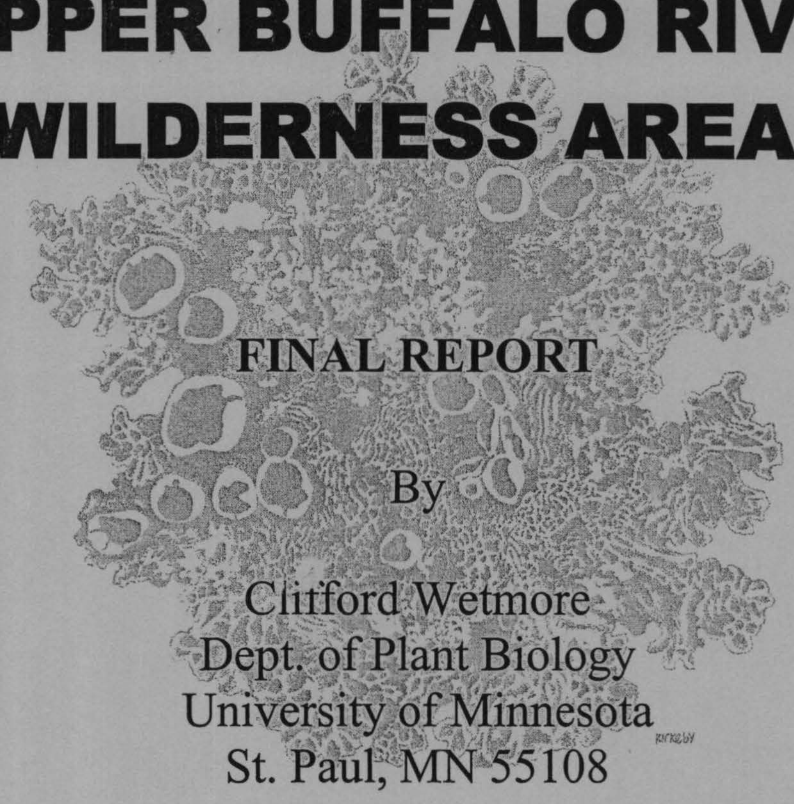
Working

LICHENS AND AIR QUALITY

IN

CANEY CREEK AND UPPER BUFFALO RIVER WILDERNESS AREAS



Parmelia bolliana

FINAL REPORT

By

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April 2001

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WILDERNESS AREAS

Final Report

Prepared for

USDA Forest Service

Purchase Order # 08-99-09-CCS-008

by

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April 2001

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LICHENS OF TWO WILDERNESS AREAS

ABSTRACT

This study of the lichens of Caney Creek and Upper Buffalo River Wilderness areas was designed 1) to collect lichens for lichen species lists, 2) to collect lichens for elemental analysis, 3) to study the health of species most sensitive to air pollution, and 4) to assess the effects of air quality on lichens. Each area is treated in a separate section of this report. Sixteen localities were studied in Caney Creek and eleven localities in Upper Buffalo River.

The purchase order also included a restudy of elemental analysis of Hercules Glades in the Mark Twain National Forest. Samples of one species was also collected at localities in each area for elemental analysis. The elemental analysis section is treated in a separate report (Bennett & Wetmore 2001).

The lichen floras are quite diverse for each area. There were 129 species present in Caney Creek and 132 species present in Upper Buffalo River. All of the lichens found were in good health and with normal fertility. The lichens studied by elemental analysis (Bennett & Wetmore 2001) showed elemental levels comparable to other clean areas. There seemed to be no indications of threatening air quality problems (primarily from sulfur dioxide) in these wilderness areas.

Recommendations are for periodic (5 year) restudy of the lichens by elemental analysis. A complete lichen restudy of the lichen flora should be done every 10-15 years.

PREFACE

Under a purchase order from the USDA Forest Service a lichen study was performed in two wilderness areas of the Ozark-St. Francis and Ouachita National Forests and a restudy of the elemental analysis of Hercules Glades lichens on the Mark Twain National Forest. The objectives were to survey the lichens in each area, produce an inventory of the lichen flora, collect and analyze lichens for chemical contents, and evaluate the lichen flora with reference to the air quality. This establishes baseline data to determine the future change in air quality. All herbarium work was done at the University of Minnesota Herbarium and consultation with personnel in the forests.

The floristic parts of this report are divided into two sections (one for each wilderness area). The elemental analysis report includes the data from these two areas and the resurvey of Hercules Glades Wilderness of the Mark Twain National Forest. The results of these elemental analysis studies are presented in a separate report (Bennett & Wetmore 2001).

All forest 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 USDA Forest Service. 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. In areas of high humidity or fog there are more lichen species while in areas of low humidity there are fewer lichens. This difference in moisture requirements is very important in the distribution of lichens. In Hercules Glades the climate is much drier than in Caney Crook and Upper Buffalo River. In these latter two areas the humidity is also higher in than valleys, on north facing cliffs, and near streams. These habitats usually have more lichens than the ridgetops and are searched for when planning collection localities.

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 May, 2000 by the author. A complete list of collection localities for each area is given at the end of each section of the report and the localities are indicated on the maps of each area. Collection localities, about 2 acres in size, were selected first to give a general coverage of the area, 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. At some localities additional material of selected species was collected for chemical analysis (see below). 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 on all of the trees 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 and have been entered into the herbarium computerized data base maintained there. The species mainly follows Esslinger & Egan (1995).

CANEY CREEK WILDERNESS AREA

This area is located in west central Arkansas south of Mena and has 14,433 acres. The terrain has steep hills and includes the two main streams, Caney Creek and Short Creek, with three trails for access. The climate is quite moist, especially in the valleys. The vegetation is mixed hardwoods and areas of conifers. The main hardwoods are oaks (Quercus, hickory (Carya) with beech (Fagus) and maples (Acer) in the lowlands. The main conifers are pines (Pinus).

There has been no publication on the lichens of the wilderness and probably no lichen collections have ever been made in Caney Creek Wilderness. For this study 564 collections were made at 16 localities (Fig. 1). These localities are listed below.

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.

Species with blue-green algae are indicated by #.

CANEY CREEK SPECIES LIST

Anaptychia palmulata (Michaux) Vainio
Anzia colpodes (Ach.) Stizenb. RARE
Aspicilia caesiocinerea (Nyl. ex Malbr.) Arn. RARE
Aspicilia cinerea (L.) Körber RARE
Bacidia polychroa (Th. Fr.) Körber RARE

Bacidia schweinitzii (Fr. ex Michener) A. Schneider
Brigantiaea leucoxantha (Sprengel) R. Sant. & Hafellner
Buellia spuria (Schaerer) Anzi RARE
Buellia stigmaea Tuck.
I Buellia stillingiana J. Steiner
Caloplaca camptidia (Tuck.) Zahlbr. RARE
Caloplaca cinnabarina (Ach.) Zahlbr.
Caloplaca flavovirescens (Wulfen) Dalla Torre & Sarnth.
S-I Candelaria concolor (Dickson) Stein
Candelariella reflexa (Nyl.) Lettau
Canomaculina subtinctoria (Zahlbr.) Elix
Canoparmelia caroliniana (Nyl.) Elix & Hale
Catapyrenium tuckermanii (Rav. ex Mont.) Thoms.
I Chrysothrix candelaris (L.) Laund.
Chrysothrix chlorina (Ach.) Laund. RARE
Cladina rangiferina (L.) Nyl.
Cladina subtenuis (Abbayes) Hale & Culb.
Cladonia caespiticia (Pers.) Flörke
Cladonia cariosa (Ach.) Sprengel
I Cladonia coniocraea (Flörke) Sprengel
I Cladonia cristatella Tuck.
Cladonia furcata (Hudson) Schrader
Cladonia grayi G. Merr. ex Sandst. RARE
Cladonia mateocyatha Robbins RARE
Cladonia pyxidata (L.) Hoffm. RARE
Cladonia robbinsii Evans
Cladonia squamosa Hoffm.
Cladonia uncialis (L.) F. Wigg. RARE
Coccocarpia palmicola (Sprengel) Arv. & Galloway
Collema subflaccidum Degel.
Dimelaena oreina (Ach.) Norman
Flavoparmelia baltimorensis (Gyelnik & Fariss) Hale
Flavoparmelia caperata (L.) Hale
Fuscopannaria leucosticta (Tuck.) Jxrg.
Graphis insidiosa (Knight & Mitten) Hook. f.
I Graphis scripta (L.) Ach.
Haematomma fenzlianum Massal.
Heterodermia albicans (Pers.) Swinscow & Krog
Heterodermia ~~diademata~~ (Taylor) Awast. hypoleuca
Heterodermia echinata (Taylor) Culb.
Heterodermia obscurata (Nyl.) Trevisan
Heterodermia speciosa (Wulfen) Trevisan
Hypotrachyna livida (Taylor) Hale
Hypotrachyna pustulifera (Hale) Skorepa
Lecanora caesiorubella subsp. prolifera (Fink) Harris
Lecanora hybocarpa (Tuck.) Brodo
Lecanora imshaugii Brodo RARE

Lecanora strobilina (Sprengel) Kieffer
Lecidea plebeja Nyl. RARE
Lepraria lobificans Nyl. RARE
Leptogium austroamericanum (Malme) C. W. Dodge
Leptogium corticola (Taylor) Tuck.
Leptogium cyanescens (Rabenh.) Körber
Leptogium denticulatum Tuck.
Leptogium hirsutum Sierk
Leptogium milligranum Sierk RARE
Lobaria ravenelii (Tuck.) Yoshim. RARE
Loxospora pustulata (Brodo & Culb.) Harris
Marchandiomyces corallinus (Roberge) Diederich & Hawksw. RARE
Myelochroa aurulenta (Tuck.) Elix & Hale
Myelochroa galbina (Ach.) Elix & Hale RARE
Ochrolechia africana Vainio RARE
I Opegrapha varia Pers.
I Opegrapha vulgata Ach.
Pannaria tavaresii Jørg. RARE
Parmelia squarrosa Hale
Parmelinopsis minarum (Vainio) Elix & Hale
Parmotrema austrosinense (Zahlbr.) Hale RARE
Parmotrema crinitum (Ach.) Choisy
Parmotrema eurysacum (Hue) Hale
Parmotrema hypotropum (Nyl.) Hale
Parmotrema margaritatum (Hue) Hale
Parmotrema perforatum (Jacq.) Massal. RARE
Parmotrema ultralucens (Krog) Hale RARE
Peltigera canina (L.) Willd.
Peltigera polydactylon (Necker) Hoffm. RARE
I Pertusaria amara (Ach.) Nyl.
Pertusaria copiosa Erichsen RARE
Pertusaria globularis (Ach.) Tuck.
Pertusaria hypothamnolica Dibben
Pertusaria neoscotica Lamb
Pertusaria ostiolata Dibben
Pertusaria paratuberculifera Dibben
Pertusaria plittiana Erichsen RARE
Pertusaria propinqua Müll. Arg.
Pertusaria subpertusa Brodo
Pertusaria texana Müll. Arg. RARE
Pertusaria trachythallina Erichsen
Pertusaria velata (Turner) Nyl.
Phaeophyscia adiastola (Essl.) Essl.
Phaeophyscia pusilloides (Zahlbr.) Essl.
Phaeophyscia rubropulchra (Degel.) Essl.
Physcia americana G. Merr.
Physcia halei Thoms.

I Physcia stellaris (L.) Nyl.
Physconia leucoleiptes (Tuck.) Essl. RARE
Porpidia albocaerulescens (Wulfen) Hertel & Knoph
Pseudocyphellaria aurata (Ach.) Vainio RARE
Punctelia bolliana (Müll. Arg.) Krog RARE
Punctelia punctilla (Hale) Krog
I Punctelia rudecta (Ach.) Krog
Punctelia semansiana (Culb. & C. Culb.) Krog
Pyrenula caryae Harris
Pyrenula cruenta (Mont.) Vainio RARE
Pyrenula pseudobufonia (Rehm) Harris RARE
Pyxine sorediata (Ach.) Mont.
Pyxine subcinerea Stirton RARE
S Ramalina americana Hale
Rimelia cetrata (Ach.) Hale & Fletcher RARE
S Rimelia reticulata (Taylor) Hale & Fletcher
Sticta beuvoisii Delise
Sticta carolinensis sp. nov ined.
Teloschistes chrysophthalmus (L.) Th. Fr. RARE
Trypethelium virens Tuck. ex Michener
Usnea mutabilis Stirton
Usnea rubicunda Stirton
Usnea strigosa (Ach.) Eaton
Usnea subscabrosa Mot.
Xanthoparmelia cumberlandia (Gyelnik) Hale
Xanthoparmelia dierythra (Hale) Hale RARE
Xanthoparmelia lineola (Berry) Hale
Xanthoparmelia plittii (Gyelnk) Hale RARE
Xanthoparmelia tasmanica (Hook. f. & Taylor) Hale RARE
Xanthoria fulva (Hoffm.) Poelt & Petutschnig

DISCUSSION OF LICHEN FLORA

This list of species presents the first listing of lichens from Caney Creek and includes 129 species found during this study. There are also about 13 additional unidentified species, some of which may be undescribed. The lichen flora is typical of the Ozark deciduous forest. Some of the most common species are Bacidia schweinitzii, Canoparmelia caroliniana, Parmelinopsis minarum, Pertusaria propinqua, and Rimelia reticulata.

One of the unidentified lichens is an undescribed one according to studies by one of my students, Tami McDonald, who studied the genus Sticta in the Smokey Mountains. She is now preparing a paper describing this species.

There were no cases where lichens sensitive to sulfur dioxide were observed to be damaged or killed. All species normally found fertile were also fertile in the areas. There are several species with blue-green algae (indicated by # in the species list), which are very sensitive to sulfur dioxide. These observations indicate that there is no air quality degradation in the wilderness due to sulfur dioxide that causes visible damage to the lichen flora.

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 areas. The cases of rarity do not necessarily reflect sensitivity damage due to sulfur dioxide. The species listed as RARE on the species list may be rare because of the rare occurence of suitable substrates or habitats. None of the species on the species list are nationally or regionally known to be threatened or endangered.

The few 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 areas because of climatic factors. In addition, there are no important pollution sources near the areas. 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 areas it cannot be determined whether the present lichen flora has changed prior to this study.

CANEY CREEK COLLECTION LOCALITIES

Collection numbers are those of Clifford Wetmore. All collections are listed in ascending order by collection number and date of collection. All localities are in Polk County, Arkansas. The latitude and longitude were taken by GPS unit as near the collection site as possible. Localities where lichens were collected for elemental analysis are indicated by "CHEM".

Loc. 1. 84220-84258 High ridge N of Short Creek just E of Cossatot River with oaks, hickory, black cherry and other small hardwoods and rocks, elev. 1520 ft. Sec. 6 & 7, T4S, R29W. 34°25'34"N, 94°08'46"W. 18 May 2000.

Loc. 2. 84259-84297 Along Short Creek and side ravine 0.5 mi E of Cossatot River. Steep N facing hillside with short leaf pines and sugar maple and river bottom with sassafras, beech, oaks and some pines, elev. 1150 ft. Sec. 7, T4S, R29W. 34°25'22"N, 94°08'22"W. 18 May 2000.

Loc. 3. 84298-84333 N facing hillside above Short Creek 0.25 mi E of Cossatot River. Plateau on steep N facing hillside with oaks, red maple and some sort leaf pines, elev. 1100 ft. Sec. 7, T4S, R29W. 34°25'20"N, 94°08'46"W. 18 May 2000.

Loc. 4. 84334-84373 Half mile W of Buckeye Mt. On ridge with hickory, oaks and rock cliffs, elev. 2160 ft. Sec. 13, T4S, R29W. 34°24'16"N, 94°02'37"W. 20 May 2000. CHEM

Loc. 5. 84374-84402 Buckeye Mt. Around peak in shady woods with oaks, hickory, and rock outcrops, elev. 2300 ft. Sec. 18, T4S, R28W. 34°24'24"N, 94°02'09"W. 20 May 2000.

Loc. 6. 84403-84444 End of East ridge from Hanna Mt. Ridgetop with oaks, hickory, and rock cliffs on S facing slope, elev. 1700 ft. Sec. 14, T4S, R29W. 34°24'18"N, 94°04'23"W. 21 May 2000.

Loc. 7. 84445-84468 1.2 mi E of East Hanna Mt. On N side of ridge with oaks and hickory, elev. 1940 ft. Sec. 14, T4S, R29W. 34°24'25"N, 94°03'47"W. 21 May 2000.

Loc. 8. 84469-84485 E slope of Buckeye Mt. near old mine. On E facing hillside with large boulders in oak-hickory forest, elev. 1920 ft. Sec. 18, T4S, R28W. 34°24'20"N, 94°01'48"W. 21 May 2000.

Loc. 9. 84486-84536 Near W end of west ridge from Tall Peak. Along upper N facing slope with rock ledges, basswood, hickory and oaks, elev. 2100 ft. Sec. 24, T4S, R29W.

34°23'18"N, 94°03'14"W. 22 May 2000.

Loc. 10. 84537-84572 South side of Tall Peak. On S facing slope above cliffs with hickory and oaks, elev. 2100 ft. Sec. 24, T4S, R29W. 34°23'06"N, 94°02'35"W. 22 May 2000.

Loc. 11. 84573-84600 One mile N of Shady Lake along Saline River. On lowland near river with oaks, beech, sweetgum, and holly, elev. 1200 ft. Sec. 30, T4S, R28W. 34°22'38"N, 94°01'43"W. 22 May 2000.

Loc. 12. 84601-84657 S of Katy Mt. along Caney Creek. In lowland on S side of creek with beech, oaks, holly and some pines and rock ledges, elev. 1280 ft. Sec. 23, T4S, R29W. 34°23'33"N, 94°04'11"W. 23 May 2000.

Loc. 13. 84658-84679 SE of Katy Mt. along Caney Creek. At trail crossing of creek on S facing ledges above creek with some sycamore and oak, elev. 1340 ft. Sec. 13, T4S, R29W. 34°23'41"N, 94°03'07"W. 23 May 2000.

Loc. 14. 84680-84704 Half mile W of East Caney Creek Trailhead. In valley with big old beech, oaks, and few short leaf pines, elev. 1440 ft. Sec. 18, T4S, R28W. 34°24'00"N, 94°01'48"W. 23 May 2000.

Loc. 15. 84705-84741 Along Cossatot River at NW corner of wilderness. Lowland by river with sweetgum, oaks, and short leaf pines, elev. 1020 ft. Sec. 6, T4S, R29W. 34°25'39"N, 94°08'15"W. 24 May 2000.

Loc. 16. 84742-84783 SW corner of wilderness SW of Porter Mt. On western point of ridge just inside border with elm, oaks, hickory, short leaf pines, and black cherry, elev. 1420 ft. Sec. 24, T4S, R30W. 34°23'30"N, 94°09'35"W. 24 May 2000. CHEM.

UPPER BUFFALO RIVER WILDERNESS AREA

This wilderness area is 10,590 acres in size and is located in northwestern Arkansas south of Jasper. The wilderness includes rugged hills surrounding the Upper Buffalo River with steep cliffs in many places. The climate is quite moist, especially along streams and below north facing cliffs. Only a few trails enter the area. The vegetation is mixed hardwoods with some conifer areas. The main hardwoods are oaks (Quercus), hickory (Carya), beech (Fagus), and maple (Acer) and the main conifers are pines (Pinus) and occasional juniper (Juniperus).

Prior to this study there were no known lichen collections from this wilderness area. For this study 448 collections were made at 11 localities (Fig. 2). A complete list of the collection localities is given below.

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 areas. The cases of rarity do not necessarily reflect sensitivity damage due to sulfur dioxide.

The few 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 areas because of climatic factors. The presence of some lichens with blue green algae (that are more sensitive to sulfur dioxide and indicated by # in the species list) also indicates that there is probably no air quality problem in the wilderness areas. In addition, there are no important pollution sources near the areas.

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 areas it cannot be determined whether the present lichen flora has changed prior to this study.

Species with blue-green algae are indicated by #.

UPPER BUFFALO RIVER SPECIES LIST

Anaptychia palmulata (Michaux) Vainio RARE
Arthothelium spectabile Massal.
Arthothelium taediosum (Nyl.) Müll. Arg.
Bacidia polychroa (Th. Fr.) Körber
Bacidia schweinitzii (Fr. ex Michener) A. Schneider
Buellia curtisii (Tuck.) Imsh.
Buellia spuria (Schaerer) Anzi RARE
Buellia stigmaea Tuck. RARE
I Buellia stillingiana J. Steiner
S-I Caloplaca camptidia (Tuck.) Zahlbr. RARE
Caloplaca cerina (Ehrh. ex Hedwig) Th. Fr. RARE
Caloplaca flavovirescens (Wulfen) Dalla Torre & Sarnth. RARE
Caloplaca holocarpa (Hoffm. ex Ach.) Wade RARE
Caloplaca pollinii (Massal.) Jatta
S-I Candelaria concolor (Dickson) Stein
Candelaria fibrosa (Fr.) Müll. Arg. RARE
S-I Candelariella xanthostigma (Ach.) Lettau
Canomaculina subtinctoria (Zahlbr.) Elix RARE
Canoparmelia crozalsiana (B. de Lesd. ex Harm.) Elix & Hale RARE
Catapyrenium tuckermanii (Rav. ex Mont.) Thoms. RARE
Cetraria viridis Schwein.

I Chrysothrix candelaris (L.) Laund.
Cladina rangiferina (L.) Nyl. RARE
Cladina subtenuis (Abbayes) Hale & Culb. RARE
Cladonia caespiticia (Pers.) Flörke
Cladonia cariosa (Ach.) Sprengel
Cladonia chlorophaea (Flörke ex Sommerf.) Sprengel RARE
I Cladonia coniocraea (Flörke) Sprengel RARE
Cladonia cryptochlorophaea Asah. RARE
Cladonia furcata (Hudson) Schrader
Cladonia grayi G. Merr. ex Sandst. RARE
Cladonia peziziformis (With.) Laund. RARE
Cladonia robbinsii Evans RARE
Cladonia squamosa Hoffm. RARE
Cladonia strepsilis (Ach.) Grognot RARE
Cladonia uncialis (L.) F. Wigg.
Coccocarpia palmicola (Sprengel) Arv. & Galloway
Collema subflaccidum Degel.
Conotrema urceolatum (Ach.) Tuck.
Dermatocarpon miniatum (L.) W. Mann RARE
Diploschistes actinostomus (Ach.) Zahlbr. RARE
Diploschistes scruposus (Schreber) Norman RARE
Dirinaria frostii (Tuck.) Hale & Culb. RARE
Flavoparmelia baltimorensis (Gyelnik & Fariss) Hale
Flavoparmelia caperata (L.) Hale
Fuscopannaria leucophaea (Vahl) Jørg. RARE
Fuscopannaria leucosticta (Tuck.) Jørg.
I Graphis scripta (L.) Ach.
Heterodermia ~~diademata~~ (Taylor) Awast. hypoleuca
Heterodermia obscurata (Nyl.) Trevisan
Heterodermia speciosa (Wulfen) Trevisan
Hypotrachyna livida (Taylor) Hale
Lecanora caesiorubella subsp. glaucomodes (Nyl.) Imsh. & Brodo RARE
Lecanora caesiorubella subsp. prolifera (Fink) Harris
Lecanora hybocarpa (Tuck.) Brodo
Lecanora imshaugii Brodo
Lecanora thysanophora Harris in Harris & Tønsb.
Lecidella stigmatea (Ach.) Hertel & Leuckert RARE
Lepraria lobificans Nyl. RARE
Leptogium austroamericanum (Malme) C. W. Dodge RARE
Leptogium corticola (Taylor) Tuck.
Leptogium cyanescens (Rabenh.) Körber
Leptogium hirsutum Sierk
Leptogium milligranum Sierk
S Lobaria pulmonaria (L.) Hoffm. RARE
Lobaria quercizans Michaux RARE
Loxospora pustulata (Brodo & Culb.) Harris
Marchandiomyces corallinus (Roberge) Diederich & Hawksw. RARE

Megaspora verrucosa (Ach.) Hafellner & Wirth RARE
Myelochroa aurulenta (Tuck.) Elix & Hale
Myelochroa galbina (Ach.) Elix & Hale
Nephroma helveticum Ach.
Ochrolechia trochophora (Vainio) Oshio RARE
I Opegrapha varia Pers. RARE
I Opegrapha vulgata Ach. RARE
Pannaria tavaresii Jørg. RARE
Parmelia squarrosa Hale
Parmelinopsis minarum (Vainio) Elix & Hale RARE
Parmotrema crinitum (Ach.) Choisy
Parmotrema eurysacum (Hue) Hale
Parmotrema hypotropum (Nyl.) Hale
Parmotrema margaritatum (Hue) Hale
Parmotrema perforatum (Jacq.) Massal.
Parmotrema submarginale (Michx.) DePriest & Hale RARE
Peltigera canina (L.) Willd. RARE
#I Peltigera horizontalis (Hudson) Baumg. RARE
Peltigera phyllidiosa Goffinet & Maidl.
Peltigera praetextata (Flörke ex Sommerf.) Zopf RARE
I Pertusaria amara (Ach.) Nyl.
Pertusaria globularis (Ach.) Tuck. RARE
Pertusaria macounii (Lamb) Dibben
Pertusaria ostiolata Dibben
Pertusaria paratuberculifera Dibben
Pertusaria plittiana Erichsen
Pertusaria texana Müll. Arg.
Pertusaria trachythallina Erichsen RARE
Pertusaria velata (Turner) Nyl.
Pertusaria xanthodes Müll. Arg. RARE
Phaeophyscia adiastola (Essl.) Essl.
I Phaeophyscia orbicularis (Necker) Moberg RARE
Phaeophyscia rubropulchra (Degel.) Essl.
I Physcia aipolia (Ehrh. ex Humb.) Fürnr. RARE
Physcia americana G. Merr.
Physcia stellaris (L.) Nyl.
Physconia leucoleiptes (Tuck.) Essl.
Placynthium petersii (Nyl.) Burnham RARE
Porpidia albocaerulescens (Wulfen) Hertel & Knoph
Porpidia tahawasiana Gowan
I Punctelia rudecta (Ach.) Krog
Punctelia semansiana (Culb. & C. Culb.) Krog
Pyrenula caryae Harris
Pyrenula pseudobufonia (Rehm) Harris
Pyrrhospora russula (Ach.) Hafellner RARE
Pyxine sorediata (Ach.) Mont.
Pyxine subcinerea Stirton RARE

S Ramalina americana Hale
S Rimelia reticulata (Taylor) Hale & Fletcher
Rimeliella subtinctoria (Zahlbr.) Kurok. RARE
Sarcogyne clavus (DC.) Kremp. RARE
Scoliciosporum umbrinum (Ach.) Arnold RARE
Sphinctrina turbinata (Pers. : Fr.) De Not. RARE
Sticta carolinensis sp. nov. ined.
Trypethelium virens Tuck. ex Michener
Usnea ceratina Ach. RARE
Usnea mutabilis Stirton
Usnea rubicunda Stirton
Usnea strigosa (Ach.) Eaton
Usnea subscabrosa Mot.
Xanthoparmelia dierythra (Hale) Hale RARE
Xanthoparmelia lineola (Berry) Hale RARE
Xanthoparmelia tasmanica (Hook. f. & Taylor) Hale
Xanthoria fulva (Hoffm.) Poelt & Petutschnig

DISCUSSION OF LICHEN FLORA

The lichen flora of this wilderness is quite diverse. There were 132 species found in the wilderness. Many of the RARE species were found on rocks in openings and such habitats are not common. The most common species are Bacidia schweinitzii, Graphis scripta, Loxospora pustulata, Pertusaria velata, Punctelia rudecta, and Pyxine sorediata.

There were about 11 unidentified species, one is an undescribed one according to studies by one of my students, Tami McDonald, who studied the genus Sticta in the Smokey Mountains. She is now preparing a paper describing this species.

There were no cases where lichens sensitive to sulfur dioxide were observed to be damaged or killed. All species normally found fertile were also fertile in the areas. There are several species with blue-green algae (see species list), which are very sensitive to sulfur dioxide. These observations indicate that there is no air quality degradation in the wilderness due to sulfur dioxide that causes visible damage to the lichen flora.

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 areas. The cases of rarity do not necessarily reflect sensitivity damage due to sulfur dioxide. The species listed as RARE on the species list may be rare because of the rare occurrence of suitable substrates or habitats. None of the species on the species list are nationally or regionally known to be threatened or endangered.

The few 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 areas 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 wilderness areas. In addition, there are no important pollution sources near the areas. 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 areas it cannot be determined whether the present lichen flora has changed prior to this study.

UPPER BUFFALO RIVER COLLECTION LOCALITIES

Collection numbers are those of Clifford Wetmore. All collections are listed in ascending order by collection number and date of collection. All localities are Newton County, Arkansas. The latitude and longitude were taken by GPS unit as near the collection site as possible. Localities where elemental analysis collections were made are indicated by "CHEM".

Loc. 1. 84784-84828 Lower Fork Creek. At side ravine above waterfalls on rock ledges and woods with oak, hickory, and beech, elev. 1920 ft. Sec. 8, T14N, R23W. 35°53'37"N, 93°26'48"W. 26 May 2000.

Loc. 2. 84829-84864 Half mile E of Ryker. On S facing slope with oaks, hickory and young maples, elev. 2150 ft. Sec. 7, T14N, R23W. 35°53'08"N, 93°28'07"W. 26 May 2000.

Loc. 3. 84865-84910 Upper Boen Gulf Branch, S of Mossville. Stream valley with oak, hickory, beech, and red maple, elev. 2000 ft. Sec. 11, T14N, R23W. 35°53'04"N, 93°23'17"W. 28 May 2000. CHEM

Loc. 4. 84911-84951 SE of Boen Gulf Branch, NW of Terrapin Road. Hilltop above stone wall with pine, oaks, hickory, juniper, and red maple, elev. 2150 ft. Sec. 14, T14N, R23W. 35°51'55"N, 93°23'26"W. 28 May 2000.

Loc. 5. 84952-84980 Headwaters of Terrapin Branch. Stream valley with oaks, beech, red maple, and Carpinus, elev. 1860 ft. Sec. 26, T14N, R23W. 35°50'38"N, 93°23'08"W. 28 May 2000.

Loc. 6. 84981-85023 Above Buffalo River near SW corner of wilderness. On N facing hillside with oaks, hickory, and red maple, elev. 1750 ft. Sec. 5, T13N, R23W. 35°49'13"N, 93°27'06"W. 29 May 2000.

Loc. 7. 85024-85070 One mile NE of SW corner of wilderness. On NW facing hillside above deep ravine with oaks, hickory, red maple and some beech, elev. 2050 ft. Sec. 32, T14N, R23W. 35°49'19"N, 93°26'32"W. 29 May 2000.

Loc. 8. 85071-85118 Dug Hollow 1 mile from Buffalo River. Along top of ledge and stream in side ravine, elev. 1800 ft. Sec. 5, T14N, R23W. 35°54'24"N, 93°26'18"W. 30 May 2000.

Loc. 9. 85119-85157 Buffalo River at mouth of Dug Hollow. River flats with mostly beech and some oaks, elev. 1280 ft. Sec. 4, T14N, R23W. 35°54'16"N, 93°25'20"W. 30 May 2000.

Loc. 10. 85158-85197 Half mile SE of Turner Ward Knob. On N facing hill above ravine with oaks, hickory, and red maple, elev. 2150 ft. Sec. 20, T14N, R23W. 35°51'24"N, 93°26'39"W. 31 May 2000. CHEM.

Loc. 11. 85198-85231 Near top of Turner Ward Knob on W ridge with oaks, hickory, and sugar maple, elev. 2400 ft. Sec. 19, T14N, R23W. 35°51'45"N, 93°27'27"W. 31 May 2000.

ELEMENTAL ANALYSIS

The elemental analysis part of this report are covered in a separate report (Bennett & Wetmore 2001).

CONCLUSIONS FROM THE STUDY OF BOTH WILDERNESS AREAS

There are no indications that the lichens of the two wilderness areas 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 area. 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.

Many of the species in both wilderness areas are more southern in their distribution patterns with a strong similarity to the lichens of the Appalachian Mts. One undescribed species (Sticta carolinensis), with its main distribution in the Appalachian Mts, was also found in both of these wilderness areas.

RECOMMENDATIONS

Although there seem to be no sulfur dioxide effects or impacts from other elements monitored in the areas now, periodic restudy is recommended. Elemental analysis should be done every 5 years and compared to the levels reported in this study. A complete floristic restudy should be done every 10-15 years.

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

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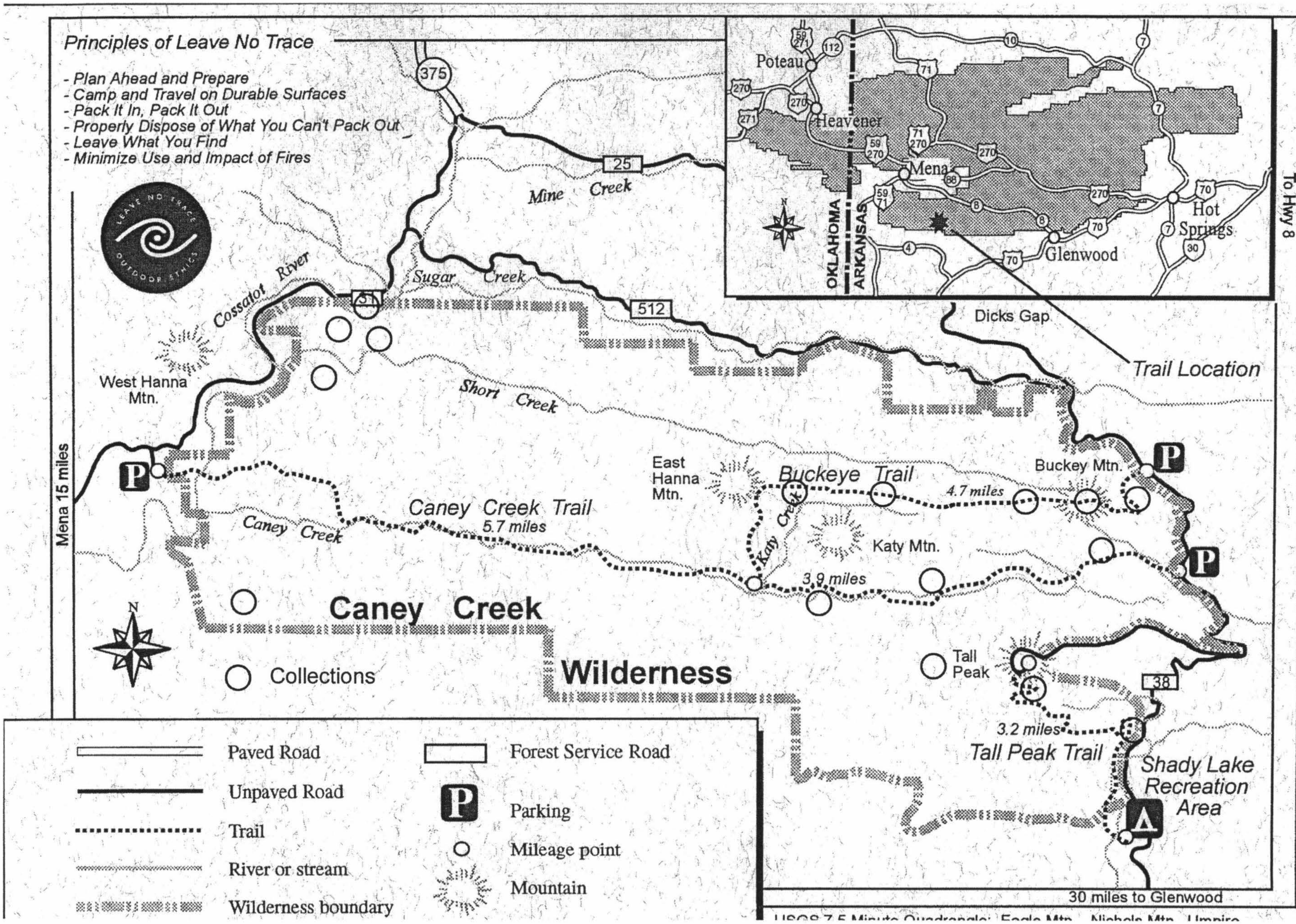

Fig. 1 Open circles are collection localities.

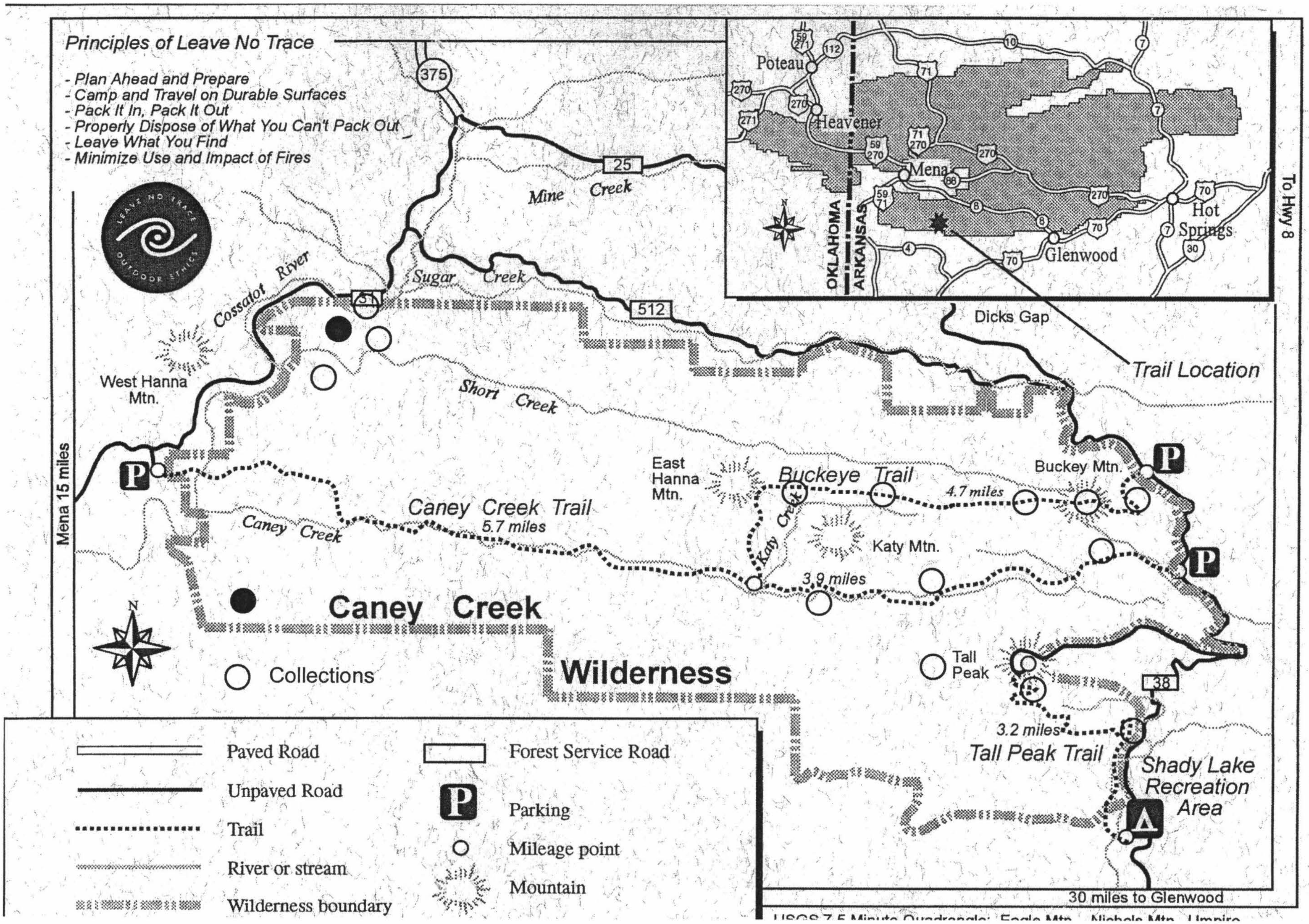

Fig. 2. Black dots are localities of Ramalina americana.

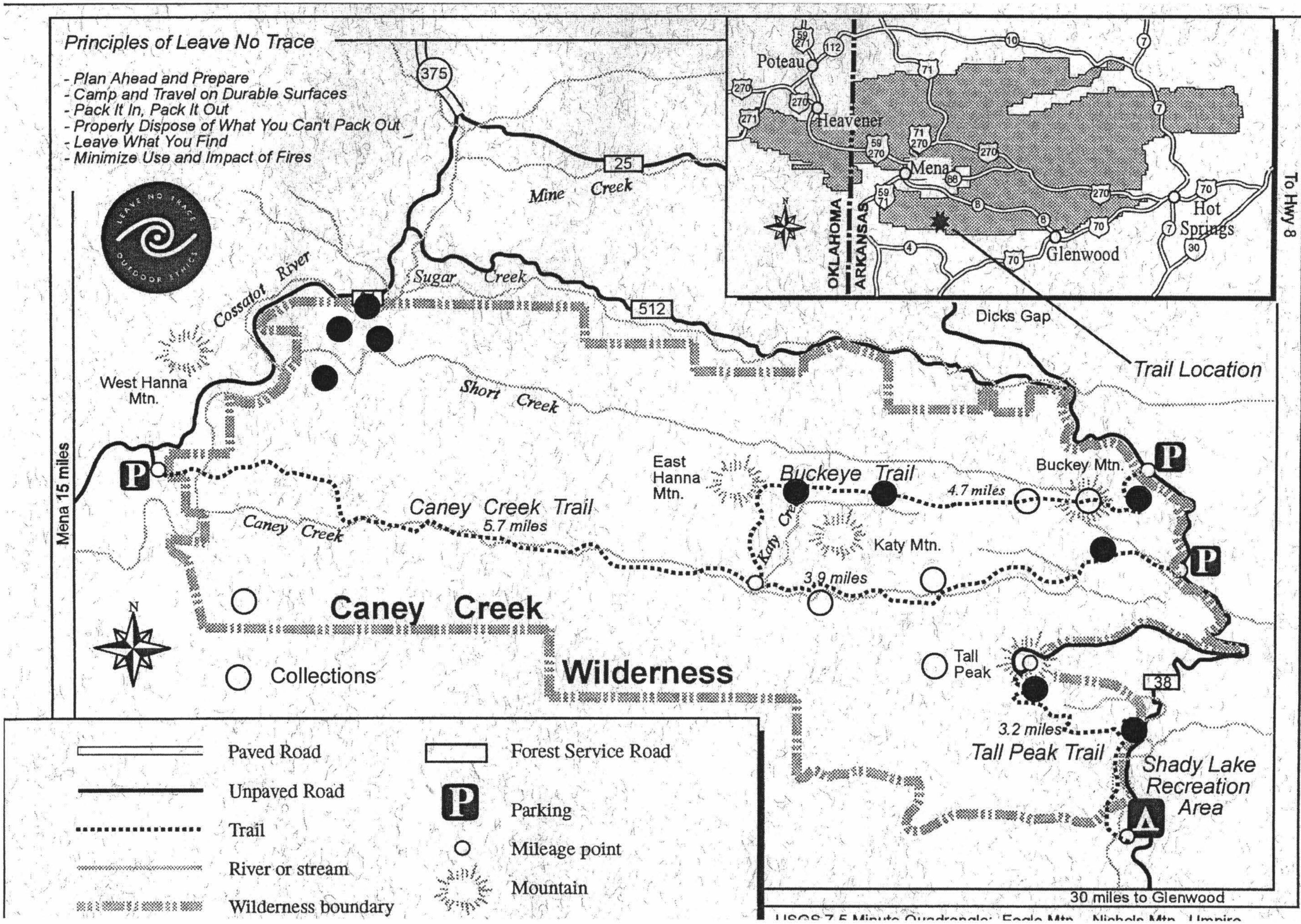

Fig. 3. Black dots are localities of Rimelia reticulata.

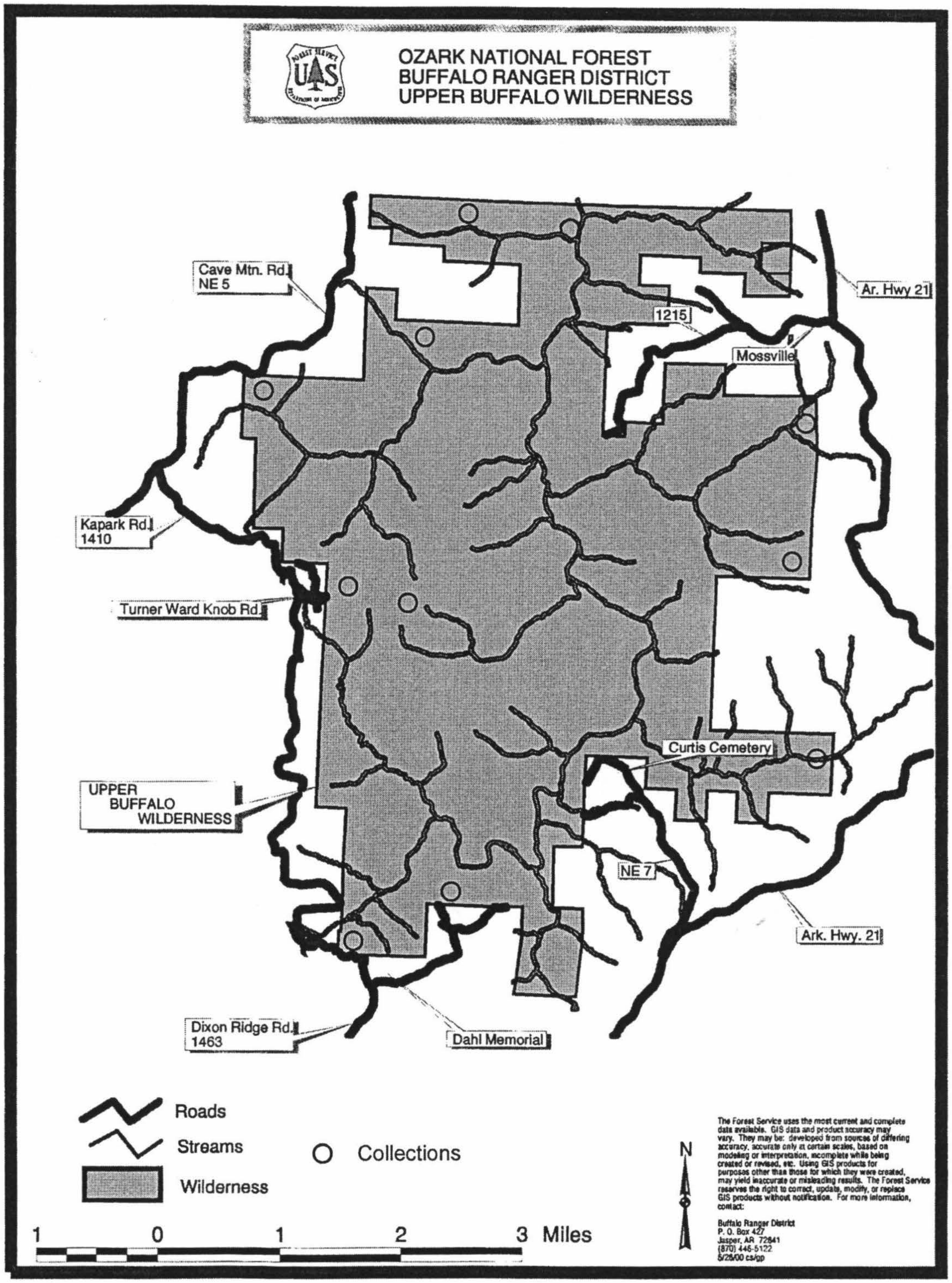

Fig. 4. Open circles are collection localities.

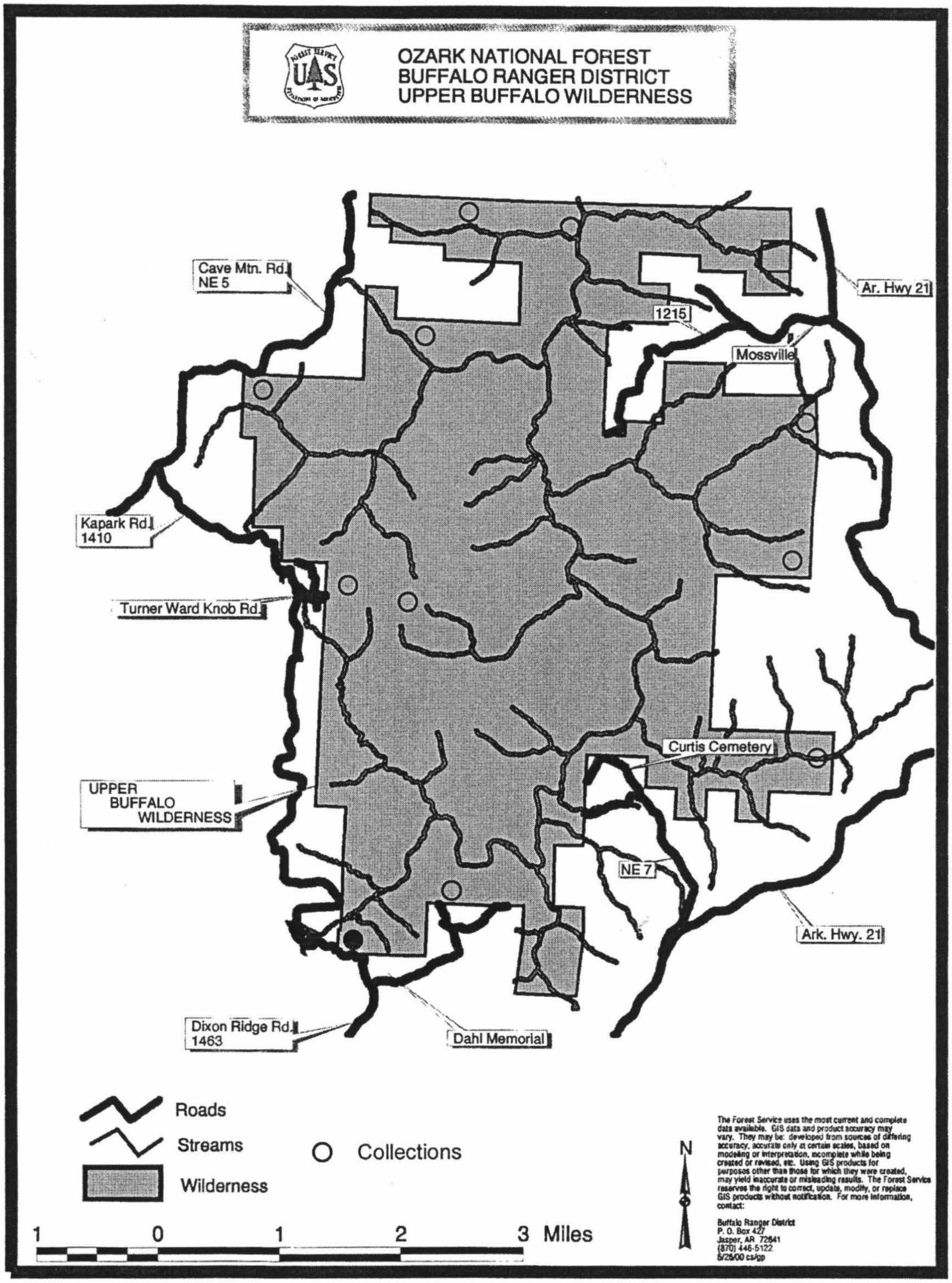

Fig. 5. Black dot is locality of Lobaria pulmonaria.

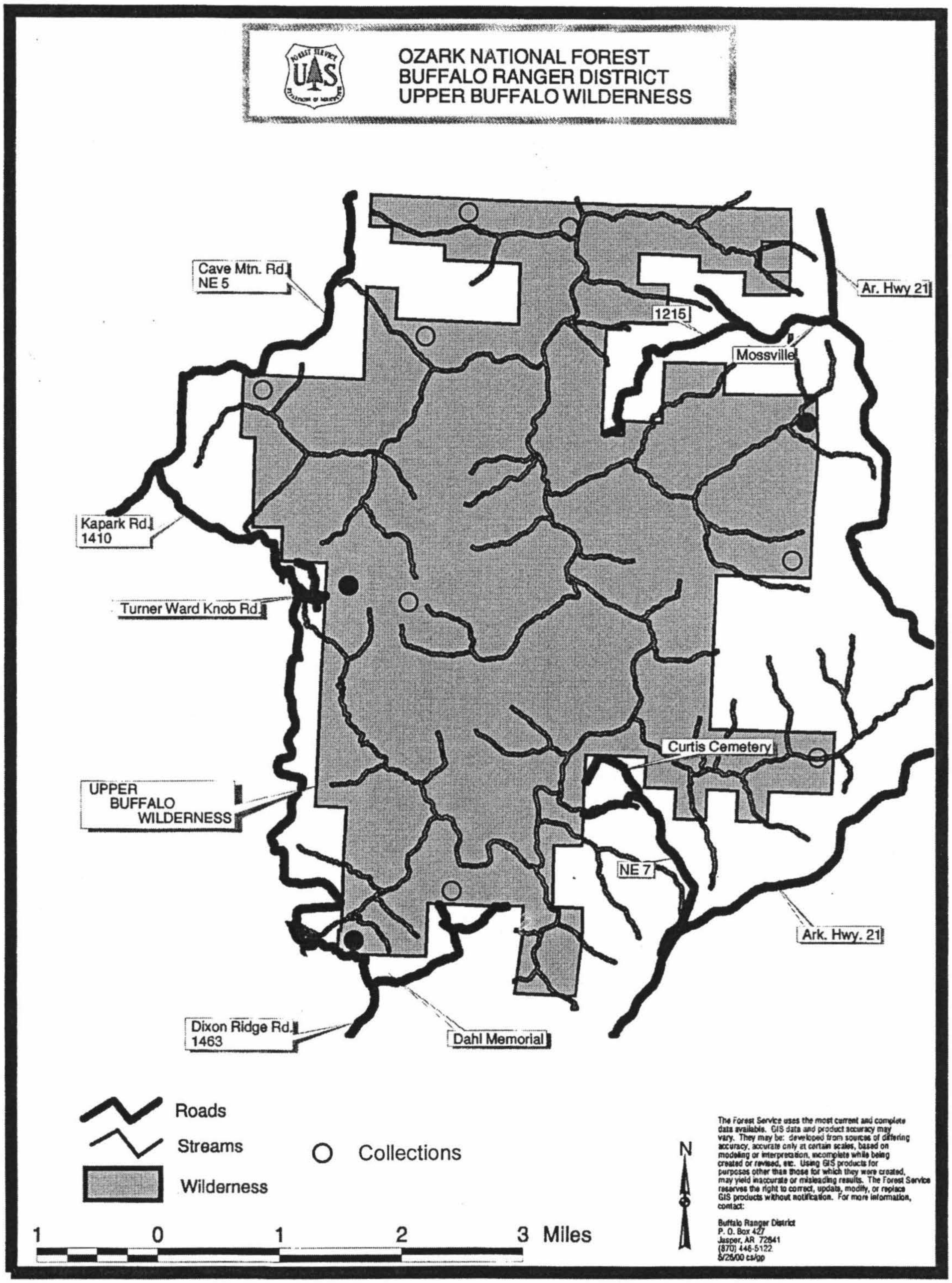

Fig. 6. Black dots are localities of *Ramalina americana*.

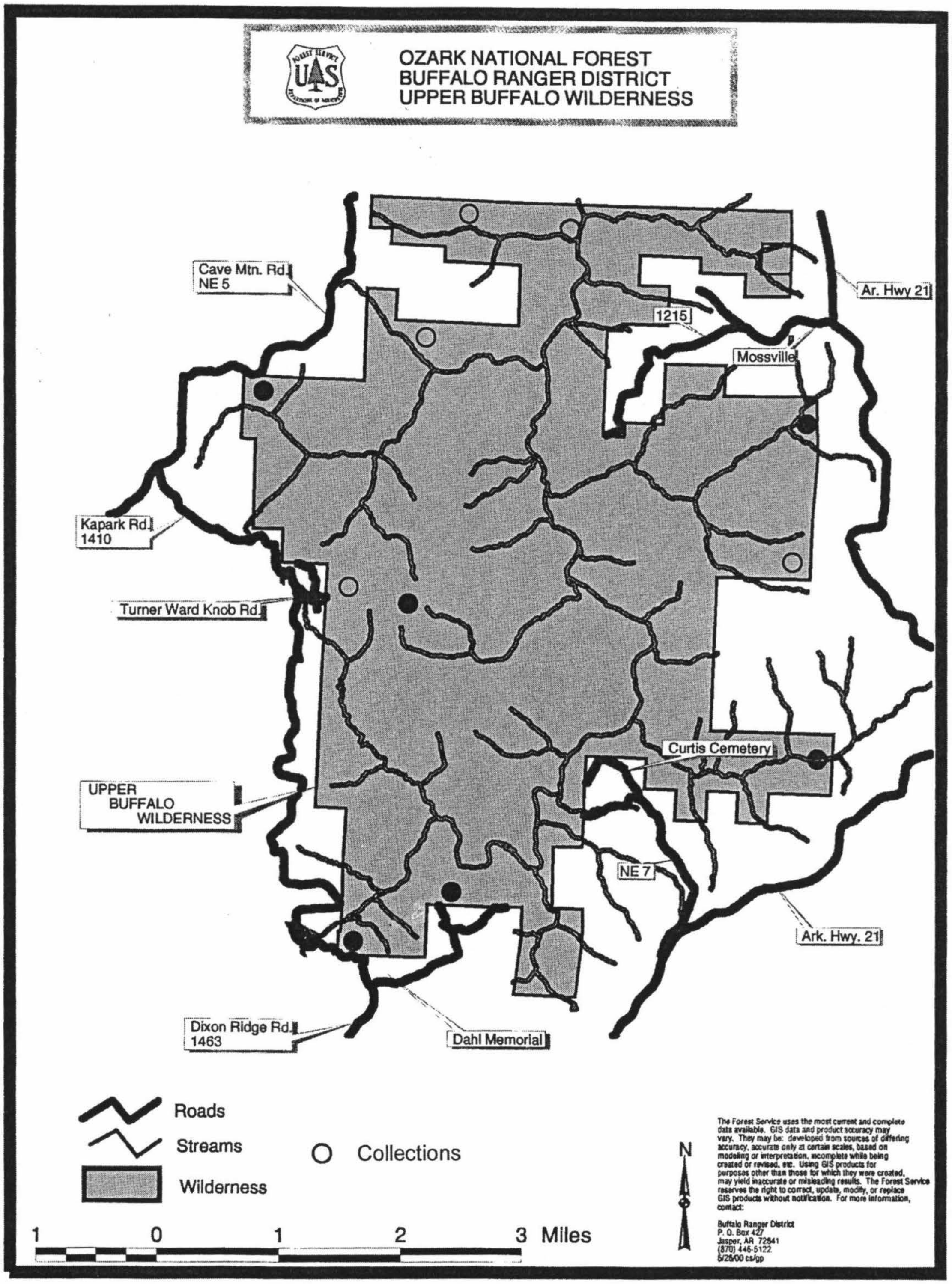

Fig. 7. Black dots are localities of _Rimelia_ _reticulata_.