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LICHENS OF BADLANDS NATIONAL PARK, SOUTH DAKOTA, USA

Susan Will-Wolf
Department of Botany
University of Wisconsin
430 Lincoln Drive
Madison, Wisconsin 53706-1381

Abstract

One hundred seventy-one species of lichens and lichenicolous fungi are reported from Badlands National Park, South Dakota, USA, from collections spanning several years. *Macentina dictyospora* Orange is a genus and species new to North America. Several species represent major range extensions. The lichen flora is moderately similar to two other well-collected areas in the region; 77% of the species reported here are shared with those areas. The three major lichen substrates available are calcareous rock, bark and wood, and prairie soil. Two uncommon habitats contribute disproportionately to park lichen diversity: deciduous and conifer tree groves near permanent surface water, and conifer-mixed grass "savanna" on high buttes.

Introduction

Badlands National Park (BNP) is located in southwestern South Dakota, USA, 80-160 km (50-100 mi) east of the southern Black Hills (BH) and in their rain shadow. The park encompasses about 985.5 km^2 (244,000 acres), about equally divided into North and South Units (Figure 1) connected by a narrow neck of the park crossed by South Dakota Highway 44. Part of the South Unit, the Palmer Creek Area, is separated from the rest of the park. The park extends about 110 km (70 mi) east to west, and almost 50 km (30 mi) north to south in its western part in a broad, irregular arc. Elevation ranges from a low of 730 m in the lowest flats to almost 1000 m at several high pinnacles or buttes; average relief between high grassland or butte tops and low grassland is 100-250 m.

The climate of BNP is semiarid continental, with an average annual rainfall of 406 mm (16 in). Summers are hot, with an average of 13 days with highs over 38°C (100°F), though July and August nights average 17°C (62°F). Winters are cold, with an average of 18 days with highs below -18°C (0°F). Average growing season is 152 frost free days (Hauk 1969).

Permanent surface water is found at only a few places in the park. A few small permanent natural ponds and springs are widely scattered. Sage Creek flows continuously in most years from the northwestern part of the park. The permanent White River flows through about 3.5 km (2 mi) of the southern edge of the park. Other streams and ponds dry up seasonally, with water available under the surface for rooted plants.

The park includes the largest protected mixed grass prairie in the United States, interspersed with steep unvegetated butte slopes and spires and sparsely vegetated gentler slopes and erosion flats. Woody vegetation is uncommon in the park. With the exception of widespread sagebrush (*Artemisia* spp.) and other grassland shrubs, woody vegetation is found mostly in protected draws and in the vicinity of seasonal or permanent surface water. The most common and widespread tree is juniper or redcedar (hybrids between rocky mountain juniper, *Juniperus scopulorum* Sarg. and eastern redcedar *J. virginiana* L.), with the deciduous shrubs chokecherry (*Prunus virginiana* L.) and skunkbush sumac (*Rhus aromatica* Ait. var. *trilobata* (Nutt.) A. Gray) in protected draws. Ponderosa pine (*Pinus ponderosa* Laws.) occurs with juniper on a few high buttes. Cottonwood (*Populus deltoides* Marsh subsp. *monilifera* (Ait.) Eckenw.) is found in stream beds and pond areas, sometimes with green ash (*Fraxinus pennsylvanica* Marshall), elms (*Ulmus* sp.), and deciduous shrubs. Vascular plant names follow Great Plains Flora Association (1986). Woody vegetation occasionally forms small dense thickets, but these are never large enough to be called forests. In the past occasional fires swept the plains, limiting woody vegetation to protected areas. Fire suppression since the 1930's has allowed

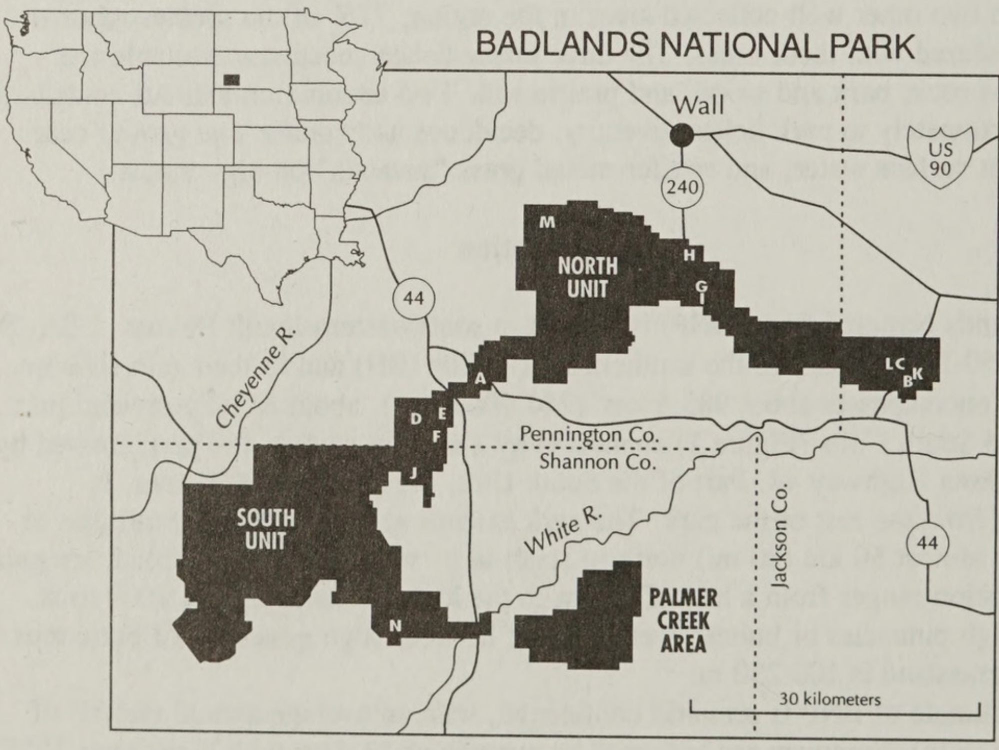

Figure 1. Badlands National Park and vicinity showing the general location of collecting areas, designated by letters (see text). B and K together comprise the Millard Ridge area, J marks Cedar Butte, and M marks the Sage Creek area.

expansion of woody growth. Fire is being reintroduced with prescribed burns for management of some park areas, with the expectation that woody growth will be reduced in those areas.

Available substrates for lichens in BNP include woody plants, rocks, and ground in sparse grassland. Woody plants (described above) grow slowly, so all but the smallest provide a long-lived surface for lichen colonization. Rocks are almost exclusively sedimentary. The Eocene age Chadron formation and Oligocene age Brule formation are mostly soft, easily erodable mudstones with clay-size particles. These rocks provide relatively short-duration mineral substrates for lichens. Both include layers of slightly harder sandstone with calcareous cement. Some of the sandstone deposits include pebble- to cobble-sized stones and have relatively hard cement; these channel sandstones erode more slowly and have more durable surfaces than other rocks. Moderately hard tufa layers (consolidated volcanic ash) are interspersed with other rocks. All of these rocks include calcium carbonate minerals which evolve CO_2 when treated with hydrochloric acid (HCl+ reaction). The Cretaceous age Pierre shales have different chemistry, but they also react weakly HCl+, indicating the availability of cations useful as mineral nutrients. Park soils are all derived from these formations and are neutral to alkaline in chemistry. The most common non-calcareous rock is chalcedony (a silicious solution deposit) which appears on the ground surface as thin, light fragments which are mobile and so provide mostly short-duration substrate for lichens. Waterworn silicate and granitic gravels originating from the Black Hills to the west include heavier and more stable cobbles. They accumulate on the surface in small, widely scattered "desert pavement" areas throughout the park.

Very little lichen collecting was done in the park before this study; only four lichens were officially recorded for the park as of 1988 (Bessken, personal communication.

Methods

I spent several days each year collecting in BNP in 1988, 1990, and 1991, with two days in 1992. During this time I collected from thirteen different areas in the park (Figure 1), selected in collaboration with park personnel to represent a wide range of potential habitats and substrates for lichens. At each area I collected vouchers for all lichen species seen, from all substrates available. Particularly lichen-rich areas were revisited several times. I recorded substrate and habitat for each specimen collected, and noted abundance of species which could be recognized in the field. No formal sample design was adopted, nor was any attempt made to quantify abundance. In all, 822 collections were made; about 90% of them are represented in this publication. Location, elevation and description of collecting areas are listed by letter below with collection years; general locations are marked by letters on the map in Figure 1.

A: Lat.42°45'N,Long.102°30'W; T3S,R13E,E1/4Sec25; 840 m; Brule mudstone slopes and sparsely vegetated erosion slopes; 1988,1992.

B: Lat.43°45'N,Long.101°56'W; T3S,R18E,SW1/4Sec26; 800 m; Cliff Shelf Nature Trail area: juniper and deciduous wooded groves with a permanent pond, Brule mudstone; 1991.

C: Lat.43°46'N,Long.101°57'30"W; T3S,R18E,E1/4Sec22; 800 m; Brule mudstone slopes and sparsely vegetated erosion flats; 1988.

D: Lat.43°43'15"N,Long.102°34'45"W; T4S,R13E,NE1/4Sec8; 890 m; sparsely vegetated erosion flats, mixed grass prairie; 1988,1990.

E: Lat.43°43'20"N,Long.102°31'45"W; T4S,R13E,NW1/4Sec11; 860 m; Brule sandstone outcrops and sparsely vegetated erosion flats; 1988.

F: Lat.43°41'20"N,Long.102°34'5"W; T43N,R44W,NE1/4Sec21; 960 m; wooded draw off Sheep Mountain, N of county line; 1988.

G: Lat.43°50'40"N,Long.102°11'30"W; T2S,R16E,NW1/4Sec27; 820 m; weathered Pierre shale slopes with sandstone nodules; 1988.

H: Lat.43°52'10" N,Long.102°13'30"W; T2S,R16E,SE1/4Sec17; 940 m; juniper grove; 1988.

I: Lat.42°49'45"N,Long.102°11'45"W; T2S,R16E,NW1/4Sec34; 780 m; deciduous tree grove, bank of dry stream; 1988.

J: Lat.43°40'30"N,Long.102°35'W; T43N,R44W,Sec29; 980-990 m; top of Cedar Butte: mixed grass prairie and conifer groves; 1990, 1991.

K: Lat.43°46'N,Long.101°55'45"W; T3S,R18E,SW1/4Sec26; 750-850 m; Millard Ridge area: ridgetops and steep, narrow canyons with sparse vegetation in Brule mudstone and sandstone, sparsely vegetated erosion flats; 1990,1991.

L: Lat.43°46'N,Long.101°57'W; T3S,R18E,Sec21,22; 800-810 m; Medicine Root Trail area: mixed grass prairie, sparsely vegetated erosion flats, Brule mudstone slopes, and silicious gravel deposits; 1990,1991.

M: Lat.43°54'N,Long.102°25'W; T2S,R14E,Sec1,2; 780-830 m; Sage Creek valley: mixed conifer-deciduous wooded draws, mixed grass prairie, silicious gravel deposits, Chadron mudstone slopes, weathered Pierre shale slopes with nodules and rock outcrops, deciduous tree groves on banks of permanent stream; 1990,1991,1992.

N: Lat.43°31'15"N,Long.102°36'30"W; T41N,R44W,SW1/4Sec18,N1/2Sec19; 860-930 m; Fog Creek area: mixed conifer-deciduous wooded groves near small permanent stream, mixed grass prairie, sparsely vegetated erosion flats; 1991.

Identifications were made at the University of Wisconsin-Madison, with the exception of specimens sent to other lichenologists for identification or confirmation, as noted in the species list below. Chemical contents were checked when necessary with microcrystal tests for *Cladonia* (Thomson 1967; Hale 1979) and thin-layer chromatography with solvent A (White & James 1985) for other groups; results are noted in brief after listed species. A complete set of vouchers has been deposited in WIS, and an almost-complete set of duplicates has been deposited in the Herbarium of Badlands National Park.

List of Species

A total of 167 lichen species and four species of lichenicolous fungi are reported for BNP, based mostly on my collections. In addition, one species of ascomycete fungus which strongly resembles a lichen is reported at the end of the list. Collection localities and substrates are reported for each species, and a representative specimen in WIS is cited as a Will-Wolf collection number, with its location letter (see Figure 1) when needed. Two species not also collected by me are included in brackets. In addition to these species, about 15 taxa remain unidentified, including two *Caloplaca* species (*fide* Wetmore) and two *Rinodina* species (*fide* Sheard). Names for lichens and lichenicolous fungi follow Esslinger and Egan (1995) except where noted. Species also reported from Theodore Roosevelt National Park (TRNP: Wetmore 1985) and the Black Hills (BH: Wetmore 1967, personal communication) are marked with subscripts (see notes at end of list). Nomenclatural synonomy reported in Esslinger and Egan (1995) was used to compare the species list below with those of Wetmore (1967, 1985).

Species Name	**Areas**	**Substrate**[c]
Acarospora arenacea H. Magn., 2000	A	si
[b]*Acarospora badiofusca* (Nyl.) Th. Fr., 2507	N	si
Acarospora nevadensis H. Magn., 2807	M	si
Acarospora californica Zahlbr., M:2806	KMN	ca,si
[b]*Acarospora glaucocarpa* (Ach.) Körber, 2600.	B	ca
Acarospora coloradiana H. Magn., 2019.	C	ca
Acarospora fuscescens H. Magn., 2601.	B	ca
[ab]*Acarospora schleicheri* (Ach.) A. Massal., K:2158.	CK	ca
[b]*Acarospora strigata* (Nyl.) Jatta, C:2020.	CM	ca
Acarospora veronensis A. Massal., A:2002.	AN	ca
[ab]*Agrestia hispida* (Mereschk.) Hale & Culb., M:2329.	BM	g
[ab]*Amandinea punctata* (Hoffm.) Coppins & Scheid., B:2618.	BJN	ca,b(c)
[ab]*Arthonia lapidicola* (Taylor) Branth & Rostrup, C:2022.	CEL	ca
[b]*Aspicilia calcarea* (L.) Mudd, M:2353.	AGM	ca,si

This species was distinguished from the following two using the characters listed below (based on species descriptions, assorted keys, and specimens in WIS):

	A. calcarea	A. contorta	A. desertorum
Thallus morphology	Areoles always contiguous.	Areoles isolated to partly contiguous.	Contiguous areolate to radiate at margins.
	-- Areoles flat (partly concave) to -- -- centrally elevated, not bullate.--		Areoles convex to bullate.
Thallus color	--Thallus white to pale gray.--		Thallus tan to brown.
	Thallus epruinose.	Thallus pruinose.	Thallus epruinose.
Apothecia	-- Apothecia single in areoles, -- -- pruinose margin often prominent.--		Apothecia single to grouped in areoles.

Wetmore (personal communication) thinks most North American A. calcarea specimens belong in A. contorta; the two taxa are kept separate here pending a published study because this group is notoriously difficult.

[a]*Aspicilia contorta* (Hoffm.) Kremp., 2369.	L	ca
Aspicilia desertorum (Kremp.) Mereschk., M:2671.	ALMN	ca,si
[b]*Aspicilia laevata* (Ach.) Arnold, 2232.	M	ca

[ab]*Bacidia bagliettoana* (Massal. & deNot.) Jatta, D:2482.	DJM	o
[b]*Bacidia beckhausii* Körber, J:2417.	JN	b(c,d)
[b]*Bacidia herbarum* (Stizenb.) Arnold, 2463.	J	o
Bacidia schweinitzii (Fr. *ex* Michener) A. Schneider, 2631.	B	b(d)
[a]*Buellia elegans* Poelt, M:2805.	MD	g
Buellia schaereri DeNot., 2715.	J	b(c)
Buellia turgescens Tuck., B:2610. (Det. Sheard)	BJ	b(c)
Buelliella minimula (Tuck.) Fink, K:2161.	CDGK	p:ca
Lichenicolous on *Caloplaca atroalba* and other crustose spp.		
[b]*Caloplaca approximata* (Lynge) H. Magn., K:2162.	KLM	ca,si
[a]*Caloplaca atroalba* (Tuck.) Zahlbr., K:2167. (Det. Wetmore) One bark specimen, very unusual for this species.	ABCDGJK LMN	ca,si,b(d)
[ab]*Caloplaca cerina* (Hedwig) Th. Fr., M:2286.	BCMN	o,b(c,d)
Caloplaca dakotensis Wetmore, 2425. (Det. Wetmore)	J	b(c)
[ab]*Caloplaca decipiens* (Arnold) Blomb. & Forss., K:2790. Also reported by Wetmore (1967).	CKLM	ca
[b]*Caloplaca ferruginea* (Hudson) Th. Fr., I:2121.	IK	b(d)
[a]*Caloplaca flavorubescens* (Hudson) J.R. Laundon, I:2119	IJ	b(c,d)
Caloplaca fraudans (Th. Fr.) H. Olivier, L:2373.	KLM	ca
[ab]*Caloplaca holocarpa* (Hoffm. *ex* Ach.) M. Wade, M:2287.	ABDIKMN	o,b(c,d)
Caloplaca cf invadens gp., not *castellana* (Räsänen) Poelt., 2026. (Det. Poelt). - Lichenicolous on *Caloplaca trachyphylla*.	C	p:ca
Caloplaca lactea (Massal.) Zahlbr., L:2695.	LM	ca
[ab]*Caloplaca microphyllina* (Tuck.) Hasse, J:2424.	BJMN	b(c,d)
[ab]*Caloplaca saxicola* (Hoffm.) Nordin, K:2144.	CKM	ca,b(c)
(Det. Wetmore) All specimens have a subsquamulose growth form and tan upper surface (possibly pruina) unusual for this species; one specimen on bark. Similar to *Caloplaca lobulata* (Flörke) de Lesd.		
[a]*Caloplaca trachyphylla* (Tuck.) Zahlbr., C:2028.	CKM	ca
[ab]*Caloplaca ulmorum* (Fink) Fink, 2075.	F	b(c)
[ab]*Candelaria concolor* (Dickson) Stein, F:2083.	FJMN	b(c,d)
[ab]*Candelariella aurella* (Hoffm.) Zahlbr., L:2374.	ABCEFHKL	ca,b(c)
[a]*Candelariella deflexa* (Nyl.) Zahlbr., M:2289.	BCDEFIJ KMN	ca,b(c,d)
[a]*Candelariella efflorescens* R.C. Harris & W.R. Buck, 2428.	J	b(c)
[a]*Candelariella subdeflexa* (Nyl.) Lettau, F:2078.	BFKMN	b(c,d)
Candelariella terrigena Räsänen, 2394.	J	g
[ab]*Candelariella vitellina* (Hoffm.) Müll. Arg., 2095.	G	ca
Catapyrenium compactum (Massal.) R. Sant., 2792.	K	ca
[b]*Catapyrenium daedalum* (Krempelh.) Stein, 2702.	L	g
[ab]*Catapyrenium lachneum* (Ach.) R. Sant., A:2006.	ADIKLMN	g
[ab]*Catapyreneum plumbeum* (de Lesd.) J.W. Thomson,	CDM	ca,g

C:2032.		
Catapyrenium schaereri (Fr.) R. Sant., L:2375.	LM	ca
[b]*Catillaria chalybeia* (Borrer) A. Massal., 2376.	L	ca
[a]*Catillaria nigroclavata* (Nyl.) Schuler, J:2719.	FJM	b(c)
[ab]*Cladonia chlorophaea* (Flörke *ex* Sommerf.) Sprengel, 2397. fumarprotocetraric acid only, in GE	J	g
Cladonia cryptochlorophaea Asah., 2430. cryptochlorophaeic acid in GE	J	g,b(c)
[ab]*Cladonia fimbriata* (L.) Fr., 2058.	F	g
[ab]*Cladonia macilenta* var. *bacillaris* (Genth) Schaerer, 2429.	J	b(c)
Cladonia merochlorophaea Asah., merochlorophaeic acid + (J:2395) and - (F:2059) fumarprotocetraric acid in GE	DFJM	g
Cladonia pocillum (Ach.) Grognot, N:2496. fumarprotocetraric acid only, in GE	KN	g
Cladonia polycarpoides Nyl., 2781.	J	g
[ab]*Cladonia robbinsii* A. Evans (sterile), 2492. usnic + barbatic acids in GE	D	g
[ab]*Cladonia subulata* (L.) F. H. Wigg, 2784.	J	g
[b]*Cladonia sulphurina* (Michaux) Fr., 2785.	J	g
[ab]*Collema cf coccophorum* Tuck. (sterile), A:2007.	AHN	g
[ab]*Collema furfuraceum* (Arnold) Du Rietz, 2431.	J	b(c)
[b]*Collema subflaccidum* Degel., N:2530.	JN	b(c,d)
[ab]*Collema tenax* (Swartz) Ach., L:2359.	ABHIKL	g
[ab]*Cyphelium notarisii* (Tul.) Blomb. & Forss., J:2405.	JM	b(c)
Dactylospora inquilina (Tuck.) Hafellner, 2721. Lichenicolous on *Lecanora* sp.	J	p:b(c)
[ab]*Diploschistes scruposus* (Schreber) Norman, J:2466.	DIJLN	o,b(c)
Diplotomma epipolium (Ach.) Arnold, M:2341.	ACDGKMN	ca,si
[ab]*Endocarpon pusillum* Hedwig, L:2361.	BKL	g
[ab]*Flavopunctelia flaventior* (Stirton) Hale, J:2436.	HJMN	b(c)
[ab]*Flavopunctelia soredica* (Nyl.) Hale, J:2437.	FHJMN	b(c)
[ab]*Fulgensia bracteata* (Hoffm.) Räsänen, J:2467.	DHJKLN	g
[ab]*Fulgensia fulgens* (Swartz) Elenkin, K:2183.	DIJKLN	g
[ab]*Heppia lutosa* (Ach.) Nyl., L:2355.	JKLMN	g
[a]*Hyperphyscia adglutinata* (Flörke) Mayrh. & Poelt, M:2661.	FJKMN	b(c)
[b]*Lecania dubitans* (Nyl.) A.L. Sm., B:2643.	BN	b(d)
[ab]*Lecania erysibe* (Ach.) Mudd, A:2009.	ACN	ca
[a]*Lecania fuscella* (Schaerer) Körber, D:2045.	ADK	b(d)
[ab]*Lecanora chlarotera* Nyl., H:2110.	HJM	b(c)
Lecanora circumborealis Brodo & Vitik., J:2726. TLC: atranorin, roccellic acid.	JMN	b(c)
Lecanora crenulata Hook, A:2011.	ABDEGJ KMN	ca,si
[ab]*Lecanora dispersa* (Pers.) Sommerf., N:2515.	JKN	ca,si
[ab]*Lecanora hagenii* (Ach.) Ach., N:2531. TLC, typical collections: unknown UVL white spots at RF5-6.	BDFHIJ KMN	b(c,d)

Four collections, *e.g.* J:2763, also have gangaleoidin.

[ab]*Lecanora impudens* Degel., J:2441. JN b(c,d)

[ab]*Lecanora muralis* (Schreber) Rabenh., 2514. N si

[ab]*Lecanora piniperda* Körber, N:2546. BN b(d)

Lecanora meridionalis H. Magn., 2409. J b(c)

TLC: atranorin, roccellic, gangaleoidin.

Lecanora salicicola H. Magn., 2730. J b(c)

[b]*Lecanora symmicta* (Ach.) Ach., J:2731. JN b(c,d)

[*Lecidella anomaloides* (Massal.) Hertel & R. Kilias] --- -----

Wetmore 10125 in MIN, collected 1960.

[ab]*Lecidella euphorea* (Flörke) Hertel, J:2767. FHJKMN b(c,d)

[a]*Lecidella patavina* (Lynge) Hertel & Leuck., K:2141. ACK ca,si

[b]*Lempholemma cf.albonigrum* (sterile), J:2402. DJ g,o

Lichinella minnesotensis (Fink) Essl., E:2089. EK ca

[ab]*Lobothallia alphoplaca* (Wahlenb.) Hafellner, 2808. M si

Macentina dictyospora Orange, det. Coppins, M:2302 MN b(c,d)

Genus and species new to North America. *Macentina* Vezda (Verrucariaceae) has tiny, pale globose perithecia with no involucrellum, pale elongated cells in vertical x-section of the exciple, disappearing paraphyses, periphyses present, asci clavate with an ocular chamber, and 8 colorless, septate spores/ascus (Coppins & Vezda 1977). My four collections have finely granular-verrucose crustose thalli, 0.1-0.2 mm wide perithecia, submuriform spores 17-23 x 6-9 μm, and hymenial gelatin I+ red, K/I+ blue, consistent with *M. dictyospora* (Orange 1991). Specimens were found on the edges of bark plates of medium to large trees (willow, elm, juniper) in moist wooded draws.

[ab]*Megaspora verrucosa* (Ach.) Hafellner & V. Wirth, 2449. J b(c)

[b]*Melanelia elegantula* (Zahlbr.) Essl., 2734. J b(c,d)

Melanelia infumata (Nyl.) Essl., 2444. J b(c)

[ab]*Melanelia subargentifera* (Nyl.) Essl., J:2445. BDJ o,b(c)

[a]*Melanelia subolivacea* (Nyl.) Essl., 2770. J b(c)

Melaspilea sp., 2590 N p:w(c)

Lichenicolous on unidentified granular crustose lichens. This is probably a new species. In common with *M. tribuloides* (Tuck.) Müll. Arg. (see Fink 1935), my specimens have lirellate fruits, carbonaceous exciple and epithecium, pale hymenium, unevenly 2-celled spores 14-18 x 7-8 μm and 8/ascus, and asci with I- apical dome 5 μm thick and I+ red contents when young. The type of *M. tribuloides* (FH: Tuckerman, no #, Texas, as *Opegrapha tribuloides*) has an I-, K/I- (greenish yellow) hymenium, saccate asci, and spores darkening to brown in the ascus. In contrast, my #2590 has I+ blue hymenium, clavate asci, and spores remaining hyaline.

[b]*Micarea peliocarpa* (Anzi) Coppins & R. Sant., 2736. J b(c)

Ochrolechia androgyna (Hoffm.) Arnold (sterile), 2737. J b(c)

[ab]*Parmelia sulcata* Taylor, J:2446. JN b(c)

[b]*Peccania arizonica* (Tuck.) Herre, 2504. N g

[b]*Peccania texana* (Tuck.) Wetmore, N:2505. LN g

[ab]*Peltigera canina* (L.) Willd., 2788.	J	g
[b]*Peltigera didactyla* (With.) J.R. Laundon, 2448.	J	g
[ab]*Peltigera rufescens* (Weiss) Humb., J:2470.	FJ	g
[ab]*Peltula patellata* (Bagl.) Swinscow & Krog, 2356.	L	g
[ab]*Pertusaria saximontana* Wetmore, 2447.	J	b(c)
[a]*Phaeophyscia cernohorskyi* (Nadv.) Essl., M:2300.	BFJKMN	b(c,d)
[b]*Phaeophyscia ciliata* (Hoffm.) Moberg, 2113.	H	b(c)
[ab]*Phaeophyscia nigricans* (Flörke) Moberg, I:2124.	IM	b(c,d)
[ab]*Phaeophyscia orbicularis* (Necker) Moberg, I:2125.	IK	b(c,d)
Phaeophyscia pusilloides (Zahlbr.) Essl., 2584.	N	b(c,d)
[ab]*Physcia adscendens* (Fr.) H. Olivier, F:2073.	FIJKMN	b(c,d)
[ab]*Physcia aipolia* (Ehrh. *ex* Humb.) Fürnr., F:2084.	FKM	b(c,d)
[b]*Physcia americana* G. Merr., 2114.	H	b(c)
[a]*Physcia bizania* (Massal.) Zahlbr., J:2452.	BJMN	o,b(c,d)
[ab]*Physcia dimidiata* (Arnold) Nyl., J:2453.	JN	b(c)
[a]*Physciella chloantha* (Ach.) Essl., K:2236.	FK	b(c,d)
[a]*Physciella melanchra* (Hue) Essl., M:2257.	FMN	b(c,d)
[b]*Physconia enteroxantha* (Nyl.) Poelt, J:2454. (Det. Esslinger)	JN	b(c)
Physconia perisidosa (Erichsen) Moberg, F:2081. (Det. Esslinger)	FJ	b(c)
[b]*Polychidium muscicola* (Sw.) S. Gray, 2456.	J	o,b(c)
[ab]*Polysporina simplex* (Davies) Vezda, A:2014.	ACEJKLMN	ca,si
[ab]*Psora decipiens* (Hedwig) Hoffm., A:2015.	ADIJKLN	g
[b]*Psorotichia schaereri* (Massal.) Arnold, M:2679.	JM	ca
Pyrenopsis cf phaeococca Tuck., 2211.	K	ca
Rinodina castanomela (Nyl.) Arnold, K:2173. (Det. Sheard)	ACKLM	ca,si
[ab]*Rinodina colobina* (Ach.) Th. Fr., 2588. (Det. Sheard)	N	b(c)
[a]*Rinodina mucronatula* H. Magn., 2196. (Det. Sheard)	K	g
[ab]*Rinodina pyrina* (Ach.) Arnold, F:2088. (Det. Sheard)	ABFIJKMN	b(c,d)
[a]*Rinodina riparia* Sheard, N:2536. (Sheard 1998; Det. Sheard)	FN	b(c,d)
[*Rinodina zwackhiana* (Kremp.) Körber] Reported by Anderson (1962).	---	----
Ropalospora chlorantha (Tuck.) S. Ekman, 2418.	J	b(c)
Sarcogyne novomexicana H. Magn., M:2345.	LMN	ca,si
[ab]*Sarcogyne regularis* Körber, K:2154.	JKM	ca
[a]*Squamarina lentigera* (Weber) Poelt, D:2051.	DILN	g
[ab]*Staurothele drummondii* (Tuck.) Tuck., C:2041. Also Wetmore 10120 in MIN, collected 1960.	BCDGJK LMN	ca,si
[ab]*Staurothele elenkinii* Oxner, C:2040.	CJKM	ca
[a]*Staurothele monicae* (Zahlbr.) Wetmore, C:2039.	CDGJKM	ca
[b]*Strangospora microhaema* (Norman) R. Anderson, 2117.	I	b(d)
[b]*Strangospora cf moriformis* (Ach.) Stein, 2665.	M	b(c)
Strangospora ochrophora (Nyl.) R. Anderson, 2647.	B	b(d)
Thelidium olivaceum (Fr.) Körber, 2518.	N	ca

[ab]*Toninia sedifolia* (Scop.) Timdal, D:2052. DJKL g
[ab]*Trapeliopsis granulosa* (Hoffm.) Lumbsch., 2774. J b(c)
[ab]*Usnea hirta* (L.) F. H. Wigg., J:2457. FJ b(c)
Verrucaria calkinsiana Servít, 2476. J ca
[b]*Verrucaria fuscella* (Turner) Winch, M:2348. CKLM ca
[a]*Verrucaria muralis* Ach., K:2177. KM ca
Verrucaria cf. muralis Ach., M:2303 MN b(c,d)

The five collections on bark (3 tree species) are consistent with descriptions of *V. muralis* on rock. They are quite similar to one another, with moderately thick, pale gray-brown thallus, perithecia almost sessile and with conspicuous pale ostiole, and hymenium I+ red, K/I+ blue.

[b]*Verrucaria nigrescens* Pers., K:2157. GKM ca
[b]*Xanthoparmelia dierythra* (Hale) Hale, N:2520. MN si

TLC: usnic, norstictic and connorstictic acids.

[ab]*Xanthoparmelia plittii* (Gyelnik) Hale, J:2458. DJ b(c)

TLC: usnic, stictic and norstictic acids. Two full-sun specimens have dark rhizines and underside blackening in places, but they lack the additional substances typical for *X. conspersa*.

[b]*Xanthoparmelia subdecipiens* (Vainio) Hale, 2521. N si

TLC: usnic acid.

Xanthoparmelia cumberlandia (Gyelnik) Hale, 2814. M si,g

TLC: usnic, stictic and norstictic acids. Specimens vary from being loosely attached on pebbles to vagrant on soil, are profusely apotheciate and have lobe widths of 1-5mm.

[ab]*Xanthoria elegans* (Link) Th. Fr., A:2017. ABMN ca,si
[ab]*Xanthoria fallax* (Hepp) Arnold, H:2115. BFHJKMN b(c,d)
[ab]*Xanthora polycarpa* (Hoffm.) Rieber, I:2128. BIKN b(c,d)

Lecanidion atratum (Hedw.) Rabenh., 2053. D b(c)

(Det. Coppins) This ascomycete fungus strongly resembles a lichen, and has occasionally been described as a *Bacidia* species (Coppins, personal communication). It is neither lichenized nor lichenicolous.

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[a]Also reported from Theodore Roosevelt National Park (Wetmore 1985).
[b]Also reported from the Black Hills (Wetmore 1967, personal communication).
[c]ca=calcareous rocks, see text; si=non-calcareous rocks; o=non-woody organic substrates; g=soil; b=bark or wood (c=conifers, d=deciduous trees or shrubs); p=lichenicolous: host substrate given.

Discussion

The 163 lichen species and three lichenicolous fungus species reported here probably represent most of the total lichen flora of BNP. The northwestern part of the South Unit of BNP (Fig. 1) remains undercollected, and the Palmer Creek Area was not visited.

Species. The genus *Macentina* is first reported from North America as *M. dictyospora* Orange. The four collections were all accidental, with the specimen distinguished only under a dissecting scope. The species may actually be fairly common here. Only a few collections have been reported so far from Europe (Coppins, personal communication).

Acarospora arenacea is reported well north of its normal southwestern USA range. It is moderately abundant at a single site in BNP, immediately adjacent to a highway and very close to where the road surface formerly switched from asphalt to gravel. Since the species has not been found at other similar sites, nor away from disturbed areas, the possibility that *A. arenacea* is a human introduction to BNP should be considered.

The lichenicolous fungus *Melaspilea* sp. is probably a new species, and is reported far north of the southeastern USA coastal plain range of its close relative *M. tribuloides*.

Lecanora circumborealis and *L. meridionalis* are found in more arid climates than is usual for these species.

Xanthoparmelia plittii, usually a species of acid rock, was found only on juniper wood at BNP. *X. cumberlandia* has an unusual vagrant growth form. None of the typical vagrant *Xanthoparmelia* species was found.

Rinodina castanomela shares an unusual (for the genus) subsquamulous growth form with a variant of *Caloplaca saxicola* found in BNP; both are moderately common there.

Floras. Comparison of the BNP lichen flora with those of both the nearby Black Hills (BH) and Theodore Roosevelt National Park (TRNP) about 320 km (200 mi) to the north shows much overlap, but also significant differences. Some differences in taxonomic interpretation were considered when floras were compared. Wetmore's (1967, 1985) *Cladonia chlorophaea* included all chemical species in the group (Wetmore, personal communication), so I did not count *C. cryptochlorophaea* and *C. merochlorophaea* for comparisons. Wetmore's (1967) *Physcia grisea* and *Physconia detersa* (1985) may have included *Physconia perisidiosa*. In each case, those species were counted as one group for comparison of floras. Thus 159 BNP lichen species were used for comparison with the lichen floras of TRNP and BH.

Sixty-nine (43%) of BNP lichen species are shared with both BH and TRNP. BH and TRNP have each been more thoroughly collected than BNP. Common arid land ground taxa, taxa common on bark and wood in general and on conifers, and taxa common on calcareous rock comprised most of the shared species.

An additional 33 species are shared only between BNP and BH; a moderately large proportion (30%) of these are taxa found on both conifer and deciduous substrates. BH, more than ten times the size of BNP, and with much greater topographic and habitat diversity, has over 400 lichen species (Wetmore 1967). A total of 102 (64%) of BNP species are shared with BH.

Another 24 species are shared only between BNP and TRNP; a large proportion (38%) of these are taxa of deciduous tree bark and wood. TRNP, about one third the size of BNP, has similar plains habitat and erosion features, but has more area of moist habitat, woodland, and stable non-calcareous rock substrate than does BNP. TRNP has 204 lichen species (Wetmore 1985). A total of 90 (57%) of BNP species are shared with TRNP.

Thirty-four (21%) of the compared species found at BNP are not reported from either BH or TRNP; taxa on calcareous rock (47%) and on conifers (28%) predominate in this group. Most of the species found only in BNP are uncommon and have erratic distributions in the park. Three of these species, however, *Diplotomma epipolium*, *Lecanora crenulata*, and *Verrucaria calkinsiana*, are common and widespread in BNP as well as elsewhere in arid western North America.

The lichen flora of BNP is primarily a microlichen flora; only 33% of the species can be classed as macrolichens (foliose, fruticose and at least medium-sized squamulose growth forms), and over half of these are small macrolichens (*e.g.* the genus *Physcia*). This contrasts with the lichen flora of TRNP (Wetmore 1985), which has 54% macrolichen species, more than half of them large macrolichens (*e.g.* the genus *Parmelia*). While both BNP and TRNP are in the semi-arid plains region, BNP has a much lower proportion and much less variety of moisture-rich habitat within its boundaries.

Communities and Habitats. Three groups of lichen species based on substrate preference are distinct and well represented in BNP: those on calcareous rock, on bark and wood, and on soil. There is relatively little overlap between groups. Bark and wood lichens form the largest group, with 73 species. The most common of these, found at seven or more sites and on both conifers and deciduous species, are the microlichens *Caloplaca cerina*, *C. holocarpa*, *Candelariella deflexa*, and *Rinodina pyrina*, plus *Xanthoria fallax*, the only common macrolichen species. A total of 30 species have been found on both conifers and deciduous species. *Candelariella aurella* is common both on conifer bark and on calcareous rock, one of the few species equally common on two different substrate groups. An additional 37 species have been found only on conifers, and six species only on deciduous taxa.

Forty-seven species occur on calcareous rock. The most common are *Caloplaca atroalba*, *Diplotomma epipolium*, *Lecanora crenulata*, *Polysporina simplex*, and *Staurothele drummondii*. Most of these also grow on the scarce silicious rocks; in addition there are six species found only on silicious rocks. Several of the relatively common calcareous rock lichens are occasionally found on woody plants, especially where calcareous dust has lodged in the bark. Only one of the 31 species growing on soil is relatively common: *Catapyrenium lachneum*.

Three widely spaced ($>$ 55 km distant), large (4-10 ha) areas with varied habitats were each visited repeatedly. The Millard Ridge area (B and K, Figure 1) is at the northern and eastern end of the park, in Oligocene Brule rock deposits. The Sage Creek site (M, Figure 1) is at the northwestern corner of the park, with Cretaceous Pierre Shale and Eocene Chadron deposits. Both of these areas have calcareous rock outcrops of varying hardness, some silicious rocks, sparsely vegetated prairie soils, and mixed conifer and deciduous tree groves near permanent free water. Sixty-four and 67 species, respecively, were found at the sites, with just over half the species in common. Six species at Millard Ridge and five species at Sage Creek have been collected nowhere else.

The Millard Ridge and Sage Creek areas include habitats widespread in BNP, and they also both include conifer and deciduous tree groves adjacent to free water, a relatively rare habitat in the park. Twenty-one lichen species appear to be restricted to these moist habitats, being found in one or more of the three examples visited (B,M,N, Figure 1) and nowhere else. Eight macrolichen species on bark, wood or rock are included among the twenty.

The third area, Cedar Butte (J, Figure 1), is in the northeastern part of the South Unit, with Oligocene Brule rock deposits. It is one of the few high buttes having ponderosa pine, and has extensive groves of pine and juniper interspersed with mixed grass prairie. It has relatively fewer rock deposits on top, and has no permanent water, though being high, it is cooler and therefore less dry than most of BNP. Eighty lichen species have been found here, almost half the total flora. Only 34% of the species are shared with either of the other two large areas, and 38% of the species were collected only at this locality. The Cedar Butte site is the only example I visited of high, cool, conifer-mixed grass "savanna," a rare habitat in the park. It illustrates well how important this habitat is to increasing the lichen species diversity in BNP.

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I learned lichenology from Dr. John Thomson starting almost 30 years ago when I came to UW-Madison as an ecology graduate student. I was quite surprised when he told me that he has never taught a course in lichenology. John has been a kind, patient, and extremely supportive teacher to me and to several other lichenologists who came here to learn from him over the years; we are the lucky few.

I have greatly enjoyed and benefited from his consultation and encouragement as I moved from student to independent researcher over the years. John has built up and maintained (with minimal financial resources) an outstanding lichen herbarium, reference library and reprint collection which I have been fortunate to be able to use regularly.

John and his wife Olive have remained active and engaged long after retirement age. John comes in regularly to work on his manuscript "Lichens of Wisconsin," when he's not helping Olive with their extensive garden or on trips to garden club or lichenolgy conferences. Plus he still finds time and energy to identify boxes and boxes of lichen specimens from colleagues and students across the continent. And keep up with myriad changes in the profession! My goal for myself as I age is to be as active, engaged, and open to advances in lichenology and life in general as is Dr. John Thomson.

---Susan Will-Wolf