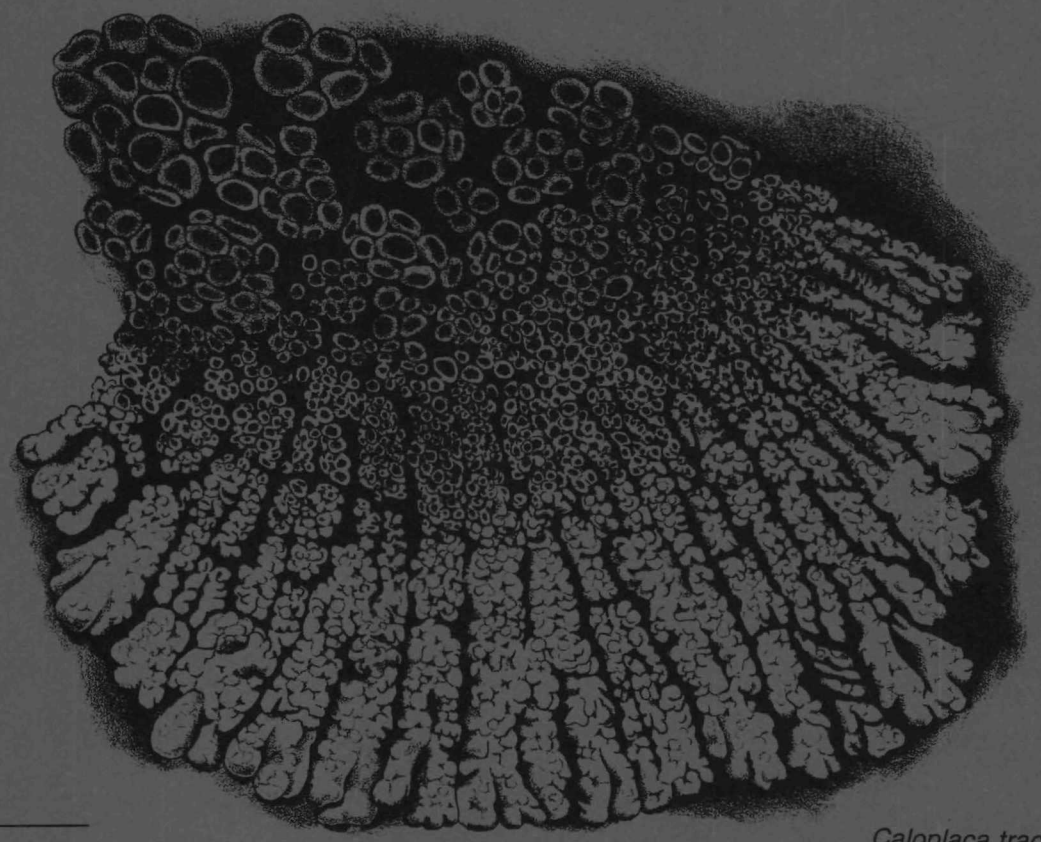
THE LICHENS OF

SCOTTS BLUFF NATIONAL MONUMENT

AND

AGATE FOSSIL BEDS NATIONAL MONUMENT



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Caloplaca trachyphylla

Prepared for the
National Park Service

and

Biological Resources Division
U.S. Geological Survey

by

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April 1998

THE LICHENS OF

SCOTTS BLUFF NATIONAL MONUMENT

AND

AGATE FOSSIL BEDS NATIONAL MONUMENT

Final Report

Prepared for

National Park Service

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Biological Resources Division
U. S. Geological Survey

Purchase Order # 84040-7-0220

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ABSTRACT

This study of the lichens of Scotts Bluff and Agate Fossil Beds National Monuments was designed 1) to collect lichens for lichen species lists, and, 2) to collect lichens for elemental analysis (if suitable species occurred). Each park is treated in a separate section of this report. Fifteen localities were studied in Scotts Bluff and eleven in Agate Fossil Beds. No suitable species were found in either park for elemental analysis.

The lichen floras are reasonably diverse for such dry areas. There were 65 species present in Scotts Bluff and 64 species present in Agate Fossil Beds. All of the lichens found were in good health and with normal fertility. There seemed to be no indications of threatening air quality problems (primarily from sulfur dioxide) in these parks.

Recommendations are for a complete lichen restudy of the lichen flora every 10-15 years. Localities with numerous rare lichens should receive special protection to prevent loss of species. If construction or maintenance activities are planned within these areas a lichenologist should be consulted to prevent loss of critical habitats and species.

PREFACE

Under a purchase order from the Biological Resources Division of the US Geological Survey a lichen study was performed in Scotts Bluff and Agate Fossil Beds National Monuments. The objectives were to survey the lichens in each park, produce an inventory of the lichen flora, collect and analyze lichens for chemical contents (if suitable species were present), and evaluate the lichen flora with reference to the air quality. This establishes baseline data to determine the future changes in the lichen flora and contributes to the knowledge of the biodiversity of the

National Parks. All herbarium work was done at the University of Minnesota Herbarium with consultation with Dr. James P. Bennett and with personnel in the parks.

There are six parks in the "Prairie Cluster Parks": Effigy Mounds, Pipestone National Monument, Homestead National Monument, Wilson's Creek National Battlefield, Agate Fossil Beds National Monument, and Scotts Bluff National Monument. Of these, Pipestone had a previous lichen study (Wilson & Vinyard 1986), Effigy Mounds, Homestead, and Wilson's Creek were studied in 1996 (Wetmore & Bennett 1997). This study of Scotts Bluff and Agate Fossil Beds completes the lichen floras of all of the "Prairie Cluster Parks".

The floristic parts of this report are divided into two sections (one for each park).

All Park Service personnel have been very helpful during the field work which has contributed significantly to the success of the project. The study was made possible by funds from the USGS Biological Resources Division. Dr. James P. Bennett contributed in discussions and ideas and in making the funds available for the study. The assistance of all of these is gratefully acknowledged.

INTRODUCTION

Lichens are composite plants composed of two different types of organisms. The lichen plant body (thallus) is made of fungi and algae living together in a symbiotic arrangement in which both partners are benefited and the composite plant body can grow in places where neither component could live alone. The thallus has no protective layer on the outside, such as the epidermis of a leaf, so the air in the thallus has free exchange with the atmosphere. Lichens are slow growing (a few millimeters per year) and remain alive for many years and so they must have a habitat that is relatively undisturbed in order to survive. Lichens vary greatly in

their ecological requirements but almost all of them can grow in places that only receive periodic moisture. When moisture is lacking they go dormant until the next rain or dew-fall. Some species can grow in habitats with very infrequent occurrences of moisture while others need high humidity and frequent wetting in order to survive. This difference in moisture requirements is very important in the distribution of lichens.

Lichens are known to be very sensitive to low levels of many atmospheric pollutants. Many are damaged or killed by levels of sulfur dioxide, nitrogen oxides, fluorides or ozone alone or in various combinations. Levels of sulfur dioxide as low as 13 μg/cubic meter (annual average) will cause the death of some lichens (LeBlanc et al., 1972). Other lichens are less sensitive and a few can tolerate levels of sulfur dioxide over 300 μg/cubic meter (Laundon, 1967, Trass, 1973). The algae of the thallus are the first to be damaged in areas with air pollution and the first indication of damage is discoloring and death of the algae causing bleached lobes, which quickly leads to the death of the lichen. After the lichen dies it disappears from the substrate within a few months to a year as it disintegrates and decomposes (Wetmore, 1982).

Lichens are more sensitive to air pollution when they are wet and physiologically active and are least sensitive when dry (Nash, 1973, Marsh & Nash, 1979) and are more sensitive when growing on acid substrates.

Contrary to some published reports (Medlin, 1985) there is little evidence that most lichens are good indicators of acid precipitation. However, Sigal & Johnston (1986) have reported that one species of Umbilicaria shows visible damage due to artificial acid rain. They also report that similar symptoms were found in collections from various localities in North America. Lechowicz (1987) reported that acid rain only slightly reduced growth of Cladina stellaris but Hutchinson et al. (1986) reported that extremely acid precipitation (less than pH

3.5) killed or damaged some mosses and lichens. Scott & Hutchinson (1987) showed temporary reduction of photosynthesis in Cladina stellaris and C. rangiferina after artificial acid rain.

Lichens are able to accumulate chemical elements in excess of their metabolic needs depending on the levels in the substrate and the air, and, since lichens are slow growing and long lived, they serve as good summarizers of the environmental conditions in which they are growing. Chemical analysis of the thallus of lichens growing in areas of high fallout of certain elements will show elevated levels in the thallus. Toxic substances (such as sulfur) are also accumulated and determination of the levels of these toxic elements can provide indications of the sublethal but elevated levels in the air.

METHODS

Field work was done during June and July, 1997 by the author. A complete list of collection localities for each park is given at the end of each park section of the report and the localities are indicated on the maps of each park. Collection localities, about 1 acre in size, were selected first to give a general coverage of the park; second, to sample all vegetational types; and third, to be in localities that should be rich in lichens. Undisturbed as well as disturbed habitats (such as old roadsides and trails) were studied. At each locality voucher specimens of all species found were collected to record the total flora for each locality and to avoid missing different species that might appear similar in the field. No species were found that would be satisfactory for elemental analysis because of the lack of common foliose species (see Elemental Analysis section). While collecting at each locality observations were made about the general health of the lichens. Lichen health was evaluated by looking for damaged or dying lichens where collections were made. The presence of many dead, dying, or abnormal thalli of particular species at a locality would indicate poor health, but an occasional damaged thallus

is not significant.

Identifications were carried out at the University of Minnesota with the aid of comparison material in the herbarium and using thin layer chromatography for identification of the lichen substances where necessary. The original packet of each collection has been deposited in the University of Minnesota Herbarium. All specimens deposited at the University of Minnesota have been entered into the herbarium computerized data base maintained there.

The following lists of lichens are based on these collections. Species found only once are indicated by "Rare". In the first columns the letters indicate the sensitivity to sulfur dioxide, if known, according to the categories proposed by Wetmore (1983): S=Sensitive, I=Intermediate, T=Tolerant. S-I is intermediate between Sensitive and Intermediate and I-T is intermediate between Intermediate and Tolerant. Species in the Sensitive category are absent when annual average levels of sulfur dioxide are above 50 μg per cubic meter. The Intermediate category includes those species present between 50 and 100 μg and those in the Tolerant category are present at over 100 μg per cubic meter. Those species without sensitivity designations have unknown sensitivity.

Some of the species found only once are rare wherever they are found throughout their distributional range and might be found at other localities with further searching and others may require special substrates that are rare in the park. The cases of rarity do not necessarily reflect sensitivity damage due from sulfur dioxide.

The lack of species in the most sensitive category probably does not indicate poor air quality. Most of the species with known sensitivities are northern species which are lacking in the park because of climatic factors. The presence of some lichens with blue green algae (that are more sensitive to sulfur dioxide) also indicates that there is probably no air quality problem in the parks. In addition, there

are no important pollution sources near the parks.

Most lichen species are unknown as to sensitivity category. In areas of high sulfur dioxide the tolerant category would have more species and the most sensitive categories would have fewer species. The Rare species in are not necessarily related to air quality (see above). The only way to determine past air quality impacts on the present lichen species inventory is by comparison with historical data (from before the presumed impacts occurred). Since there are no historical species lists from these parks it cannot be determined whether the present lichen flora has changed prior to this study.

SCOTTS BLUFF NATIONAL MONUMENT

This park in central western Nebraska was established in 1919 and has almost 3,000 acres. The park includes high buttes, some with a limestone cap, surrounded by prairies. The park includes a section of the North Platte River on the north end. Some of the north facing slopes and the tops of the buttes have juniper (Juniperus) and ponderosa pine (Pinus ponderosa) and the river flats have a few cottonwood (Populus deltoides), willow (Salix), and green ash (Fraxinus pensylvanica).

Lichen collections were made at 15 localities in the park and 313 collections were made.

SCOTTS BLUFF SPECIES LIST

*Acarospora americana Magn. **RARE**
Acarospora fuscata (Nyl.) Arn. **RARE**
*Acarospora stapfiana (Müll. Arg.) Hue
*Acarospora strigata (Nyl.) Jatta
Bacidia bagliettoana (Mass. & De Not.) Jatta **RARE**
Caloplaca atroalba (Tuck.) Zahlbr.
S-I Caloplaca cerina (Ehrh.) Th. Fr.
*Caloplaca decipiens (Arn.) Blomb. & Forss.
I Caloplaca holocarpa (Hoffm.) Wade
Caloplaca microphyllina (Tuck.) Hasse
*Caloplaca saxicola (Hoffm.) Nordin
Caloplaca trachyphylla (Tuck.) Zahlbr.
I-T Caloplaca vitellinula (Nyl.) Oliv.
*Candelariella aurella (Hoffm.) Zahlbr.
*Candelariella deflexa (Nyl.) Zahlbr.
*Candelariella rosulans (Müll. Arg.) Zahlbr.
*Candelariella subdeflexa (Nyl.) Lett. **RARE**
*Catapyrenium lacinulatum (Ach.) Breuss
Cladonia pyxidata (L.) Hoffm.
Cladonia symphycarpa (Ach.) Fr.
Collema tenax (Sw.) Ach.
*Diploschistes muscorum (Scop.) R. Sant.
*Diplotomma venustum (Körb.) Körb. **RARE**
Endocarpon pusillum Hedw.
Fulgensia bracteata (Hoffm.) Räs.
Fulgensia subbracteata (Ntl.) Poelt
*Heppia adglutinata (Kremp.) Mass.
T *Lecanora dispersa (Pers.) Somm.
T Lecanora hagenii (Ach.) Ach.
*Lecanora meridionalis Magn. **RARE**
T Lecanora muralis (Schreb.) Rabenh. **RARE**
*Lecanora piniperda Körb.
I Lecanora saligna (Schrad.) Zahlbr. **RARE**

Lecidella euphorea (Flörke) Hert.
*Lecidella stigmatea (Ach.) Hert. & Leuck.
Parmelia elegantula (Zahlbr.) Szat.
Parmelia flaventior Stirt. **RARE**
Parmelia soredica Nyl.
Parmelia subolivacea Nyl. in Hasse
Peltigera rufescens (Weis) Humb. **RARE**
Phaeophyscia chloantha (Ach.) Moberg
*Phaeophyscia melanchra (Hue) Hale
I Physcia adscendens (Th. Fr.) Oliv.
*Physcia dimidiata (Arn.) Nyl.
T *Physcia dubia (Hoffm.) Lett. **RARE**
I Physcia stellaris (L.) Nyl.
Physconia leucoleiptes (Tuck.) Essl. **RARE**
*Polysporina simplex (Dav.) Vezda
Psora decipiens (Hedwig) Hoffm.
*Rinodina archaea (Ach.) Arn.
*Rinodina milliaria Tuck. **RARE**
Sarcogyne privigna (Ach.) Mass.
*Sarcogyne regularis Körb.
Staurothele drummondii (Tuck.) Tuck.
*Staurothele elenkinii Oksn.
*Staurothele monicae (Zahlbr.) Wetm.
Toninia sedifolia (Scop.) Timdal
S-I Usnea hirta (L.) Weber ex Wigg. **RARE**
*Verrucaria fuscella (Turn.) Winch
*Verrucaria glaucovirens Grumm.
*Verrucaria marmorea (Scop.) Arn.
*Verrucaria muralis Ach.
Xanthoria elegans (Link) Th. Fr.
S-I Xanthoria fallax (Hepp in Arn.) Arn.
I Xanthoria hasseana Räs.

* = new state record

DISCUSSION OF LICHEN FLORA

This species list of 65 species gives the first lichen records from Scotts Bluff County (Egan et al. 1995) and 30 of them are new state records (indicated by "*" in the list). The presence of numerous calcareous habitats provides good habitats for many species. The few areas with trees provide a different substrate for some additional species. Only a few lichens were found on the hardwoods along the river but the conifers at the higher elevations had many species. The grassland with dense grass cover does not allow many soil species but some were found on the steep slopes and thin soil on the ridges. Overall, the low precipitation limits the numbers of lichens as it does the vascular plants.

The most common lichens were Caloplaca trachyphylla, Candelariella aurella, Lecidella stigmatea, Verrucaria muralis, Xanthoria elegans, and Xanthoria fallax.

The locality with the greatest number of Rare lichens was Locality 3 (North side of South Bluff) with six Rare species, floowied by locality 13 and locality 14 with two Rare species. Locality 3 was apparently more moist and had a large stand of pines which accounted for the rare species. This area (Locality 3) deserves special protection.

SCOTTS BLUFF NATIONAL MONUMENT COLLECTION LOCALITIES

Collection numbers are those of Clifford Wetmore. All collections are listed in ascending order by number and date of collection. All localities are in Scotts Bluff County, Nebraska. The latitude and longitude were taken by GPS unit at each of the collection sites.

Loc. 1. #77425-77460 On top of bluff around North Overlook with rock outcrops, ponderosa pine and juniper. elev. 4649ft. (1417m). Sec. 33, T22N, R55W, 41°50'23"N, 103°41'53"W. 30 June 1997.

Loc. 2. #77461-77479 On top of bluff around South Overlook with rock

outcrops, ponderosa pine and juniper. elev. 4645 ft. (1415m). Sec. 33, T22N, R55W, 41°50'07"N, 103°42'04"W. 30 June 1997.

Loc. 3. #77480-77519 North side of South Bluff SW of Coyote Pass. On hillside in gullies with ponderosa pine and juniper, elev. 4300 ft. Sec. 5, T21N, R55W, 41°49'25"N, 103°43'12"W. 1 July 1997.

Loc. 4. #77520-77526 Prairie north of South Bluff SW of Coyote Pass. Open prairie along gully with partly consolidated clay. Sec. 5, T21N, R55W, 41°49'36"N, 103°43'06"W. 1 July 1997.

Loc. 5. #77527-77555 On top of Saddle Rock ridge on rocky ridge, elev. 4400 ft. Sec. 33, T22N, R55W, 41°50'05"N, 103°41'43"W. 2 July 1997.

Loc. 6. #77556-77576 On NW spur ridge from parking lot on top of N bluff. Ridge with outcrops and limestone cap in places, elev. 4500 ft. Sec. 33, T22N, R55W, 41°50'19"N, 103°42'10"W. 2 July 1997.

Loc. 7. #77577-77577 In ponderosa pine area on top of bluff, 4600 ft. Sec. 33, T22N, R55W, 41°50'17"N, 103°42'04"W. 2 July 1997.

Loc. 8. #77578-77583 At northern edge of park along Mitchell Gering Canal in badlands along access road, elev. 3970 ft. Sec. 28, T22N, R55W, 41°50'48"N, 103°42'13"W. 3 July 1997.

Loc. 9. #77584-77589 Near NW corner of park along Mitchell Gering Canal around canal overflow, elev. 3970 ft. Sec. 28, T22N, R55W, 41°50'60"N, 103°42'37"W. 3 July 1997.

Loc. 10. #77590-77626 Along top of SW ridge from parking lot above road. On rock outcrops with scattered ponderosa pine and juniper, elev. 4600 ft. Sec. 33, T22N, R55W, 41°50'07"N, 103°42'14"W. 3 July 1997.

Loc. 11. #77627-77662 South Bluff on point of ridge S of Coyote Pass. On ridgetop with hard rocks and scattered ponderosa pine and juniper, elev. 4550 ft. Sec. 4, T21N, R55W, 41°49'20"N, 103°42'51"W. 4 July 1997.

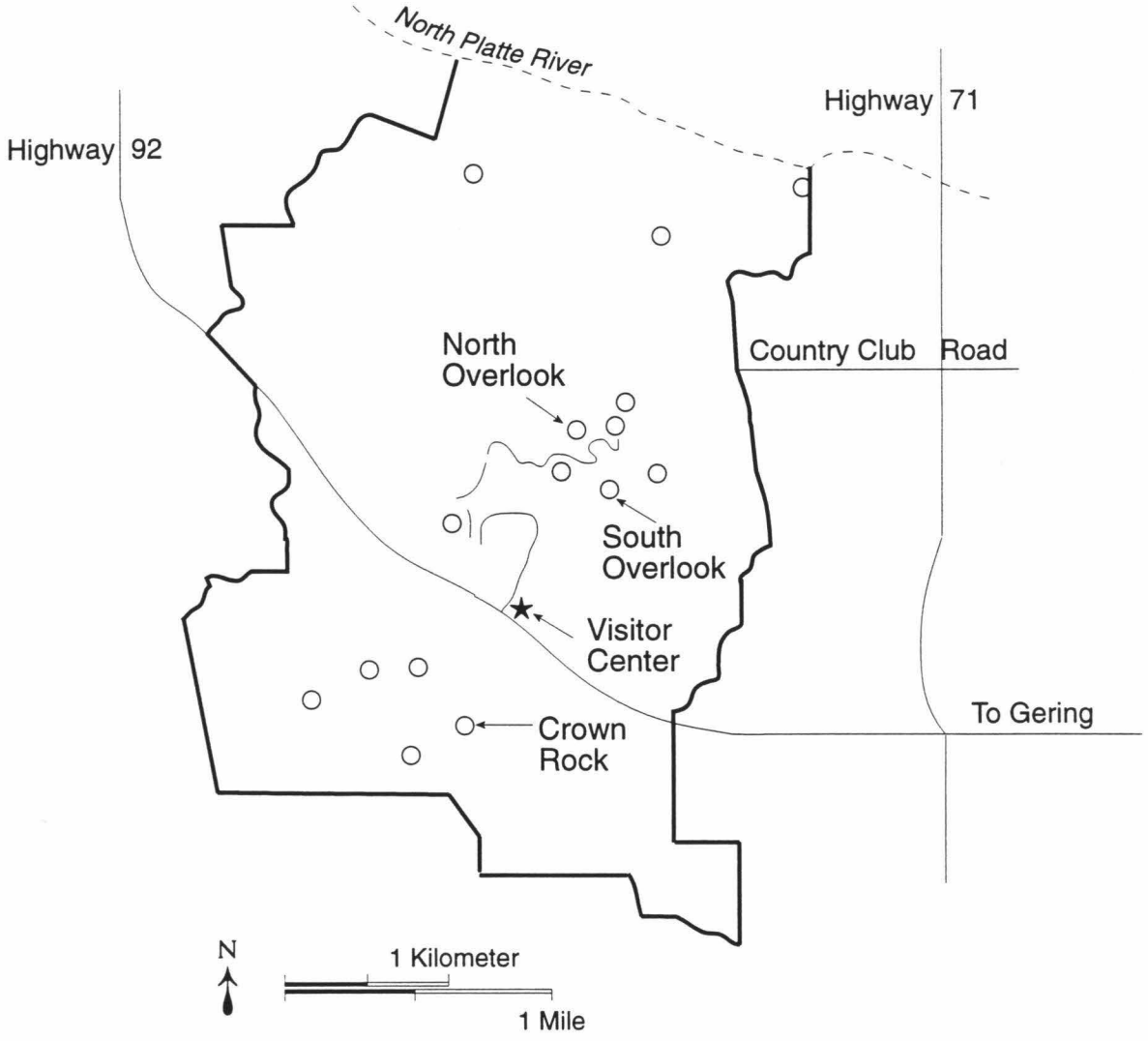
Loc. 12. #77663-77684 South Bluff on south point of ridge. On ridge with rock outcrops. elev. 4550 ft. Sec. 4, T21N, R55W, 41°49'04"N, 103°42'44"W. 4 July 1997.

Loc. 13. #77685-77710 South Bluff on ridge W of Crown Rock. On point of ridge and N facing slopes with few ponderosa pine and juniper, elev. 4550 ft. Sec. 4, T21N, R55W, 41°49'13"N, 103°42'39"W. 4 July 1997.

Loc. 14. #77711-77732 West side of Mitchell Pass along Oregon Trail. In prairie and junipers in a wash with clumps of Rhus trilobata, elev. 4200 ft. Sec. 33, T22N, R55W, 41°49'45"N, 103°42'45"W. 5 July 1997.

Loc. 15. #77733-77737 At NE corner of park along North Platte River near canal. River bottoms with cottonwood, green ash, and willow, elev. 3900 ft. Sec. 27, T22N, R55W, 41°51'03"N, 103°41'18"W. 5 July 1997.

Scotts Bluff National Monument



AGATE FOSSIL BEDS NATIONAL MONUMENT

This park was established in 1965 and is about 3,000 acres in size. The land is rolling prairie with scattered buttes and hills. The Niobrara River flows through the center of the park. The buttes and hills often had limestone caps and most of the rocks and soil contained lime. One area surrounding the Daemonelix Site had non-calcareous rocks. No trees were found on the hills but a few planted elms (Ulmus), juniper (Juniperus), and cottonwood (Populus deltoides) were at one location in the valley. According to information provided by park personnel, the elm and juniper trees were planted in 1952 or soon after, and the cottonwoods have their origin in cottonwoods planted a century ago at the Agate Springs Ranch. No collections were made on the privately owned and grazed grassland within the park.

Lichen collections were made at 11 localities and 235 collections were made.

AGATE FOSSIL BEDS SPECIES LIST

*Acarospora americana Magn.
*Acarospora stapfiana (Müll. Arg.) Hue
*Acarospora strigata (Nyl.) Jatta
*Arthonia intexta Almqu.
*Aspicilia contorta (Hoffm.) Kremp. **RARE**
Caloplaca atroalba (Tuck.) Zahlbr.
Caloplaca citrina (Hoffm.) Th. Fr.
*Caloplaca decipiens (Arn.) Blomb. & Forss.
Caloplaca flavovirescens (Wulf.) Dalla Torre & Sarnth. **RARE**
I Caloplaca holocarpa (Hoffm.) Wade
*Caloplaca saxicola (Hoffm.) Nordin
Caloplaca trachyphylla (Tuck.) Zahlbr.
I-T *Caloplaca vitellinula (Nyl.) Oliv.
*Candelariella aurella (Hoffm.) Zahlbr.
*Candelariella deflexa (Nyl.) Zahlbr.
*Candelariella rosulans (Müll. Arg.) Zahlbr.
*Candelariella subdeflexa (Nyl.) Lett. **RARE**
*Catapyrenium lacinulatum (Ach.) Breuss
Cladonia pyxidata (L.) Hoffm. **RARE**
Collema tenax (Sw.) Ach.
Dermatocarpon moulinsii (Mont.) Zahlbr. **RARE**
*Diplotomma venustum (Körb.) Körb.
Endocarpon pusillum Hedw.
Fulgensia bracteata (Hoffm.) Räs.
Fulgensia subbracteata (Nyl.) Poelt

*Lecanora argopholis (Ach.) Ach. **RARE**
T *Lecanora dispersa (Pers.) Somm.
Lecanora garovaglii (Körb.) Zahlbr.
T Lecanora muralis (Schreb.) Rabenh.
*Lecanora piniperda Körb. **RARE**
*Lecanora rupicola (L.) Zahlbr. **RARE**
Lecidea tessellata Flörke **RARE**
*Lecidella stigmatea (Ach.) Hert. & Leuck.
*Lichinella nigritella (Lett.) Moreno & Egea **RARE**
*Lobothallia alphoplaca (Wahlenb.) Haffeln.
*Parmelia lavicola (Gyeln.) **RARE**
*Parmelia somloensis Gyeln. **RARE**
Peltula patellata (Bagl.) Swins. & Krog
Phaeophyscia chloantha (Ach.) Moberg **RARE**
*Phaeophyscia melanchra (Hue) Hale **RARE**
I Physcia adscendens (Th. Fr.) Oliv. **RARE**
T *Physcia dubia (Hoffm.) Lett. **RARE**
*Polysporina simplex (Dav.) Vezda
*Psora cerebriformis W. Weber
Psora decipiens (Hedwig) Hoffm.
*Psora tuckermanii R. Anders. ex Timdal
*Rhizoplaca chrysoleuca (Sm.) Zopf **RARE**
Rhizoplaca melanophthalma (DC. in Lam. & DC.) Leuck. & Poelt **RARE**
*Rhizoplaca subdiscrepans (Nyl.) R. Sant. **RARE**
*Rinodina archaea (Ach.) Arn. **RARE**
Rinodina bischoffii (Hepp) Mass.
*Sarcogyne regularis Körb.
Staurothele drummondii (Tuck.) Tuck.
*Staurothele elenkinii Oksn.
*Staurothele monicae (Zahlbr.) Wetm.
Toninia sedifolia (Scop.) Timdal
Toninia tristis (Th. Fr.) Th. Fr. **RARE**
*Verrucaria calciseda DC.
*Verrucaria fuscella (Turn.) Winch
*Verrucaria glaucovirens Grumm.
*Verrucaria muralis Ach.
Xanthoria elegans (Link) Th. Fr.
I Xanthoria hasseana Räs. **RARE**
Xanthoria sorediata (Vain.) Poelt **RARE**
* = new state record

DISCUSSION OF LICHEN FLORA

This lichen list of 64 species significantly increases the known lichen flora of Sioux County (Egan et al. 1995). Only seven lichens were known from the county prior to this study although none of these were know from the park. In addition 38 new state records are present in the park (indicated by "*" in the list). The presence of calcareous rocks and soil provides a good habitat for many lichens. The

few trees limits the numbers of species as does the low precipitation. In most places in the prairie and in the river bottom the dense vascular plant vegetation present too much competition for lichens but some of the ridges with thin soil provide satisfactory habitats for soil lichens.

The most common species were Acarospora stapfiana, Caloplaca decipiens, Caloplaca trachyphylla, Candelariella rosulans, Lecidella stigmatea, Verrucaria muralis, and Xanthoria elegans.

The locality with the greatest number of Rare lichens was locality 4 (Daemonelix site) with 11 Rare species, followed by locality 3 (Around residence in Niobrara River bottom) with six species. The Daemonelix site (locality 4) was unique because of the non-calcareous rocks, and the residence site (locality 3) was special because it was the only site with trees. These areas deserve special protection. Admitedly, the trees around the residence are planted, but they should be preserved if the species are to saved.

AGATE FOSSIL BEDS NATIONAL MONUMENT COLLECTION LOCALITIES

Collection numbers are those of Clifford Wetmore. All collections are listed in ascending order by number and date of collection. All localities are in Sioux County, Nebraska. The latitude and longitude were taken by GPS unit at each of the collection sites.

Loc. 1. #77758-77771 NW of headquarters along dirt road to wells. On cliffs and ridge, elev. 4500 ft. Sec. 4, T28N, R55W, 42°25'38"N, 103°44'29"W. 7 July 1997.

Loc. 2. #77772-77786 W of headquarters at S end of ridge near road. On cliffs at end of ridge, elev. 4480 ft. Sec. 4, T28N, R55W, 42°25'33"N, 103°44'47"W. 7 July 1997.

Loc. 3. #77787-77794 Around residence in Niobrara River bottom W of headquarters. On hedge trees of elm, juniper & cottonwood, elev. 4400 ft. Sec. 9,

T28N, R55W, 42°25'13"N, 103°44'29"W. 7 July 1997.

Loc. 4. #77795-77820 At W end of park above Daemonelix Trail. On cap rocks of buttes, elev. 4480 ft. Sec. 6, T28N, R55W, 42°25'41"N, 103°47'07"W. 7 July 1997.

Loc. 5. #77821-77843 Carnegie Hill S of visitors center. Around top of butte on hard rock, elev. 4600 ft. Sec. 10, T28N, R55W, 42°24'59"N, 103°43'36"W. 8 July 1997.

Loc. 6. #77844-77856 University Hill S of visitors center. Around top of butte, elev. 4580 ft. Sec. 10, T28N, R55W, 42°25'01"N, 103° 43'41"W. 8 July 1997.

Loc. 7. #77857-77877 Stenomylus Quarry unit SE of main park unit. Bluffs with sandstone cap, elev. 4620 ft. Sec. 12, T28N, R55W, 42°24'38"N, 103°41'38"W. 8 July 1997.

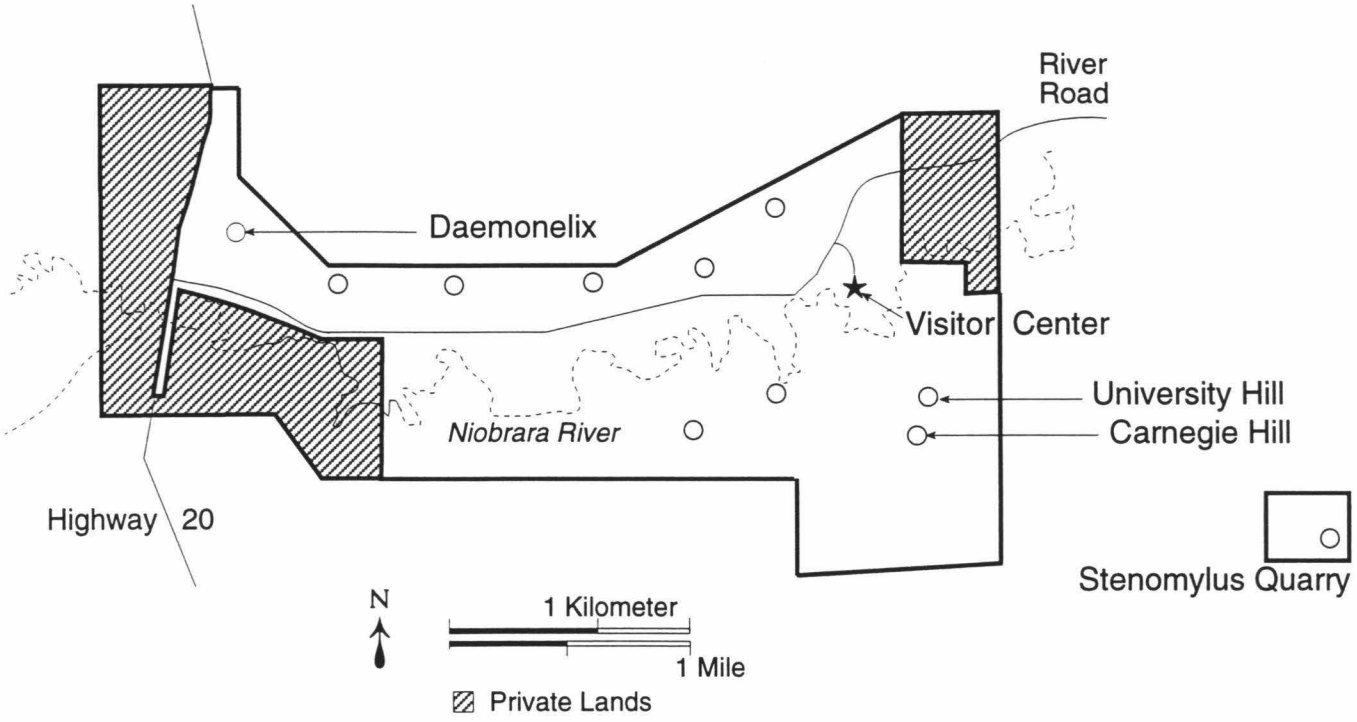
Loc. 8. #77878-77893 1 mile W of headquarters on N side of road. On end of ridge with no hard cap rock, elev. 4500 ft. Sec. 4, T28N, R55W, 42°25'31"N, 103°45'26"W. 9 July 1997.

Loc. 9. #77894-77915 1.5 mile W of headquarters on N side of road. On end of ridge with hard cap rock, elev. 4530 ft. Sec. 5, T28N, R55W, 42°25'34"N, 103°46'03"W. 9 July 1997.

Loc. 10. #77916-77948 1 mile W of Carnegie Hill on S side of road. On bluff at N end of ridge with little hard rock cap, elev. 4540 ft. Sec. 9, T28N, R55W, 42°24'60"N, 103°44'51"W. 9 July 1997.

Loc. 11. #77949-77972 1 mile E of entrance on N side of road. On ridge with hard rock chips, elev. 4520 ft. Sec. 5, T28N, R55W, 42°25'30"N, 103°46'32"W. 9 July 1997.

Agate Fossil Beds National Monument



ELEMENTAL ANALYSIS

This sensitive method of indicating the presence of air pollution could not be used in either of these parks. The best lichens for elemental analysis are common foliose or fruticose species growing on trees. Lichens on rocks and soil are less efficient accumulators of air pollutants. There were few trees in either park and adequate quantities of suitable species were not present.

COMPARISON OF LICHEN FLORAS OF BOTH PARKS

The lichen floras of these two parks are very similar. There were 41 species common to both parks. Many of the species found only in Scotts Bluff were because of the numerous trees present. Most of the species found only in Agate Fossil Beds were found on the non-calcareous rocks at the Daemonelix site.

CONCLUSIONS FROM THE STUDY OF BOTH PARKS

This report includes numerous new county records for Nebraska and some new state records. The species reported will significantly contribute to the knowledge of the biodiversity of these parks and the state. The lichen floras of these parks are typical of the western prairies and these studies provide important baselines for this part of the prairies.

There are no indications that the lichens of the three parks are being damaged by sulfur dioxide or the other elements studied. The lichen flora is diverse for such areas and there is no impoverishment of the lichen flora in any park. The rarity of some species seems to be due more to ecological and climatic conditions than pollution since these species are quite healthy when present. There is no evidence of damaged or dead lichens in any area where healthy ones are not also present.

RECOMMENDATIONS

These recommendations apply to both parks.

A complete floristic restudy should be done every 10-15 years.

The localities with numerous rare lichens should receive special protection to

prevent loss of species.

Lichens are easily killed by fires however, if moderate sized areas (20 acres?) are burned rather than large areas (100 acres?) the lichens can recolonize the burned areas before the next prescribed burn. Most of the lichens on the rocks and higher on the trees will not be damaged by low intensity fires. There were few lichens in the grasslands of the parks so the lichen floras will probably not be damaged by moderate sized prescribed burns.

If plans are developed to do extensive trail construction or maintenance in the parks, a lichenologist should be consulted to help design the work so that rare lichens are not lost.

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