chlorophaea has short podetia (4-6 mm) that end in well-formed, goblet-shaped cups. The podetia are mostly corticate, although with occasional ecorticate areas, and are covered in granular soredia. Primary squamules are large, well-developed, and somewhat ascending. Common on soil, rotten wood, pine and juniper bark.

Chemistry: fumarprotocetraric acid

Niobrara: 183, 188, 190, 198, 210, 265, 287, 314

Pine Ridge: 371, 553, 582, 13334 Wildcat Hills: 463, 13464

McKelvie: 351a Bessey: 514, 520

Cladonia coniocraea (Flörke) Sprengel

Podetia of this species do not end in cups, are unbranched, covered with farinose soredia, and have occasional ecorticate areas. Primary squamules are small, not closely appressed. Found occasionally on soil.

Chemistry: fumarprotocetraric acid

Pine Ridge: 441 Wildcat Hills: 13470

Cladonia fimbriata (L.) Fr.

This species has tall (5-10+ mm) podetia that end in narrow, flaring cups that are not deeply goblet-shaped as in *C. chlorophaea.* Podetia have ecorticate areas covered in farinose soredia. Primary squamules are large, lying flat to substrate. Common on soil, rotten wood and pine bark. *Cladonia fimbriata* has been previously reported in Nebraska and from Colorado, Wyoming and South Dakota (Brodo et al. 2001).

Chemistry: fumarprotocetraric acid

Niobrara: 298a Pine Ridge: 406, 434, 440, 564, 13373, 13370

Wildcat Hills: 473 McKelvie: 351 Bessey: 13486

Cladonia humilis (With.) J. R. Laundon

The podetia of this species are short (4-6 mm) and end in well-formed, goblet-shaped cups similar to *C. chlorophaea* and *C. pyxidata.* Podetia have some ecorticated areas and are covered in areoles. Primary squamules are small, lying flat to substrate. Rare on soil.

Chemistry: atranorin and fumarprotocetraric acid

Niobrara: 300a Pine Ridge: 13384

Cladonia macilenta var. ***bacillaris*** (Genth) Schaerer

Podetia are tall (5-10 mm), do not end in cups, are unbranched and covered in farinose soredia with large ecorticate areas. Primary squamules are smaller, often covered in soredia. *Cladonia macilenta* var. *bacillaris* is the only member of the Section Cocciferae reported in this study, and accordingly some specimens have red pycnidia, although no apothecia were seen on Nebraska specimens. Found frequently on soil, rotten wood and pine bark. This species has been recorded from Iowa, Missouri and Nebraska (Brodo et al. 2001).

Chemistry: barbatic acid

Niobrara: 269, 325 Pine Ridge: 372, 583 McKelvie: 352, 352a

Bessey: 511, 518

Cladonia pocillum (Ach.) Grognot

This species has shorter (4-6 mm) podetia that end in well-formed, goblet-shaped cups. Podetia are largely corticate and covered in areoles. Primary thallus is made of thick, radiating lobes that are closely appressed and form rosettes. Rare on soil. Brodo et al. (2001) show *C. pocillum* as occurring in South Dakota, Wyoming, Colorado, and Nebraska.

Chemistry: fumarprotocetraric acid

Pine Ridge: 13384a

Cladonia pyxidata (L.) Hoffm.

Podetia in this species are short (4-6 mm) and end in well-formed, goblet-shaped cups. Podetia are mostly corticate with areoles on the podetia and the inside of the cups. Primary squamules are large, somewhat ascending. Common on soil and pine bark.

Chemistry: fumarprotocetraric acid

Niobrara: 188a, 191, 218, 225, 298, 304, 326, 13254

Pine Ridge: 371a, 543, 553a, 13434 Wildcat Hills: 13451

Cladonia ramulosa (With.) J.R. Laundon

In Nebraska, this species has very short (mostly under 5 mm) podetia that do not end in well-formed cups. Podetia have granular soredia, some ecorticate areas and squamules which are close to the base. Primary squamules are small and can be sorediate. Rare on soil and pine bark. Brodo et al. (2001) refer to *C. ramulosa* as a widespread temperate species, but this is the first record for Nebraska.

Chemistry: homosekikaic acid

Pine Ridge: 554 Bessey: 505

Cladonia rei Schaerer

Cladonia rei has tall (10-15 mm) podetia that do not end in well-formed cups. The podetia are mostly unbranched, although they can branch once or twice. The podetia also have ecorticate areas covered in farinose soredia and occasional squamules towards the base of the podetia. Primary squamules are small and can become sorediate. Common on soil and rotten wood.

Chemistry: homosekikaic acid

Niobrara: 184, 199, 199a, 219, 315 Wildcat Hills: 472

Bessey: 511a, 514a, 515

Cyphelium notarisii (Tul.) Blomb. & Forss.

This crustose species has a bright yellow thallus that can disappear between apothecia when not well-developed. Apothecia are mazaedial with spores loose in a black mass within a thalloid exciple. Spores are submuriform measuring 13.8–20.0 μm in length and 10.0-17.5 μm in width. Common on wood and pine bark. This species was first designated as a subspecies of *C. tigillare* (Ach.) Ach. (Weber 1967), but has since been raised to the species level because *C. tigillare* has 1-spetate spores.. Earlier reports of *C. tigillare* in Nebraska may refer to *C. notarisii*. Although it has

been found in South Dakota (Wetmore 1968), this is the first report of *C. notarisii* in the state.

Niobrara: 250, 270, 301, 319 Pine Ridge: 13341, 13365

McKelvie: 342, +362, 13270 Bessey: 486

Diploschistes

1. Thallus pruinose, whitish-gray, on rock.....*Diploschistes scruposus*
1. Thallus not pruinose, grayish-green, on moss, soil or other lichens.....*Diploschistes muscorum*

Diploschistes muscorum (Scop.) R. Sant.

The grayish-green, areolate thallus of *D. muscorum* is epruinose, and has apothecia embedded in the thallus. Spores are muriform, 4/ascus, and measure 21.0-26.5 µm in length and 9.5-12.0 µm in width. Frequent on soil, mosses or other lichens. *Diploschistes muscorum* has been collected in Missouri (Ladd et al. 1994), and although Brodo et al. (2001) indicate this species as occuring in Nebraska on a distribution map, there have been no reports of this species from Nebraska within the published primary literature. Therefore, this report is considered a new state record for this species.

Chemistry: upper cortex K+ yellow, C- ; medulla K-, C+ red

Niobrara: 216 Pine Ridge: 576, 576a, 13353, 13396

Wildcat Hills: 471, 13476a

Diploschistes scruposus (Schreber) Norman

This crustose species has a whitish-gray, pruinose, areolate thallus. Apothecia are deeply embedded, so the disk may resemble the ostiole of a perithecium. Spores are muriform, 4-8/ascus. Rare on rock.

Chemistry: upper cortex K-, C- ; medulla K-, C+ red

Niobrara: 238

Diplotomma venustum (Körber) Körber

Lecideine apothecia are common on this crustose species with a white, somewhat pruinose thallus. Apothecial disks and exciple are black, lightly pruinose in some specimens. Spores are brown, 4-celled, with transverse septa and measure 14.5-20.0 μm in length and 5.5-9.0 μm in width. Frequent on rock. Although Nordin (1999) reports this species as widespread with a western tendency, this is the first report of this species for Nebraska. Dr. Anders Nordin assisted in the identification of these specimens.

Chemistry: upper cortex K-, C- ; medulla K-, C-

Niobrara: 224, 267 Pine Ridge: 540, 541, 546, 13337

Evernia mesomorpha Nyl.

This fruticose species has a yellowish-green thallus that is pendant and flattened in cross-section. Large ecorticate areas may occur. The thallus is sorediate with granular soredia that begin as soralia, but quickly become diffuse across thallus surface. Found occasionally on pine bark.

Chemistry: outer cortex K-, C- ; medulla K-, C-

Pine Ridge: 422 McKelvie: 343, 13268 Bessey: 510, 13477

Flavoparmelia caperata (L.) Hale

The yellow-green upper cortex on this foliose species has granular soredia that are mostly laminal but become marginal in older sections. Pseudocyphellae are absent. The underside is black towards the center, becoming lighter brown at lobe tips. No apothecia were seen in Nebraska specimens. Rare on pine bark.

Chemistry: upper cortex K-, C- ; medulla K-, C- ; fatty acids present

Bessey: 13489

Flavopunctelia

This genus consists of foliose lichens that have a yellowish-green upper cortex with pseudocyphellae and broad rounded lobes. The lower cortex is dark at the center

becoming tan towards the lobe tips. Rhizines are common except for a naked zone at the lobe tips.

1. Soredia mostly marginal, pseudocyphellae inconspicuous.....*Flavopunctelia soredica*
1. Soredia mostly laminal, pseudocyphellae abundant.....*Flavopunctelia flaventior*

Flavopunctelia flaventior (Stirton) Hale

Flavopunctelia flaventior has a somewhat wrinkled thallus with both laminal and marginal soredia. Occasional on pine bark.

Pine Ridge: 418a, 419, 558 McKelvie: 13275

Flavopunctelia soredica (Nyl.) Hale

A close relative of *F. flaventior*, *F. soredica* also has a somewhat wrinkled thallus, but displays strongly marginal soredia which often appear in a crescent shape. Soredia may become laminal only in older sections of the thallus. Very common on mountain mahogany, pine and juniper bark.

Niobrara: 192, 248, 252, 291, 309

Pine Ridge: 418, 426, 525, 558a, 13327, 13338, 13348, 13379, 13424

Wildcat Hills: 445, 464, 481, 13438, 13454, 13459

McKelvie: 339, 364, 13265, 13276, 13278 Bessey: 487, 13479

Heppia lutosa (Ach.) Nyl.

This squamulose species has a brown upper cortex that is lightly to heavily pruinose. The lecanorine apothecia have reddish disks and are immersed in the thallus. Squamules are appressed to the substrate, not ascending. Spores are hyaline, simple and 8/ascus. Rare on soil.

Chemistry: upper cortex K-, C- ; medulla K-, C-

Niobrara: 241

Hyperphyscia

This foliose genus has a gray-brown, K- upper cortex with very small, narrow thallus lobes. The lower cortex is white, closely attached to the substrate and lacks rhizines. Dr. Theodore Esslinger assisted in the identification of these specimens.

1. Soredia present, apothecia rare.....*Hyperphyscia adglutinata*
1. Soredia absent, apothecia common.....*Hyperphyscia syncolla*

Hyperphyscia adglutinata (Flörke) H. Mayrh. & Poelt

The gray-brown upper cortex on H. *adglutinata* has greenish, granular soredia contained in soralia that are marginal but can become laminal. Apothecia were not seen in Nebraska specimens. Found frequently on pine, juniper and oak bark.

Chemistry: upper cortex K-, C- ; medulla K-, C-

Niobrara: 167, 176, 236, 255, 313, 320, 13252

Hyperphyscia syncolla (Tuck. *ex* Nyl.) Kalb

Hyperphyscia syncolla has a gray-brown upper cortex which lacks soredia, although apothecia are commonly seen. Thallus lobes are slightly larger than those in *H. adglutinata*. Rare on bark

Chemistry: upper cortex K-, C- ; medulla K-, C-

Niobrara: 176a

Hypogymnia

This foliose lichen has a gray-green upper cortex with a black underside, often turning tan towards the lobe tips. Lobe tips are inflated and hollow. Soredia are present in both Nebraska species.

1. Soredia present in lip-shaped soralia, between cortices of lobe tips.....*Hypogymnia physodes*
1. Soredia not in soralia, on upper cortex of lobe tips.....*Hypogymnia tubulosa*

Hypogymnia physodes (L.) Nyl.

This species has lip-shaped soralia present between the split cortical layers of the inflated lobe tips. Very common on pine bark.

Pine Ridge: 376, 395, 395a, 13343, 13372 Wildcat Hills: 13465

McKelvie: 344, 354, 13273, 13281, 13284 Bessey: 13480

Hypogymnia tubulosa (Schaerer) Hav.

Hypogymnia tubulosa has farinose soredia confined to the upper cortex of the lobe tips. The lobe tips are ascending. Rare on pine bark. This is a new state record for this species, although it is reported from the Black Hills (Wetmore 1968) and is indicated on a distribution map as occuring in Colorado (Brodo et al. 2001).

Pine Ridge: 369, 432

Hypotrachyna laevigata (Sm.) Hale

This foliose species has a blue-gray upper cortex with laminal granular soredia. The underside is black and can become lighter brown at the lobe edges. The thallus is wrinkled towards the center, smoother at the lobe tips. Thallus lobes are ≥4 mm in width. Rhizines branch dichotomously. No apothecia were seen in Nebraska specimens. Rare on pine bark. This record of *H. laevigata* is not only the first report of this species from Nebraska, but also for the genus *Hypotrachyna*. Wetmore (1968) reported *H. laevigata* from South Dakota as *Parmelia laevigata*.

Chemistry: upper cortex K+ yellow, C- ; medulla K-, C-

atranorin and barbatic acid complex

McKelvie: 356

Lecania

This crustose genus has lecanorine apothecia with hyaline, 2-celled spores, although occasionally simple spores are mixed with the septate ones. The thallus is generally not well developed.

1. Thallus granular to sorediate, pale, grayish.....*Lecania erysibe*
1. Thallus not at all sorediate, darker, greenish-brown.....*Lecania perproxima*

Lecania erysibe (Ach.) Mudd

This species has a pale, granular thallus that can become sorediate. Lecanorine apothecia have a dark brown-black disk and lighter margin. Apothecial sections show a brown epithecium, clear hypothecium, and 8 spores/ascus. Spores are hyaline and 2-celled with transverse septa. Found on rock. *Lecania erysibe* has been recorded from Colorado, Iowa and South Dakota (Wetmore 1968), but this is the first report from Nebraska.

Wildcat Hills: 13441

Lecania perproxima (Nyl.) Zahlbr.

The dark, greenish-brown thallus of *L. perproxima* is not sorediate and at times is barely visible. Lecanorine apothecia have a dark brown disk and a lighter margin. Spores are mostly 2-celled, 8/ascus and measure 10.0-13.5 µm in length and

4.5-5.5 µm in width. Rare on rock. This record of *L. perproxima* is the first for the state. It is more common in the eastern part of the country on calcareous rock (Brodo et al. 2001). Doug Ladd assisted in the identification of this species.

Niobrara: 249

Lecanora

This large crustose genus produces hyaline, simple spores in lecanorine apothecia. The thalli of species collected in Nebraska are varied in color, abundance, and development. Additional *Lecanora* specimens have been sent to Dr. Irwin Brodo for verification.

1. Thallus present.....*Lecanora saligna*
1. Thallus absent.....2

2. On rock, apothecia large, conspicuous.....*Lecanora polytropa*
2. On bark or wood, apothecia very small.....*Lecanora minutella*

Lecanora minutella Nyl.

This species consists of scattered apothecia with a light tan, yellowish disk and white margins with no visible thallus. Spores measure 6.5-11.5 µm in length and 3.0-4.5 µm in width. Rare on pine bark. This report is the first of this species for Nebraska, and represents a significant westward range extension from that reported in

LaGreca & Lumbsch (2001). Dr. Scott LaGreca assisted in the identification of this species.

McKelvie: 355 Bessey: 491

Lecanora polytropa (Hoffm.) Rabenh.

Lecanora polytropa specimens consist of scattered apothecia with a light tan, yellowish disk and white margins. The thallus is lacking. Spores measure 10.0-13.75 µm in length and 5.0-7.5 µm in width. Rare on rock. Although this species has been reported from South Dakota, Wyoming (Brodo et al. 2001;Wetmore 1968), and Arizona (Printzen 2001), this report is the first for Nebraska.

Pine Ridge: 442, 443

Lecanora saligna (Schrader) Zahlbr.

This species has a well-developed, greenish-gray, granular thallus. Apothecia have a dark red to brownish disk with margins that match the thallus. Spores measure 8.75-11.25 µm in length and 3.75-6.25 µm in width. Rare on bark. *Lecanora saligna* has been reported from Colorado (Printzen 2001), South Dakota, Wyoming (Wetmore 1968), and Nebraska (Egan et al. 1995).

Wildcat Hills: 461

Lecidella

This crustose genus has hyaline, simple spores in lecideine apothecia. The thalli of species collected from Nebraska varied in color and degree of development. Since additional *Lecidella* specimens await further analysis, this is a preliminary treatment.

1. Thallus white, well-developed, thick and somewhat areolate.....*Lecidella patavina*
1. Thallus darker, not as well-developed.....2

2. On rock, thallus brownish.....*Lecidella stigmatea*
2. On bark, thallus white to gray-green.....*Lecidella euphorea*

Lecidella euphorea (Flörke) Hertel

This species has a pale to light gray-green thallus, not white, with eight spores per ascus and a yellow-brown hypothecium. Spores measured 11.0-13.0 μm in length and 6.5-7.5 μm in width. Common on pine, juniper, sumac, mountain mahogany and ash bark.

Niobrara: 166, 208, 254, 280, 318

Pine Ridge: 560, 578, 13422 Wildcat Hills: 451, 464, 13443, 13458

Lecidella patavina (A. Massal.) Knoph & Leuckert

Lecidella patavina produces a well-developed white thallus that is thick and somewhat areolate. The apothecium has a colorless to yellowish hypothecium with eight spores per ascus measuring 12.5-17.5 μm in length and 6.25-10.0 μm in width. Common on rock. Knoph & Leuckert (1994) reported this species from neighboring states (Colorado, South Dakota and Wyoming), but this is the first record of *L. patavina* for Nebraska. Some specimens previously identified as *L. stigmatea* from Nebraska may actually be *L. patavina* and can be separated on the basis of a thicker thallus and presence of oil drops in the hymenial layer (Brodo et al. 2001).

Chemistry: atranorin

Niobrara: 223, 237 Pine Ridge: 381, 439, 567, 568, 13331, 13335

Wildcat Hills: 452, 455, 13439

Lecidella stigmatea (Ach.) Hertel & Leuckert

The brownish thallus of *L. stigmatea* is not well-developed and has a colorless to yellowish hypothecium with eight spores per ascus. Spores measure 11.5-14.0 μm in length and 7.0-9.0 μm in width. Rare on rock. As with *L. patavina*, this species was reported from nearby states (Knoph & Leuckert 1994), and although Brodo et al. (2001) indicate on a distribution map that this species is found in Nebraska, there

have been no reports of this species from Nebraska within the published primary literature. Therefore, this report is considered a new state record for *L. stigmatea.*

Pine Ridge: 438

Lepraria and ***Leproloma***

These lichens are characterized by sterile, leprose, granular, greenish-gray thalli. Three different species were collected in Nebraska, all of which are morphologically similar and require thin-layer chromatography (TLC) to separate. Dr. Jack Elix assisted with the chemical determinations for these genera.

1. Thallus UV+ pale gold.....*Lepraria frigida*
1. Thallus UV-.....2

2. Atranorin and stictic acid present.....*Lepraria lobificans*
2. Pannaric acid 6-methyl ester and fumarprotocetraric acid present.....*Leproloma vouauxii*

Lepraria frigida J.R. Laundon

The thallus of *Lepraria frigida* is leprose, granular, greenish, and easily distinguished by its UV+ chemistry. This report of *L. frigida* is the first record of this species in Nebraska. Rare on soil.

Chemistry: alectorialic, barbatolic, and hypoalectorialic

Pine Ridge: 13376, 13395

Lepraria lobificans Nyl.

This species has a leprose, granular, greenish thallus that is UV-. *Lepraria lobificans* is very similar to *Leproloma vouauxii* morphologically and must be separated on the basis of secondary chemical characteristics. Occasional on bark and mosses over soil.

Chemistry: atranorin, zeorin, stictic, constictic, and cryptostictic acids

Niobrara: 170a, 328, 13256

Leproloma vouauxii (Hue) J. R. Laundon

Leproloma vouauxii has a leprose, granular, greenish thallus that is UV-. This species is morphologically similar to *Lepraria lobificans* and requires a knowledge of secondary chemical characteristics to separate. Frequent on soil and mosses over soil. This report of *L. vouauxii* is the first record of this genus and species from Nebraska.

Chemistry: pannaric acid 6-methyl ester, fumarprotocetraric acid,

4-oxypannaric acid 6-methyl ester

Pine Ridge: 383, 392 Wildcat Hills: 477, 551, 13473

Megaspora verrucosa (Ach.) Hafellner & V. Wirth

This crustose species has an areolate, grayish upper cortex which lacks pruinosity. Apothecia are deeply embedded within the thallus. Spores are simple,

hyaline and measure 25.0-37.5 µm in length and 18.75-25.0 µm in width. Rare on bark. Although *M. verrucosa* has been mapped from Colorado, Wyoming, South Dakota and Nebraska (Brodo et al. 2001), there have been no reports of this species from Nebraska within the published primary literature. Therefore, this report is considered a new state record for not only this species, but the genus *Megaspora* as well. Doug Ladd assisted in the identification of this taxon.

Chemistry: upper cortex K-, C+ yellow ; medulla K-, C-

Niobrara: 284 Wildcat Hills: 480b

Melanelia

This genus contains brown foliose parmeloid lichens with a tan to dark underside and lobes ≥3-4 mm wide.

1. Soredia or isidia absent.....*Melanelia subolivacea*
1. Soredia or isidia present.....2

2. Distinct soredia present, isidia absent.....*Melanelia subargentifera*
2. Soredia absent, isidia present though sometimes eroding away.....3

3. Isidia easily eroding, resulting in yellowish-green patches on thallus surface, medulla C+ red.....*Melanelia subaurifera*
3. No breakdown of cortex, isidia persistent, medulla C-.....4

4. Isidia thick, squat, almost lobulate.....*Melanelia exasperatula*
4. Isidia narrow, thin, thallus becoming pruinose.....*Melanelia elegantula*

Melanelia elegantula (Zahlbr.) Essl.

This species is often pruinose towards lobe margins with thin, narrow isidia that become numerous in older sections of thallus. Frequent on wood, plus juniper, pine and ash bark.

Pine Ridge: 401, 13398, 13423 Wildcat Hills: 476, 479 McKelvie: 13277

Melanelia exasperatula (Nyl.) Essl.

The thallus of *M. exasperatula* is shiny with thick, almost lobulate isidia. Rare on pine bark.

McKelvie: 346a

Melanelia subargentifera (Nyl.) Essl.

Melanelia subargentifera has numerous white patches where the upper cortex has broken down exposing the medulla. Soredia are located around these patches. Rare on ash bark.

Pine Ridge: 399, 411

Melanelia subaurifera (Nyl.) Essl.

This species shows yellowish green areas where the isidia break off and leave exposed patches. These patches are more central, leaving a bare cortical zone at the lobe tips and margins. Rare on pine bark. *Melanelia subaurifera* generally has a

more eastern distribution within North America, although Brodo et al. (2001) indicate a population in Colorado on a distribution map. This report constitutes a new record for Nebraska.

McKelvie: 346

Melanelia subolivacea (Nyl.) Essl.

This species has a shiny thallus with no soredia or isidia. Common on mountain mahogany and pine bark.

Pine Ridge: 366, 428, 521, 527, 530, 561, 13329, 13347, 13351, 13380, 13423a, 13429, Wildcat Hills: 450, 13474 McKelvie: 341

Parmelia sulcata Taylor

Parmelia sulcata is a foliose lichen with a blue-gray upper cortex with farinose soredia that begin marginally and on raised ridges but become laminal in older sections. The thallus may become reticulately cracked, exposing the white medulla on the lobe surface. The underside is black with many conspicuous squarrose rhizines that extend to lobe edges. Very common on pine and paper birch bark. *Paremelia sulcata* has been reported throughout the midwest particularly in Missouri (Ladd et al. 1994) and Nebraska (Egan et al. 1995).

Chemistry: upper cortex K+ yellow, C- ; medulla K+ yellow to red, C-

atranorin and salazinic acid

Niobrara: 179, 193, 272, 286, 308, 329, 332

Pine Ridge: 368, 421, 433, 524, 563, 13342, 13349, 13355, 13371, 13399

13430 Wildcat Hills: 474, 11379, 13466 McKelvie: 340, 13274, 13285

Bessey: 507, 509, 13478

Parmeliopsis ambigua (Wulfen) Nyl.

This foliose species has a yellow-green upper cortex with granular soredia that begin as laminal soralia but quickly become diffuse over the thallus. The underside is dark, lighter brown at lobe edges. Lobes are narrow (1-3 mm), and apothecia were not seen in Nebraska specimens. Rare on pine bark.

Chemistry: upper cortex K-, C- ; medulla K-, C-

Pine Ridge: 374, 13340

Peltigera

This foliose genus occurs commonly on soil. The thalli of species collected in Nebraska are generally blue-gray to brown and have large lobes (>4mm). The underside is pale with characteristic raised veins that are often darkened. All photobionts for Nebraska species are cyanobacteria.

1. Soredia present.....*Peltigera didactyla*
1. Soredia absent.....2

2. Isidia present.....*Peltigera evansiana*
2. Isidia absent, though lobules may be present.....3

3. Peltate lobules present.....*Peltigera lepidophora*
3. No lobules present.....4

4. Upper cortex shiny, lacking tomentum.....*Peltigera polydactylon*
4. Upper cortex dull, tomentum present.....5

5. Lobe margins mostly flat, appressed to soil, rounded and broad.....*Peltigera canina*
5. Lobe margins crisped, curled upward, narrow.....*Peltigera rufescens*

Peltigera canina (L.) Willd.

This species has a blue-gray thallus cortex that is dull-looking due to the presence of tomentum. Apothecia (if present) are on lobe tips, slightly ascending. Lobe margins undulate, are somewhat appressed to soil, and do not curl or crisp upwards. It is very similar to *P. rufescens*. Rare on soil.

Pine Ridge: 425

Peltigera didactyla (With.) J.R. Laundon

The blue-gray to brownish thallus of *P. didactyla* is somewhat shiny and not pruinose. Apothecia are rare, and soredia are common in laminal soralia. Found occasionally on soil.

Niobrara: 226, 324, 330 Pine Ridge: 556, 575

Peltigera evansiana Gyelnik

This species has a brownish thallus that is heavily pruinose and tomentose, appearing gray. Isidia are present near lobe tips, clustering towards the edges. Frequently found on soil.

Niobrara: 289, 290, 292, 295, 297, 11016

Peltigera lepidophora (Vainio) Bitter

Peltigera lepidophora has a brown thallus that appears gray where heavily pruinose and tomentose. Squamules or peltate lobules (sometimes called isidia) are very abundant laminally on the thallus. Soredia are absent. Occasional on soil. Wetmore (1968) reported this species in South Dakota and Colorado, but this is the first record for Nebraska.

Niobrara: 220, 323 Pine Ridge: 373, 565 Bessey: 517

Peltigera polydactylon (Necker) Hoffm.

The blue-gray thallus *P. polydactylon* is slightly pruinose towards the lobe tips, but remains shiny due to absence of tomentum. There are no isidia, soredia, squamules or lobules present. Apothecia are common on ascending lobe edges. This

species is similar to *P. horizontalis* (Hudson) Baumg., which has non-ascending lobes with apothecia. Occasional on soil.

Niobrara: 294, 296 Pine Ridge: 424

Peltigera rufescens (Weiss) Humb.

This species has a brown thallus that appears gray where tomentum is abundant. There are no isidia, soredia, squamules or lobules present. Apothecia (if present) are on lobe edges, somewhat ascending. Lobe margins are sharply undulate, curly and "crisping" upwards. This species is very similar to *P. canina*, and intermediate forms are sometimes found. Very common on soil in open areas.

Niobrara: 211, 221

Pine Ridge: 377, 405, 431, 572, 574, 13377, 13378, 13383, 13435

Wildcat Hills: 469, 13467, 13461

Phaeophyscia

This foliose genus is characterized by a brownish, K- upper cortex and very narrow thallus lobes. The lower cortex is brown to black, although it can occasionally be pale. Specimens collected in Nebraska vary in the production of soredia and apothecia, as well as in presence/absence of cortical hairs. This genus is separated

from *Physciella* chiefly by its paraplectenchymatous lower cortex (Esslinger 1986).

Dr. Theodore Esslinger assisted in the identification of these specimens.

1. Soredia present.....2
1. Soredia absent.....7

2. Cortical hairs present.....3
2. Cortical hairs absent.....4

3. Soredia marginal..... *Phaeophyscia cernohorskyi*
3. Soredia terminal on lobe tips..... *Phaeophyscia hirsuta*

4. Underside pale.....*Phaeophyscia insignis*
4. Underside mostly black, sometimes pale at lobe edges.....5

5. Thallus lobes ascending.....*Phaeophyscia pusilloides*
5. Thallus lobes appressed.....6

6. Soredia marginal, isidioid.....*Phaeophyscia adiastola*
6. Soredia laminal, granular.....*Phaeophyscia orbicularis*

7. Underside white, isidia present.....*Phaeophyscia nigricans*
7. Underside black, isidia absent.....*Phaeophyscia ciliata*

Phaeophyscia adiastola (Essl.) Essl.

This species has a blue-gray upper cortex with strongly marginal, coarse, granular soredia that occur near the lobe tips. The underside is black at the center but very pale near the lobe tips. Squarrose rhizines are easily seen from the slightly ascending lobe edges. No apothecia were seen in the Nebraska specimens. Rare on

bark. This report of *P. adiastola* is a new record for Nebraska. This species has a largely eastern distribution (Esslinger 1978), with its known range extending as far west as Kansas, Iowa and Missouri (Brodo et al. 2001).

Chemistry: upper cortex K-, C- ; medulla K-, C-

Niobrara: 283

Phaeophyscia cernohorskyi (Nádv.) Essl.

The thallus of *P. cernohorskyi* has a slightly pruinose pale gray upper cortex. Granular soredia are in marginal soralia which may become laminal. Cortical hairs are visible on the thallus surface particularly at the lobe edges. The underside is black at the center with a narrow white margin at the lobe tips. Rhizines are simple and not easily seen from appressed lobes. Common on rock and oak, juniper and ash bark.

Chemistry: upper cortex K-, C- ; medulla K-, C-

Niobrara: 187, 233, 245, 260, 331 Pine Ridge: 412, 413, 415, 581

Wildcat Hills: 467, 468 Bessey: 493

Phaeophyscia ciliata (Hoffm.) Moberg

Phaeophyscia ciliata is easily distinguished as one of the few *Phaeophyscia* species with no soredia, isidia or cortical hairs. The upper cortex is brownish-gray, and the underside is black throughout. Rare on elm bark.

Chemistry: upper cortex K-, C- ; medulla K-, C-

Niobrara: 164, 277

Phaeophyscia hirsuta (Mereschk.) Essl.

This species has a brownish-gray upper cortex with labriform soralia terminal on lobe tips. Cortical hairs are present on the thallus surface. The underside is black throughout. Occasional on juniper, ash and oak bark.

Chemistry: upper cortex K-, C- ; medulla K-, C-

Niobrara: 285a Pine Ridge: 397 Wildcat Hills: 480a Bessey: 493

Phaeophyscia insignis (Mereschk.) Moberg

The blue-gray upper cortex of *P. insignis* has laminal soralia that are almost as wide as the narrow (< 0.5 mm) lobes. The underside is pale brown throughout. Rare on oak bark.

Chemistry: upper cortex K-, C- ; medulla K-, C-

Niobrara: 180

Phaeophyscia nigricans (Flörke) Moberg

The small thalli, brown cortex, and narrow lobes make *P. nigricans* inconspicuous and easily overlooked in the field. Isidia are present on lobe tips. The underside is pale throughout. Rare on oak bark. While this species has been found in

Colorado (Esslinger 1978), South Dakota, and Wyoming (Wetmore 1968), this report is the first record of *P. nigricans* in Nebraska.

Chemistry: upper cortex K-, C- ; medulla K-, C-

Niobrara: 303

Phaeophyscia orbicularis (Necker) Moberg

This species has a brownish-gray upper cortex with irregular, submarginal to laminal soralia. The underside is black throughout. Rare on ash bark.

Chemistry: upper cortex K-, C- ; medulla K-, C-

Pine Ridge: 402, 403

Phaeophyscia pusilloides (Zahlbr.) Essl.

The lobe tips of *P. pusilloides* are slightly reflexed, appear ascending, and contain marginal soralia. The underside is black at the center with a white zone at the lobe tips. Rare on juniper bark.

Chemistry: upper cortex K-, C- ; medulla K-, C-

Bessey: 494

Physcia

This foliose genus has a gray, K+ yellow upper cortex with narrow-lobes. The lower cortex is usually pale, although it can occasionally become darker. Rhizines are

common (Esslinger 1986). Species collected in Nebraska vary in pruinosity and presence/absence of soredia and apothecia. Dr. Theodore Esslinger assisted in the identification of these specimens.

1. Soredia present.....2
1. Soredia absent.....4

2. Long, conspicuous cilia present.....*Physcia adscendens*
2. Cilia absent.....3

3. On rock, lobes narrow (0.5-1.5 mm), soredia laminal.....*Physcia caesia*
3. On bark, lobes broad (<1.5 mm), soredia marginal.....*Physcia dimidiata*

4. Medulla K+ yellow.....*Physcia aipolia*
4. Medulla K-.....5

5. Thallus heavily pruinose.....*Physcia biziana*
5. Thallus epruinose or only slightly pruinose.....*Physcia stellaris*

Physcia adscendens (Fr.) Olivier

This species is easily recognized by its long, conspicuous cilia along the lobe margins. Soredia are in soralia located in hooded lobe tips. The thallus is slightly pruinose. No apothecia were seen in the Nebraska specimens. Frequently found on pine, juniper and ash bark. *Physcia ascendens* has been recorded from Missouri (Ladd et al. 1994), South Dakota, Wyoming (Wetmore 1968), and Nebraska (Egan et al. 1995).

Chemistry: upper cortex K+ yellow ; medulla K-

Pine Ridge: 387, 579, 13393, 13426 Wildcat Hills: 466 Bessey: 496

Physcia aipolia (Ehrh.) Hampe

Physcia aipolia produces many apothecia whose black disks are often covered with white pruina. The upper cortex may also be pruinose. White maculae on the upper cortex are common. Occasional on juniper, ash and oak bark.

Chemistry: upper cortex and medulla K+ yellow

Niobrara: 173, 206, 276 Pine Ridge: 394, 414

Physcia biziana (Massal.) Zahlbr.

Nebraska specimens of *P. biziana* have narrow lobes and characteristic pruina. The thallus lobes lack marginal cilia, but sometimes projecting rhizines can be seen. This non-sorediate species is similar to *P. stellaris* but can be distinguished by its heavy pruinosity and slightly longer spores (Brodo et al. 2001). Rare on juniper bark. Brodo et al. (2001) indicate *P. biziana* as occurring in Colorado, South Dakota and Wyoming, but this report is the first record of this species from Nebraska.

Chemistry: upper cortex K+ yellow, medulla K-

Niobrara: 186 Pine Ridge: 13401

Physcia caesia (Hoffm.) Fürnr.

The Nebraska collection lacks apothecia, and has a slightly pruinose upper cortex with some pycnidia. Soredia begin as laminal soralia which become more diffuse. Rare on rock.

Chemistry: upper cortex K+yellow ; medulla K+ yellow

Pine Ridge: 13404

Physcia dimidiata (Arnold) Nyl.

The specimens from Nebraska lack apothecia and have a pruinose upper cortex with conspicuous pycnidia. Granular soredia occur mostly on the lobe margins but may become laminal in older sections of the thallus. Occasional on juniper bark. This lichen has been referred to as a lichen of the "arid western interior" (Brodo et al. 2001); this report is the first record of *P. dimidiata* from Nebraska.

Chemistry: upper cortex K+ yellow

Wildcat Hills: 465, 480, 13455

Physcia stellaris (L.) Nyl.

This species commonly produces apothecia and has a slightly pruinose upper cortex with conspicuous pycnidia. Lobes are ≥1 mm wide. Very common on juniper, pine, mountain mahogany, cottonwood, sumac, ash and elm bark.

Chemistry: upper cortex K+ yellow, medulla K-

Niobrara: 228, 235, 251, 317, 335, 13253

Pine Ridge: 367, 430, 523, 526, 555, 562, 580, 13382, 13428

Wildcat Hills: 447, 484, 13445 McKelvie: 361, 363, 13271

Physciella

This foliose genus has a grayish-brown upper cortex and a pale underside. Lobes are narrow ($\leq$1 mm), and both species found in Nebraska produce soredia but no apothecia. This genus is very similar to *Phaeophyscia*, differing chiefly in cortical structure. *Physciella* has a prosoplectenchymatous lower cortex, while *Phaeophyscia* has a paraplectenchymatous lower cortex (Esslinger 1986). Dr. Theodore Esslinger assisted in the identification of these specimens.

1. Soralia terminal on lobe tips, more or less rounded.....*Physciella chloantha*
1. Soralia laminal, irregular in shape.....*Physciella melanchra*

Physciella chloantha (Ach.) Essl.

This species has soralia which mostly occur towards the lobe tips and are typically rounded in shape. Occasional on juniper and ash bark.

Chemistry: upper cortex K- ; medulla K-

Niobrara: 285 Pine Ridge: 417 Bessey: 489, 495

Physciella melanchra (Hue) Essl.

Physciella melanchra produces laminal soralia that may become elongated, labriform or very irregular in shape. Occasional on mountain mahogany and ash bark.

Chemistry: upper cortex K-

Wildcat Hills: 447a, 449 Bessey: 503

Physconia

This foliose genus has a greenish-brown, K- upper cortex, and a black, rhizinate underside. Specimens collected in Nebraska vary in pruinosity from heavy to light. Nebraska specimens all produced apothecia. Dr. Theodore Esslinger assisted in the identification of these specimens.

1. Isidia present, soredia absent.....*Physconia elegantula*
1. Isidia absent, soredia present.....2

2. Medulla yellow, upper cortex heavily pruinose.....*Physconia enteroxantha*
2. Medulla white, upper cortex lightly pruinose, more so at lobe tips.....3

3. Medulla K+ yellow.....*Physconia kurokawae*
3. Medulla K-.....*Physconia leucoleiptes*

Physconia elegantula Essl.

This species is easily distinguished as the only truly isidiate *Physconia*. The upper cortex is heavily pruinose, so the lichen can look white at first glance. Apothecia were not seen in Nebraska specimens. Found on ash bark. This species was first described by Esslinger (1994) and reported in Colorado, Wyoming and other southwestern states, but this report is the first record of *P. elegantula* in Nebraska.

Chemistry: upper cortex K-

Pine Ridge: 386, 398, 409

Physconia enteroxantha (Nyl.) Poelt

Soredia in *P. enteroxantha* are marginal in labriform soralia that occur between the upper cortex and medullary layers at the lobe margins, and are not superficial on the upper cortex. The medulla is a pale yellow, and the thallus is heavily pruinose causing the lichen to apppear white. Rare on ash bark.

Chemistry: upper cortex K- ; medulla K+ yellow, KC+ yellow-orange

Pine Ridge: 396

Physconia kurokawae Kashiw.

This species a greenish-brown upper cortex but not as heavily pruinose as *P. elegantula* or *P. enteroxantha*, although more pruina occur toward the lobe tips.

Soredia begin as marginal soralia on the upper cortex, but in older sections appear laminal. This species is morphologically similar to *P. leucoleiptes*, differing mainly in the medullary reactions. *Physconia kurokawae* has a C+ reaction, while *P. leucoleiptes* is C-. Found on rock. *Physconia kurokawae* has been reported from Missouri (Ladd et al. 1994) and Nebraska (Egan et al. 1995).

Chemistry: upper cortex K- ; medulla C+ pink

Niobrara: 264

Physconia leucoleiptes (Tuck.) Essl.

The greenish-brown upper cortex of *P. leucoleiptes* is not as heavily pruinose as *P. elegantula* or *P. enteroxantha*, although more pruina occur toward the lobe tips. Soredia begin as marginal soralia that become laminal in older sections. The KC+ yellow-orange reaction of the soredia separates this species from *P. detersa* (Nyl.) Poelt. *Physconia leucoleiptes* is also morphologically similar to *P. kurokawae* but has a C- medullary reaction. Occasional on oak and juniper bark and a rotten log.

Chemistry: upper cortex K- ; medulla C- ; soredia KC+ yellow-orange

Niobrara: 185, 189, 288, 336

Pseudevernia intensa (Nyl.) Hale & Culb.

This foliose species has a gray-brown upper cortex with numerous conspicuous pycnidia. No soredia, isidia, or apothecia were seen on the Nebraska specimen. This species can appear fruticose due to elongated lobes (5-10 mm) that appear round in cross-section due to inrolling of the lobe margins. The underside is pale towards the outer lobes, but becomes quite dark towards center. Rare on pine bark. This species has been reported from Colorado (Brodo et al. 2001; Hale 1955), but this report is the first record of this genus and species from Nebraska.

Chemistry: upper cortex K+ yellow C- ; medulla K-, C+ red

atranorin and lecanoric acid

McKelvie: 13272

Psora

This squamulose genus has a light brown to reddish upper cortex and pale underside. Apothecia are superficial on the surface of the squamules and contain 1-celled, hyaline spores. Squamules are flattened, lifting at the edges and measure 3-4 mm wide (Timdal 1986). Nebraska specimens were all found on rock.

1. Squamules with a definite white margin.....*Psora pseudorussellii*
1. Squamules without a definite white margin.....*Psora globifera*

Psora globifera (Ach.) A. Massal.

This species has an upper cortex that is light brown to tan with white margins, although sometimes the medulla shows through or there is pruinosity. Apothecia arise from the center of the squamule. Rare on rock. Timdal (1986) reports *P. globifera* from neighboring states: Colorado, Montana and North Dakota. Although Brodo et al. (2001) indicate on a distribution map that this species occurs in Nebraska, there have been no reports of *P. globifera* from Nebraska within the published primary literature. Therefore, this report is considered a new state record of this species for Nebraska.

Pine Ridge: 391

Psora pseudorussellii Timdal

Squamules of *P. pseudorussellii* are reddish in color with a definite white margin. Apothecia primarily arise from the center of the squamule, but submarginal apothecia were observed. Occasional on rock. *Psora pseudorussellii* has been reported from Kansas, Iowa (Timdal 1986), and Nebraska (Egan et al. 1995).

Niobrara: 239, 266, 268 Pine Ridge: 387, 571

Punctelia

This foliose genus has a grayish-green thallus with laminal pseudocyphellae on the upper cortex. The lower cortex is pale to a light brown and moderately rhizinate with a naked zone at the lobe margins. Apothecia are lecanorine.

1. Soredia present, medulla C+ red.....2
1. Soredia absent, medulla C-.....*Punctelia bolliana*

2. Thallus reticulately ridged.....*Punctelia perreticulata*
2. Thallus not ridged, wrinkled or not.....*Punctelia subrudecta*

Punctelia bolliana (Müll. Arg.) Krog

Punctelia bolliana commonly has pycnidia and apothecia present but no soredia, isidia, or lobules. Common on pine, juniper, oak, and paper birch bark. *Punctelia semansiana* is a similar species also known from Nebraska, but is distinguished by its C+ red medullary reaction.

Chemistry: cortex K+ yellow, medulla C- ; fatty acids present

Niobrara: 169, 169a, 175, 204, 227, 253, 259, 273, 278, 281, 291a, 311, 327, 334, 13257, 13260, 13261

Punctelia perreticulata (Räsänen) Wilhelm & Ladd

Punctelia perreticulata is characterized and separated from the more widespread *P. subrudecta* by an extremely reticulate, ridged upper cortex. The soralia are laminal or marginal, sometimes located on the ridges. Rare on oak and pine bark. This is the first report from Nebraska for this species, which has been termed a rare "southern interior species" (Brodo et al. 2001).

Chemistry: cortex K+ yellow, medulla C+ red

lecanoric acid

Niobrara: 322 McKelvie: 350

Punctelia subrudecta (Nyl.) Krog

This species has a mostly smooth upper cortex, although older sections can become quite wrinkled. The soredia are laminal and marginal, starting in soralia but becoming more diffuse. Rare on pine bark.

Chemistry: cortex K+ yellow, medulla C+ red

lecanoric acid

Pine Ridge: 435 McKelvie: 348

Rimelia reticulata (Taylor) Hale & Fletcher

Rimelia reticulata is a foliose lichen with a blue-gray upper cortex, short marginal cilia and marginal granular soredia. Thallus lobes are wide (5-10 mm) and quite smooth to cracked, becoming wrinkled only in older sections. The underside is brown to black with numerous rhizines that are easily seen from curling lobe edges. Rare on pine bark.

Chemistry: upper cortex K+ yellow, C- ; medulla K+ yellow to red, C-

atranorin and salazinic acid

Niobrara: 256 Bessey: 13488

Rinodina

This crustose genus produces lecanorine apothecia with brown, 2-celled ascospores. Specimens collected in Nebraska vary in thallus development, but both species have a brown upper cortex.

1. On rock.....*Rinodina bischoffii*
1. On bark.....*Rinodina archaea*

Rinodina archaea (Ach.) Arnold

The granular, brown upper cortex of *R. archaea* is somewhat well-developed with numerous lecanorine apothecia. Spores are brown and 2-celled with angular locules when mature. Rare on wood.

Pine Ridge: 13397

Rinodina bischoffii (Hepp) A. Massal.

Rinodina bischoffii produces a granular, grayish-brown thallus that is not well developed (and may be absent). Lecanorine apothecia are frequent, although the thalloid margin often disappears. Apothecial sections show a hyaline hypothecium, brown epithecium and brown, 2-celled spores occurring 8/ascus. Spores measure 16.5-18.5 µm in length and 9.5-10.5 µm in width. Occasional on rock.

Niobrara: 305 Pine Ridge: 13388 Wildcat Hills: 455a

Sarcogyne regularis Körber

This crustose species has an absent thallus, consisting only of scattered lecideine apothecia. Apothecia are black, but the disk is very pruinose so as to appear a blue-gray color. The disk surface turns reddish when wet. Spores are hyaline, simple and 16-32/ascus. Spores measure 4.0-7.5 µm in length and 2.0-3.75 µm in width. Occasional on rock. While Brodo et al. (2001) indicate *S. regularis* on a

distribution map as occuring in Nebraska (as well as Colorado, South Dakota and Wyoming), there have been no reports of this species from the state within published primary literature. Therefore, this report is considered to be a new record of *S. regularis* for Nebraska.

Niobrara: 200 Pine Ridge: 536, 537, 570

Staurothele elenkinii Oksner

Staurothele elenkinii is a crustose species with a brown granular thallus that is not well-developed and can be absent. Numerous perithecia with hymenial algae occur on the thallus surface. Spores are muriform, 2/ascus, and measure 40.0-56.25 µm in length and 18.75-26.25 µm in width. Rare on rock. This species has been widely reported in the midwest by Thomson (1991), but this report is the first record of *S. elenkinii* from Nebraska.

Wildcat Hills: 453

Teloschistes chrysophthalmus (L.) Th. Fr.

This fruticose species has a yellow-orange thallus that is generally short and shrubby. Nebraska specimens have cilia extending from margins of deep orange apothecia. Occasional on sumac, juniper and chokecherry bark.

Chemistry: upper cortex: K+ purple, C-

Niobrara: 174, 207, 316 Bessey: 499

Toninia

This squamulose genus produces convex, variously colored squamules measuring about 1-2 mm in width. Apothecia are superficial on the surface of the squamules and contain hyaline, 2-celled ascospores (Timdal 1992).

1. Squamules blue-gray, pruinose.....*Toninia sedifolia*
1. Squamules brown, not pruinose.....*Toninia tristis*

Toninia sedifolia (Scop.) Timdal

Toninia sedifolia has blue-gray, pruinose squamules with numerous lecideine apothecia. Spores measured 13.5-17.5 µm in length and 4.0-7.5 µm in width. Rare on soil.

Pine Ridge: 388

Toninia tristis (Th. Fr.) Th. Fr.

This squamulose species has brown squamules without pruina, but with numerous pycnidia and lecideine apothecia. Rare on soil.

Niobrara: 243

Trapeliopsis flexuosa (Fr.) Coppins & P. James

The greenish-gray, very granular upper cortex of *T. flexuosa* has small, biatorine apothecia. The apothecial disk is black with paler margins. Spores are simple, measuring 8.5-10.0 µm in length and 4.5-5.5 µm in width. Found on bark and a rotten log. This species has been mapped from Colorado, Wyoming, South Dakota, Iowa and Nebraska (Brodo et al. 2001). However, since there have been no reports of this species from Nebraska within published primary literature, this is considered a new state record.

Bessey: 513, 516

Tuckermannopsis

This foliose genus has an olive-green to brown upper cortex and a pale underside. Thallus lobes are 0.5-3 mm wide and may or may not have soredia and apothecia. Marginal pycnidia are common.

1. Soredia present along lobe margins.....*Tuckermannopsis chlorophylla*
1. Soredia absent.....*Tuckermannopsis fendleri*

Tuckermannopsis chlorophylla (Willd.) Hale

This species has an olive-green to brown upper cortex with a lighter brown underside. Lobes are elongated, strap-shaped, and have soredia along the lobe margins. No apothecia were seen on Nebraska specimens. Rare on bark.

Chemistry: upper cortex K-, C+ yellow ; medulla K-, C-

Pine Ridge: 382

Tuckermannopsis fendleri (Nyl.) Hale

The olive-green thallus of *T. fendleri* has a pale white underside and rounded, flat lobes that form rosettes. No soredia or isidia are present, although thallus can be quite lobulate. Small, black, inconspicuous pycnidia can be present as well as tiny pseudocyphellae. Rare on pine bark.

Chemistry: upper cortex K-, C+ yellow ; medulla K-, C-

McKelvie: 347

Usnea

This fruticose genus has a gray-green thallus that is pendulous or "shrubby". A medullary central cord is present, and Nebraska pine forest specimens lack apothecia.

1. Isidia and dense fibrils present, no soredia.....*Usnea hirta*
1. No isidia or fibrils, soredia present.....*Usnea lapponica*

Usnea hirta (L.) F.H. Wigg.

This species has dense isidia present on the branches. *Usnea hirta* is the most common fruticose lichen in the region. Common on pine bark.

Pine Ridge: 365, 420, 427, 522, 557, 13328, 13346, 13352, 13375, 13402

Wildcat Hills: 462, 13457, 13471, 13472

McKelvie: 338, 13266, 13282, 13283, Bessey: 490, 13481

Usnea lapponica Vainio

Usnea lapponica produces distinct soralia on the branches, a feature which easliy separates this taxon from *U. hirta*. Occasional on pine bark. Halonen et al. (1998) describes the distribution of *U. lapponica* as continental within montane/boreal areas of North America. This report is the first record of this species for Nebraska.

Pine Ridge: 407 Wildcat Hills: 482, 13442, 13463a McKelvie: 353

Vulpicida pinastri (Scop.) J.-E. Mattson & M.-J. Lai

Vulpicida pinastri produces a bright yellow upper cortex, a pale underside and a bright yellow medulla (vulpinic acid). Farinose soredia are marginal and may become laminal in older sections. Rare on pine bark. The genus *Vulpicida* was first separated as a distinct genus by Mattsson & Lai (1993), but they included no

distribution information. Brodo et al. (2001) map this species from nearby South Dakota, Colorado, and Wyoming, but this record is the first report for this genus and species in Nebraska.

Chemistry: upper cortex K-, C- ; medulla K-, C-

McKelvie: 13267 Bessey: 13484

Xanthoria

This foliose genus has an orange, K+ purple upper cortex and a pale lower cortex. The apothecia (if present) have an orange disk and polarilocular spores (Lindblom 1997). Specimens collected in Nebraska varied in presence/absence of soredia and apothecia.

1. Soredia present.....*Xanthoria fallax*
1. Soredia absent.....2

2. Found on rock, thallus deep orange.....*Xanthoria elegans*
2. Found on bark 3

3. Spore septum 1-4 µm in width.....*Xanthoria montana*
3. Spore septum 5-8 µm in width.....[*Xanthoria hasseana*]

Xanthoria elegans (Link) Th. Fr.

The thallus of *X. elegans* has a deep orange color with many apothecia and no soredia. The thallus is closely appressed forming rosettes. Occasional on rock.

Pine Ridge: 544, 569, 13336, 13366

Xanthoria fallax (Hepp) Arnold

Specimens of *X fallax* produce soredia in soralia which are in hood-like expansions along lobe margins between the upper and lower cortex. Apothecia occur on some specimens. Very common on pine, juniper, cottonwood, ash, oak, elm and mountain mahogany bark.

Pine Ridge: 275, 277a, 312, 384, 410, 429, 13427

Niobrara: 163, 165, 177, 202, 247, 257, 13250,

Wildcat Hills: 448, 13452 McKelvie: 359 Bessey: 502

Xanthoria montana L. Lindblom

This species has a pale, light orange upper cortex, many apothecia and no soredia. The thallus is loosely attached to the substrate and is spreading, not forming distinct rosettes. *Xanthoria montana* is similar to *X. hasseana* Räsänen, and can be separated on the basis of isthmus width. *Xanthoria hasseana* has a wider isthmus, and has been cited from the Niobrara area (Lindblom 1997). Frequent on pine, ash and elm bark. *Xanthoria montana* has been reported from Nebraska previously (Lindblom 1997).

Pine Ridge: 429a, 528, 559, 577, 581a, 13425

RESULTS AND DISCUSSION

Floristic Analysis

Nineteen localities were visited and collected for the purposes of this study including the two planted forests in the state, Samuel R. McKelvie National Forest and the Bessey District of the Nebraska National Forest. Data presented are based on the 541 currently identified specimens deposited in the herbarium at the University of Nebraska at Omaha (OMA).

I found 110 separate species in 47 genera. Sixty-nine species were found only in natural forest populations, 11 were found only in planted populations and 30 occurred in both forest types. Thirty-nine species represent new records for Nebraska, including six new genera (*Canomaculina*, *Hypotrachyna*, *Leproloma*, *Megaspora*, *Pseudevernia*, and *Vulpicida*) never before collected in the state (Tab. 1). The majority of these species have been documented in South Dakota, Wyoming and Colorado (Brodo et al. 2001; Nordin 1999; Halonen 1998; Esslinger 1994; Knoph & Leuckert 1994; Thomson 1991; Timdal 1986; Wetmore 1968) within the forested areas comprising the Rocky Mountain ecosystem. Thus, it is not surprising that these species would occur in Nebraska given that the proper substrates exist, and the distances are not too great for dispersal over an extended period of time.

Table 1. Total Species Collected. Species in boldface are new records for the state. Those species with an asterisk are new genera recorded for the state.

Name	Niobrara	Pine Ridge	Wildcat Hills	McKelvie	Bessey
Acarospora strigata		X			
Aspicilia contorta	X	X			
Bacidia sabuletorum	X	X	X		
Bryoria fuscescens		X	X		
Caloplaca cerina	X	X		X	
Caloplaca chrysophthalma	X				
Caloplaca decipiens			X		
Caloplaca flavorubescens	X	X			
Caloplaca flavovirescens	X				
Caloplaca holocarpa		X	X	X	
Caloplaca microphyllina	X		X		
Caloplaca subsoluta	X	X	X		
Caloplaca trachyphylla			X		
Candelaria concolor	X	X		X	X
Candelariella aurella		X			
Candelariella xanthostigma	X		X		
****Canomaculina conferenda***					X
Cladonia cariosa	X	X			
Cladonia cenotea		X			
Cladonia chlorophaea	X	X	X	X	X
Cladonia coniocraea		X	X		
Cladonia fimbriata	X	X	X	X	X
Cladonia humilis	X	X			
Cladonia macilenta	X	X		X	X
Cladonia pocillum		X			
Cladonia pyxidata	X	X	X		
Cladonia ramulosa		X			X
Cladonia rei	X		X		X
Cyphelium notarisii	X	X		X	X
Diploschistes muscorum	X	X	X		
Diploschistes scruposus	X				
Diplotomma venustum		X			
Evernia mesomorpha		X		X	X

Name	Niobrara	Pine Ridge	Wildcat Hills	McKelvie	Bessey
Flavoparmelia caperata					X
Flavopunctelia flaventior		X		X	
Flavopunctelia soredica	X	X	X	X	X
Heppia lutosa	X				
Hyperphyscia adglutinata	X				
Hyperphyscia syncolla	X				
Hypogymnia physodes		X	X	X	X
Hypogymnia tubulosa		X			
****Hypotrachyna laevigata***				X	
Lecania erysibe			X		
Lecania perproxima	X				
Lecanora minutella				X	X
Lecanora polytropa		X			
Lecanora saligna			X		
Lecidella euphorea	X	X	X		
Lecidella patavina	X	X	X		
Lecidella stigmatea		X			
Lepraria frigida		X			
Lepraria lobificans	X				
****Leproloma vouauxii***		X	X		
Megaspora verrucosa	X		X		
Melanelia elegantula		X	X	X	
Melanelia exasperatula				X	
Melanelia subargentifera		X			
Melanelia subaurifera				X	
Melanelia subolivacea		X	X	X	
Parmelia sulcata	X	X	X	X	X
Parmeliopsis ambigua		X			
Peltigera canina		X			
Peltigera didactyla	X	X			
Peltigera evansiana	X				
Peltigera lepidophora	X	X			X
Peltigera polydactylon	X	X			
Peltigera rufescens	X	X	X		
Phaeophyscia adiastola	X				
Phaeophyscia cernohorskyi	X	X	X		X

Name	Niobrara	Pine Ridge	Wildcat Hills	McKelvie	Bessey
Phaeophyscia ciliata	X				
Phaeophyscia hirsuta	X	X	X		X
Phaeophyscia insignis	X				
Phaeophyscia nigricans	X				
Phaeophyscia orbicularis		X			
Phaeophyscia pusilloides					X
Physcia adscendens		X	X		X
Physcia aipolia	X	X			
Physcia biziana	X	X			
Physcia caesia		X			
Physcia dimidiata			X		
Physcia stellaris	X	X	X	X	
Physciella chloantha	X	X			X
Physciella melanchra			X		X
Physconia elegantula		X			
Physconia enteroxantha		X			
Physconia kurokawae	X				
Physconia leucoleiptes	X				
****Pseudevernia intensa***				X	
Psora globifera		X			
Psora pseudorussellii	X	X			
Punctelia bolliana	X				
Punctelia perreticulata	X			X	
Punctelia subrudecta		X		X	
Rimelia reticulata	X				X
Rinodina archaea		X			
Rinodina bischoffii	X	X	X		
Sarcogyne regularis	X	X			
Staurothele elenkinii			X		
Teloschistes chrysophthalmus	X				X
Toninia sedifolia		X			
Toninia tristis	X				
Trapeliopsis flexuosa					X
Tuckermannopsis chlorophylla		X			
Tuckermannopsis fendleri				X	
Usnea hirta		X	X	X	X

Name	Niobrara	Pine Ridge	Wildcat Hills	McKelvie	Bessey
Usnea lapponica		X	X	X	
****Vulpicida pinastri***				X	X
Xanthoria elegans		X			
Xanthoria fallax	X	X	X	X	X
Xanthoria montana		X			
Totals	57	68	37	27	27

However, I found that four species have primarily eastern ranges. Two in particular, *Melanelia subaurifera* and *Phaeophyscia adiastola*, are largely eastern in distribution (Brodo et al. 2001; Esslinger 1978) but have been shown to have a small disjunct population in Colorado (Brodo et al. 2001). These new records for Nebraska document wider ranges for *M. subaurifera* and *P. adiastola* than previously thought. Since both species produce asexual propagules that could aid in dispersal, this is not surprising.

The other two species with eastern ranges, *Lecania perproxima* and *Lecanora minutella*, have no such disjunct populations to explain their presence in Nebraska. Previously, both have been thought to have exclusively eastern ranges, with *L. minutella* occurring only as far west as southeastern Missouri (LaGreca & Lumbsch 2001). Identifications from Nebraska establishes a significant range extension. Unlike the previous taxa, no asexual propagules which would facilitate easy dispersal are produced.

Fig. 2 shows the number of species collected in the five main forested areas, distributed by substrate. The Pine Ridge and the Niobrara River Valley area, in general, had the most species collected in each of the substrate types with the exception of wood. Fig. 3 illustrates the number of species collected in each substrate

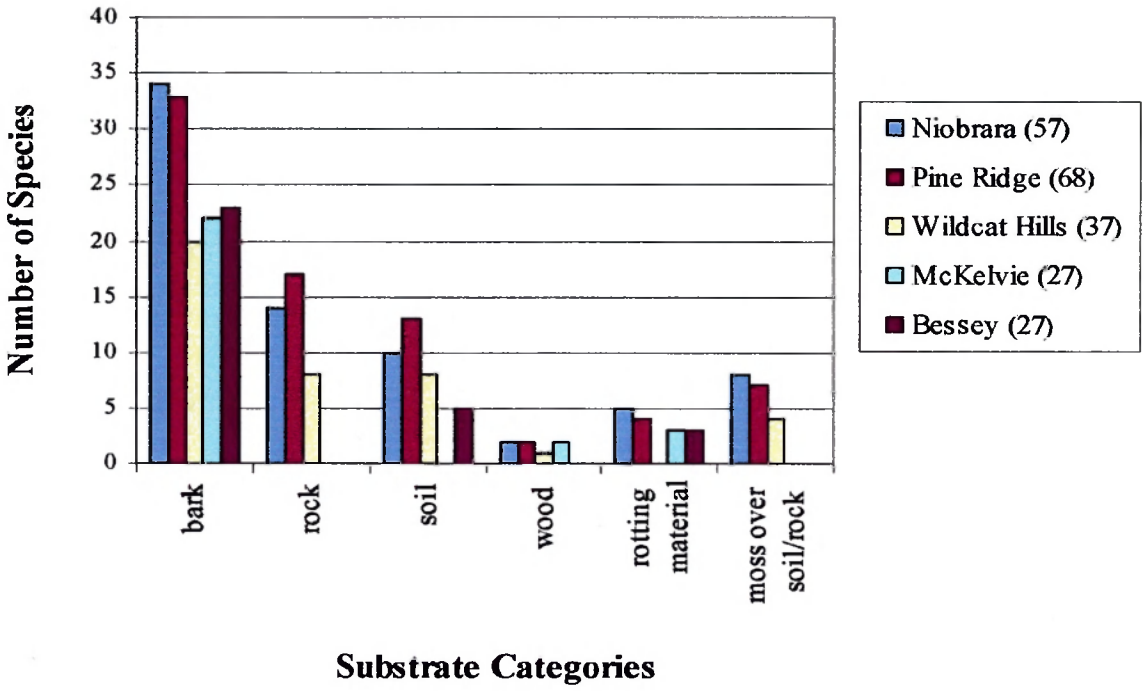

Figure 2. Lichen Diversity in Nebraska Pine Forest Areas.

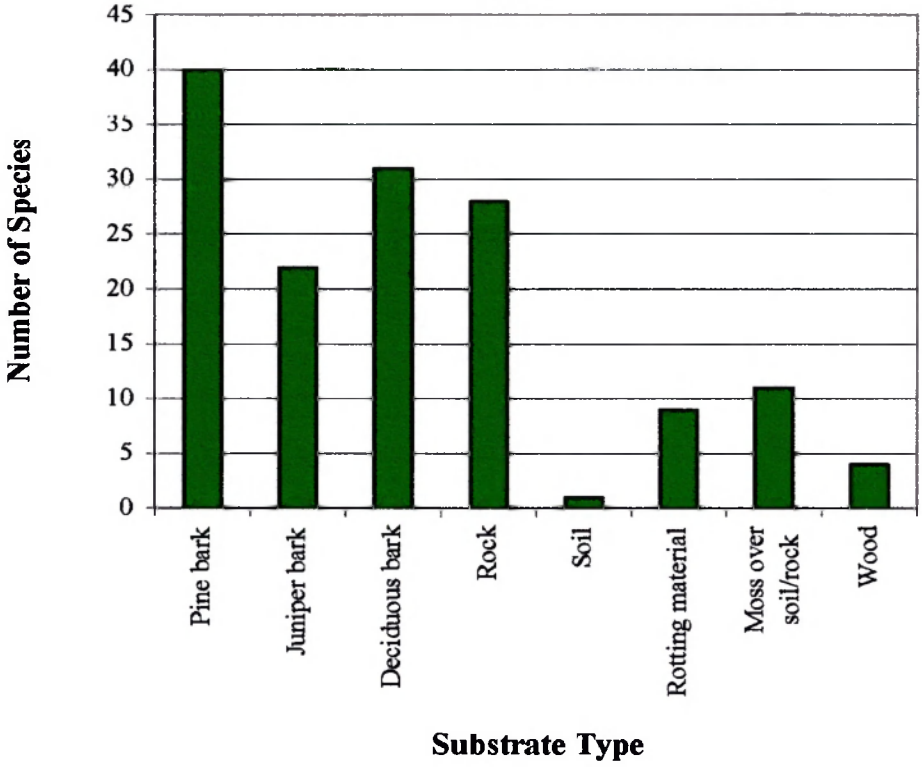

Figure 3. Lichen Diversity Among Substrate Types.

category. Corticolous lichens (both deciduous and coniferous) were the most numerous with saxicolous lichens making up the next largest category.

Within the natural forest regions, the Wildcat Hills had a lower species diversity than the Niobrara and Pine Ridge areas (Fig. 2). This is most likely due to its slightly drier climate and smaller overall size compared to the other natural pine forest areas.

Comparisons of the Natural and Planted Pine Forests

The natural forest populations had greater lichen diversity than the planted populations (Fig. 4). This is primarily due to substrate differences. The relatively large rock and deciduous bark substrate categories (Fig. 3) are entirely missing from planted populations. This accounts for a significant loss of microhabitat available for lichen colonization. Also, the lack of a well-developed understory could partially explain the decrease in soil lichens. Without understory plants to break up the dense mat of fallen pine needles, it is difficult for soil lichens to become established. In addition, few soil lichens grow well on unstable sandy soils that are common in western Nebraska.

Lower lichen diversity in the planted pine populations could also result from dispersal problems. Most of the species found in the natural populations have been

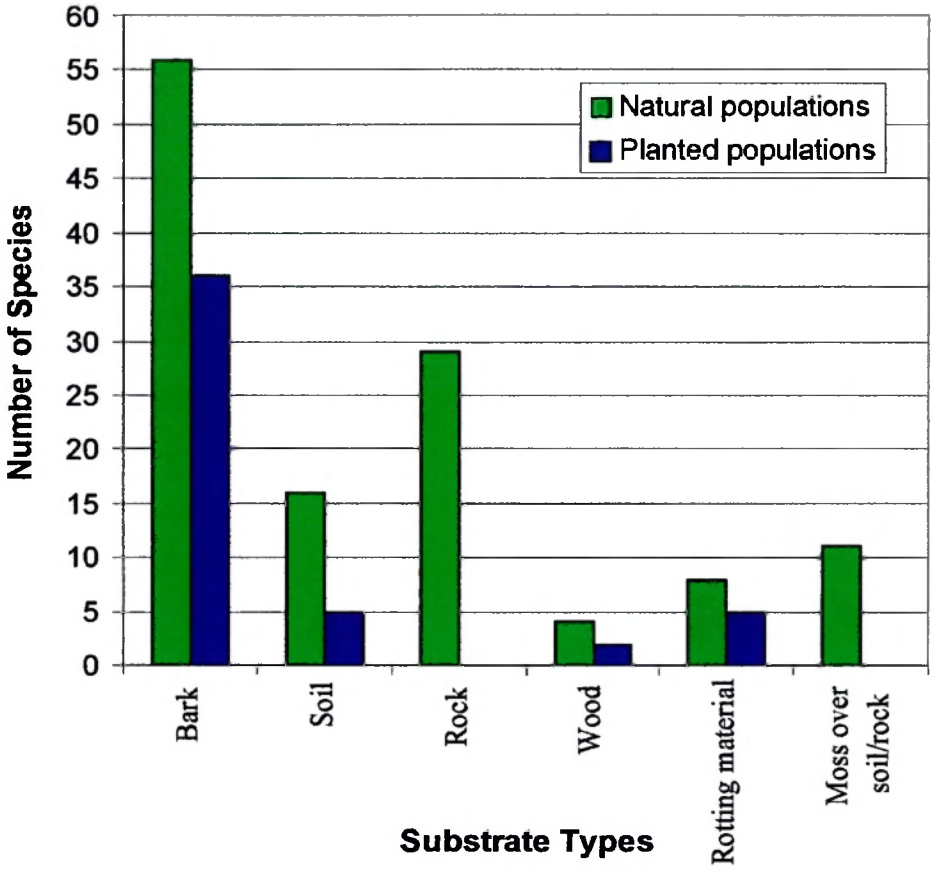

Figure 4. Lichen Diversity in Natural and Planted Pine Forests.

recorded in the Black Hills and Colorado (Brodo et al. 2001; Wetmore 1968), so it is not surprising to find them present in Nebraska's remnants of the Rocky Mountain system. The increased distance of the planted populations from other forested areas hinders dispersal and establishment, thus decreasing lichen diversity. Of the 40 lichen species found in the planted pine forests, 30 (75%) have some type of asexual propagule - soredia, isidia, or lobules. Lichens with these asexual propagules generally are able to disperse more successfully than those producing only ascospores. Lichens that reproduce only sexually via ascospores must "find" a suitable photosynthetic partner with which to reestablish the symbiotic relationship.

In this study, 11 species were found only in the planted forests and not in the natural populations (Tab. 1). This could be due to a more eastern distribution tendency of those particular species, despite the fact that the available substrates in these planted forests are more western in nature. However, only three species, *Phaeophyscia pusilloides*, *Lecanora minutella* and *Melanelia subaurifera*, have exclusively eastern ranges. *Phaeophyscia pusilloides* has been reported previously in Nebraska only from Nemaha County which is in the southeastern corner of the state (Egan et al. 1995), and Brodo et al. (2001) show its distribution range as being largely eastern across the continent. *Lecanora minutella* has a distribution range that is also

largely eastern (LaGreca & Lumbsch 2001) and, except for a small population in Colorado, Brodo et al. (2001) show *M. subaurifera* as not occurring farther west than the eastern side of Iowa.

For the remaining eight species found only in the planted populations and not in the natural areas, various authors have reported their occurrence in neighboring western states. *Flavoparmelia caperata*, *Hypotrachyna laevigata*, *Melanelia exasperatula*, and *Tuckermannopsis fendleri* have all been reported from the Black Hills (Wetmore 1968), and *Pseudevernia intensa*, *Trapeliopsis flexuosa* and *Vulpicida pinastri* are all known from Colorado (Brodo et al. 2001; Hale 1955). Therefore, the absence of these particular species from the natural populations in Nebraska is most likely due to limited collection in these large areas of the state rather than to dispersal problems or substrate preference. These species most likely occur in other areas of Nebraska and will be found with additional field work.

Future Applications

The knowledge gained in this study will be useful to various regulatory agencies, such as the Nebraska Game and Parks Commission, the U.S. Forest Service, and The Nature Conservancy. Lichens are well established as early indicators of air quality degradation, and it is essential to have a record of lichen species distributions

in various regions for comparisons in the future. This knowledge should assist in management decisions regarding human impact on preserved areas.

The information from this study will also be useful to future researchers interested in the lichen flora of Nebraska. While this project greatly increased our knowledge of lichens in pine forests across the state, there are still vast areas that remain undercollected and unknown. Further field work and analysis is required to completely document lichen diversity in Nebraska.

LITERATURE CITED

Brodo, I. M., S. D. Sharnoff & S. Sharnoff. 2001. Lichens of North America. 793 pp. Yale University Press, New Haven and London.

Culberson, C. 1972. Improved conditions and new data for the identification of lichen products by a standardized thin-layer chromatographic method. Journal of Chromatography 72: 113-125.

Egan, R. S., R. C. Witt, Y. E. Peck, J. P. Goeden & T. L. Cherney. 1995. A preliminary catalog of the lichen-forming fungi of Nebraska. Transactions of the Nebraska Academy of Sciences 22: 13-25.

Esslinger, T. L. 1978. Studies in the lichen family Physciaceae. II. The genus *Phaeophyscia* in North America. Mycotaxon 7: 283-320.

_____. 1986. Studies in the lichen family Physciaceae. VII. The new genus *Physciella*. Mycologia 78: 92-97.

_____. 1994. New species and new combinations in the lichen genus *Physconia* in North America. Mycotaxon 51: 91-99.

Hale, M. E., Jr. 1955. Studies on the chemistry and distribution of North American lichens (1-5). The Bryologist 58: 242-246.

_____. 1979. How to Know the Lichens. Second edition. WCB/McGraw-Hill,

Dubuque.

Halonen, P., P. Clerc, T. Goward, I. M. Brodo & K. Wulff. 1998. Synopsis of the genus *Usnea* (lichenized Ascomyctes) in British Columbia, Canada. The Bryologist 101: 36-60.

Harris, R. C. & D. M. Ladd. 2001. Lichens of the Ozarks: Floristics and implications for biodiversity conservation. New York Botanical Garden and The Nature Conservancy. Retrieved on 8 October 2001 from the World Wide Web at http://www.nybg.org/bsci/lichens/ozarks/ozark_checklist.html

Kaul, R. B., G. E. Kantak & S. P. Churchill. 1993. The Niobrara Valley Preserve: an inventory of a biogeographical crossroads. Transactions of the Nebraska Academy of Sciences 20: 1-12.

_____ & S. B. Rolfsmeier. 1993. Native Vegetation of Nebraska. Map. Conservation and Survey Division, Institute of Agriculture and Natural Resources, University of Nebraska-Lincoln.

Knoph, J.-G. & C. Leuckert. 1994. Chemotaxonomic studies in the saxicolous species of the lichen genus *Lecidella* (Lecanorales, Lecanoraceae) in America. Nova Hedwigia 59: 455-508.

Ladd, D., G. Wilhelm & R. C. Harris. 1994. Additions to the lichen flora of Missouri. Evansia 11: 131-138.

LaGreca, S. & H. T. Lumbsch. 2001. Three species of *Lecanora* new to North America, with notes on other poorly known lecanoroid lichens. The Bryologist 104: 204-211.

Lindblom, L. 1997. The genus *Xanthoria* (Fr.) Th. Fr. in North America. Journal of the Hattori Botanical Laboratory 83: 75-172.

Mattson, J.-E. & M.-J. Lai. 1993. *Vulpicida*, a new genus in Parmeliaceae (lichenized ascomycetes). Mycotaxon 46: 425-428.

Nebraska Off Highway Vehicle Association (NOHVA). 1998. Nebraska National Forest Bessey Ranger District ATV and dirtbike trail information and map. Grand Island, Nebraska. 1-page brochure.

Nixon, E. S. 1967. A vegetational study of the Pine Ridge of northwestern Nebraska. Southwestern Naturalist 12: 134-145.

Nordin, A. 1999. *Buellia* species with pluriseptate spores. New and unrecorded species in North America. The Bryologist 102: 249-264.

Printzen, C. 2001. Corticolous and lignicolous species of *Lecanora* (Lecanoraceae, Lecanorales) with usnic or isousnic acid in the Sonoran Desert region.

The Bryologist 104: 382-409.

Steinauer, G. & S. Rolfsmeier. 2000. Terrestrial Natural Communities of Nebraska. Nebraska Natural Heritage Program. Nebraska Game and Parks Commission. Lincoln, Nebraska.

Thomson, J. W. 1991. The lichen genus *Staurothele* in North America. The Bryologist 94: 351-367.

Timdal, E. 1986. A revision of *Psora* (Lecideaceae) in North America. The Bryologist 89: 253-275.

_____. 1992. A monograph of the genus *Toninia*. Opera Botanica 110: 1-137.

U.S. Department of Agriculture Forest Service (USDAFS). Undated. Questions and answers concerning the Samuel R. Mckelvie National Forest, Nebraska National Forest. Halsey, Nebraska. 3-page brochure.

Weber, W. A. 1967. A synopsis of the North American species of *Cyphelium*. The Bryologist 70: 197-202.

Wetmore, C. M. 1968. Lichens of the Black Hills of South Dakota and Wyoming. Publications of the Museum. Biological Series Vol. 3. Number 4. Michigan State University, East Lansing.

_____ & I. Kärnefelt. 1998. The lobate and subfruticose species of *Caloplaca* in

North and Central America. The Bryologist 101: 230-255.

White, F. J. & P. W. James. 1985. A new guide to microchemical techniques for the identification of lichen substances. British Lichen Society Bulletin. 57 (supplement): 1-47.