THE BRYOPHYTE FLORA OF THE NORTH SLOPE OF WINDING STAIR MOUNTAIN (LEFLORE COUNTY, OKLAHOMA, U.S.A.)

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ABSTRACT

We surveyed a 5948-ha study site on the north slope of Winding Stair Mountain, entirely within the Ouachita National Forest in LeFlore County, Oklahoma, U.S.A. The area is jointly managed by the National Forest Service and the Oklahoma Department of Wildlife Conservation. We made 261 collections of bryophytes from spring 2012 to early spring 2014. We found 50 families and 75 genera represented by 87 moss, 1 hornwort, and 29 liverwort species. This includes 22 state records and 34 county records. Two species (*Plagiochila dubia* and *Frullania appalachiana*) were discovered far from their previously reported ranges. The large number (18%) of species newly reported for the state of Oklahoma demonstrates the need for more bryophyte surveys to be conducted on these understudied organisms.

Key Words: Bryophytes, liverworts, mosses, Oklahoma, Ouachita National Forest, state records

RESUMEN

Hemos llevado a cabo un estudio de 5948-ha en la ladera norte de Winding Stair Mountain, dentro completamente del Ouachita National Forest en el condado de LeFlore, Oklahoma, U.S.A. El área está gestionada conjuntamente por el National Forest Service y el Departamento de Oklahoma para Wildlife Conservation. Realizamos 261 colecciones de briófitos desde la primavera de 2012 hasta el principio de la primavera de 2014. Hemos encontrado 50 familias y 75 géneros representados por 87 especies de musgos, 1 de antocero, 29 de hepáticas. Esto incluye 22 citas nuevas para el estado y 34 para el condado. Dos especies (*Plagiochila dubia* y *Frullania appalachiana*) se descubrieron lejos de su área conocida anterior. El gran número (18%) de especies citadas como nuevas para el estado de Oklahoma demuestra la necesidad de realizar más estudios de estos organismos poco estudiados.

INTRODUCTION

The Ouachita Mountains of southeastern Oklahoma contain many endemic or disjunct vertebrate and vascular plant species (e g , *Plethodon ouachitae*, *Amorpha ouachitaensis,* and *Solidago ouachitaensis*). Other groups of organisms, such as bryophytes, are poorly studied within southeastern Oklahoma. It is likely that there are many interesting bryophyte taxa waiting to be discovered in the Ouachita Mountains. The purpose of this study is to document the bryophyte flora of a portion of the Ouachita National Forest as a baseline inventory to expand our knowledge of the current bryophyte flora of Oklahoma and to be a tool with which we can document any future floristic changes.

STUDY SITE

The 5948 ha study site (Fig. 1) consists of the majority of the northern slope of Winding Stair Mountain, and is entirely within the Ouachita National Forest. The site is a single parcel bordered by Forest Service Rd. 6014 to the east, Oklahoma State Route 1 to the south, Forest Service Rd. 6010 to the west, and Holson Valley Road to the north. Latitude ranges from 34.7251N to 34.8110N and longitude ranges from -94.8797W to -94.6938W. A few private inholdings are excluded from the study and from the area total (Fig. 1). The study site contains several 1st and 2nd order streams and two 3rd order streams, the largest of which is Cedar Creek. The study site is underlain with Pennsylvanian sandstones and shales (Hatcher et al. 1989), with the sandstone forming outcrops and cliffs near the top of Winding Stair Mountain and along several of the 1st order streams. Elevation ranges from 201 m above sea level where Stark Hollow leaves the NW portion of the study area to 684 m along a portion of OK Route 1 at the top of Winding Stair Mountain.

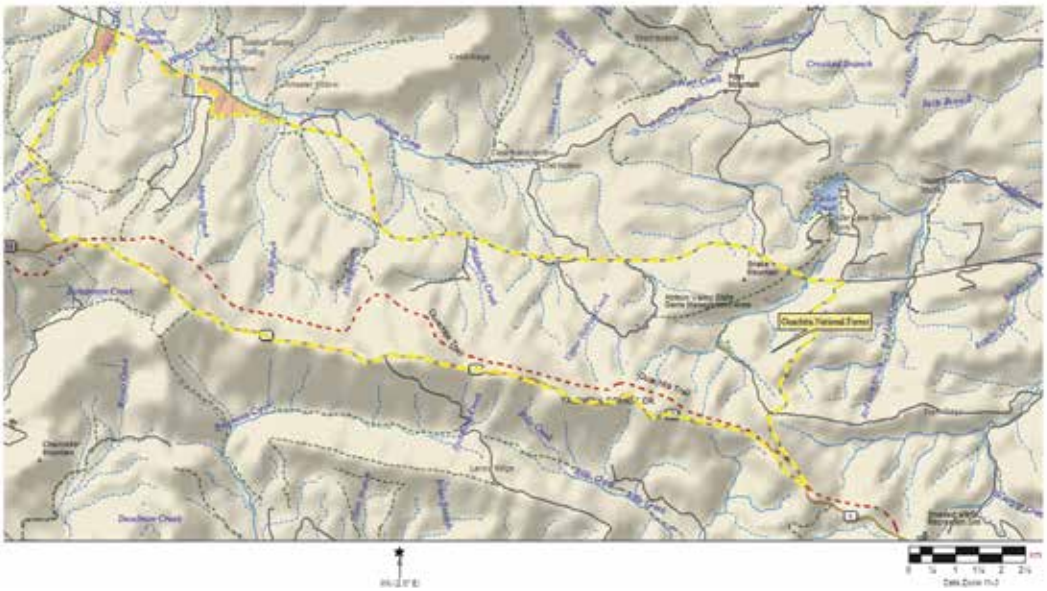

Fig. 1. Map showing the study area outlined in yellow dashed line on the north slope of Winding Stair Mountain within the Ouachita National Forest. Inholdings surrounded by green dotted lines were not studied and are not included in the area total.

The majority of the area is part of the Homer L. Johnston Wildlife Management Area (WMA), although a small portion near the ridge is within the Winding Stair Mountain National Recreation Area (WSMNRA). The WMA portion of the study area is managed for timber harvest, wildlife, and outdoor recreation, while the WSMNRA is managed using a "progressive ecosystem management policy" which focuses on maintaining biodiversity and ecosystem services (USDA Forest Service 2004b). The study area has been managed with prescribed fire since the early part of the 20th century (Strausberg & Hough 1997). The study site is currently managed with prescribed burning and selective timber harvest (USDA Forest Service 2004a). The area was burned by prescribed fire during the spring of 2012.

The study site is mostly forested (>90%). The northern portions of the study area consist mostly of gently rolling slopes and flat bottomlands dominated by *Pinus echinata* away from the streams and *Quercus stellata* closer to the streams. The elevation rises steeply to the south where the forest transitions into one with a more mesic northern affinity dominated by *Quercus alba, Carya tomentosa, Q. rubra*, and *Acer rubrum*. The most interesting and bryologically diverse areas are the higher elevation 1st order stream drainages. There are also boulder fields, which are the result of previous mass wasting events in the higher elevation areas of the study area. Although we expected to find a number of epilithic species there, bryophytes are nearly absent from these areas.

Areas of high human impact include a number of multi-use horse/hiking trails, unimproved forest service access roads, and the Horsethief Springs Recreation Area. The trails and roads provide higher disturbance areas and increase the bryophyte flora by providing habitat for otherwise un-encountered terricolous (i.e., soil dwelling) ephemeral taxa (i.e., *Fossombronia* sp , *Anthoceros laevis*). The old watering trough at the Horsethief Springs Recreation Area provides a small amount of habitat for calcicolous bryophyte taxa on the cement mortar of the structure. There are several (~12) wildlife food plots along the gravel USFS roads in the northern portion of the study site. There are several small anthropogenic ponds, which were created as wildlife habitat.

METHODS

We systematically collected bryophytes between spring 2012 and early spring 2014 during all seasons. Google earth imagery (Google Inc. 2013) and topographic GIS layers using ArcMap 10.0 (ESRI 2011) were used to insure that all representative habitats were visited. Habitat information, substrate, and geographic coordinates for each voucher specimen were recorded in the field. Specimens were deposited in the Oklahoma State University Herbarium (OKLA) with duplicates of some taxa deposited in the Morehead State University Herbarium (MDKY). We conducted a thorough search of published literature to determine state and county records (Sharp 1929; Little 1936; Bird 1960; Mahler & Mahler 1980; Churchill et al. 1981; Talbot & Ireland 1982; Timme & Redfearn 1997; FNA 2007). Collections accessible online at The Missouri Botanical Garden (MO) and The New York Botanical Garden (NY) were searched for additional collections from other collectors. In addition, Charles Gardner provided data from the Symbiota Network that included otherwise unpublished county and state records. We did not find any specimens previously collected from the current study area.

All bryophyte specimens were identified in the lab using compound and dissecting microscopes. Efforts were made to collect pure specimens, but some packets had other species of lichens or other cryptogams as minor constituents; however we did not catalog which packets contained extraneous species or sporophytes. Moss specimens were identified using the *Flora of North America north of Mexico* (FNA) volume 27 (2007) for included taxa and Crum and Anderson (1981) for groups not included in FNA volume 27. Liverworts and hornworts were identified using the appropriate volume of *The Anthocerotae and Hepaticae of North America east of the Hundredth Meridian* (Schuster 1966, 1969, 1974, 1980, 1992a, 1992b.). Nomenclature of mosses follows FNA volume 27 (2007) for included taxa and Tropicos.org (2014) for taxa that were not included in FNA volume 27. Liverwort and hornwort nomenclature follows Stotler and Crandall-Stotler (1977), except *Frullania appalachiana* and *F. ericoides,* which follow Schuster (1992a, b), and *Chiloscyphus profundus,* which follows Engel and Schuster (1984). This bryophyte flora follows the standards set forth by Palmer and Richardson (2012).

RESULTS AND DISCUSSION

We collected 261 specimens and from them documented 50 families and 75 genera represented by 87 moss, one hornwort, and 29 liverwort species for a total of 117 taxa (Table 1; Appendix 1). There were no species with more than one infra-specific taxon. All collected specimens are reported in Appendix 1, and are assigned to the finest feasible taxonomic resolution. Prior to this study there were 194 species of mosses verified in the literature for Oklahoma (Mahler & Mahler 1980; Churchill et al. 1981; Talbot & Ireland 1982). Also, prior to this study there were 43 species of liverworts and 2 species of hornworts known from the literature in Oklahoma (Sharp 1929; Little 1936; Bird 1960; Talbot & Ireland 1982; Timme & Redfearn 1997). A few extra records are known from Symbiota (Charles Gardner *pers. comm.*). This study found 22 state records and 34 county records. Nineteen percent of the species found in this flora are newly reported for the state. This study increases the known bryophyte flora of Oklahoma to 206 species of mosses, and 56 species of liverworts. This rate of discovery highlights the need for further bryological inventories in Oklahoma.

Table 1. The taxonomic distribution of the bryophyte flora of a portion of the Ouachita National Forest in Oklahoma.

	Families	Genera	Species
Anthocerophyta	1	1	1
Marchantiophyta	16	19	29
Bryophyta	33	55	87

The most diverse genera were *Frullania* with 6 species (5%), *Fissidens*, and *Brachythecium* with 5 species each (4%). The most commonly encountered species of bryophyte was the moss *Platygyrium repens*. There was little coarse woody debris in the study area, thus several epixylic species of bryophytes that would be expected to occur there were rare or absent. The abundance status of individual bryophyte species was not recorded. All species found are considered native to Oklahoma. The most interesting taxa found were *Plagiochila dubia*,

which is typically a subtropical coastal plain species, and *Frullania appalachiana*, which was previously thought to be restricted to the region of the south central Appalachian Mountains.

APPENDIX 1

Catalogue of bryophyte specimens collected from the north slope of Winding Stair Mountain, Ouachita National Forest, LeFlore County, Oklahoma, U.S.A. The species and genera are listed alphabetically by family. Family ordering of the Marchantiophyta follows Crandall-Stotler et al. (2009). Family ordering for the Bryophyta follows Goffinet et al. (2009). Some difficult specimens were annotated by Allen Risk (Morehead State University Department of Biology and Chemistry) and Paul Davison (University of North Alabama Department of Biology). Taxa newly reported for the state of Oklahoma are preceded by a double asterisk (**). Taxa known to occur in Oklahoma, but newly reported for LeFlore County are preceded by a single asterisk (*). All collection numbers are those of J.C. Richardson.

ANTHOCEROPHYTA

Anthocerotaceae
Anthoceros laevis L. 2259

MARCHANTIOPHYTA

Aytoniaceae
**Asterella tenella* (L.) P. Beauv. 2366
Reboulia hemisphaerica (L.) Raddi 2229, 2272

Fossombroniaceae
Fossombronia sp. 2367

Pallaviciniaceae
**Pallavicinia lyellii* (Hook.) Carruth. 2210

Metzgeriaceae
Metzgeria furcata (L.) Dum. 2258, 2362, 2301, 2253
***Metzgeria myriopoda* Lindb. 2170

Aneuraceae
***Riccardia chamedryfolia* (With.) Grolle 2265
***Riccardia multifida* (L.) S.F. Gray 2260

Porellaceae
Porella pinnata L. 2066, 2113, 2137, 2357, 2359
Porella platyphylla (L.) Pfeiff. 2087

Radulaceae
***Radula complanata* (L.) Dum. 2335, 2358

Frullaniaceae
***Frullania appalachiana* R.M. Schust. 2353, 2205, 2237, 2394
Frullania tamarisci subsp. *asagrayana* (Mont.) Hatt. 2085
***Frullania brittoniae* A. Evans 2350
Frullania eboracensis Gott. 2085, 2110
**Frullania ericoides* (Nees ex Mart.) Mont. 2352, 2209, 2233
**Frullania inflata* Gott. 2171, 2330, 2331, 2353, 2361, 2180, 2169
***Frullania kunzei* Lehm. & Lindenb. 2300, 2351, 2249

Lejeuneaceae
**Leucolejeunea clypeata* (Schwein) A. Evans 2112, 2172, 2134, 2138, 2182, 2223
Cololejeunea biddlecomiae (Aust.) A. Evans 2190, 2263, 2256, 2275

Lophocoleaceae
***Chiloscyphus profundus* (Nees) Eng. & Schust. 2073, 2192, 2347, 2181, 2200

Plagiochilaceae
***Plagiochila dubia* Lind. & Gott. 2276

Cephaloziaceae
***Cephalozia bicuspidata* (L.) Dum. 2069

Cephaloziellaceae
***Cephaloziella hyalina* Douin 2198

Scapaniaceae
**Diplophyllum apiculatum* (A. Evans) Steph. 2194, 2262
**Scapania nemorosa* (L.) Dum. 2090

Calypogeiaceae
***Calypogeia fissa* (L.) Raddi 2306
Calypogeia muelleriana (Schiffn.) K. Muell. 2079

Jungermanniaceae
***Jungermannia atrovirens* Dum. 2134.1

BRYOPHYTA

Sphagnaceae
Sphagnum lescurii Sull. 2280

Polytrichaceae
Atrichum angustatum (Brid.) Bruch & Schimp. 2111, 2318, 2116, 2278
**Atrichum altecristatum* (Ren. & Card.) Smyth & Smyth 2213, 2214
**Polytrichum commune* Hedw. 2228
Polytrichastrum ohioense (Ren. & Card.) G.L. Smith 2245

Diphysciaceae
Diphyscium foliosum (Hedw.) D. Mohr 2193

Funariaceae
Unidentified Funariaceae 2369

Drummondiaceae
Drummondia prorepens (Hedw.) E. Britton 2080, 2075

Grimmiaceae
Grimmia pilifera P. Beauv. 2322, 2255, 2303, 2130, 2175
**Schistidium agassizii* Sull. & Lesq. 2328, 2336
**Schistidium apocarpum* (Hedw.) Bruch. & Schimp. 2286, 2323, 2281
***Schistidium dupretii* (Ther.) W.A. Weber 2342
**Schistidium rivulare* (Brid.) Podp. 2288

Ptychomitriaceae
Ptychomitrium incurvum (Schwägr.) Spruce 2241, 2243, 2313

Archidiaceae
***Archidium alternifolium* (Dicksen ex Hedw.) 2368

Fissidentaceae
**Fissidens bryoides* Hedw. 2132, 2179, 2186, 2304
Fissidens bushii (Card. & Ther.) Card. & Ther. 2244
Fissidens dubius P. Beauv. 2078, 2277, 2325
**Fissidens subbasilaris* Hedw. 2311
Fissidens taxifolius Hedw. 2119, 2125

Ditrichaceae
Ditrichum pallidum (Hedw.) Hampe 2084, 2346

Dicranaceae
Dicranella heteromalla (Hedw.) Schimp. 2247, 2338, 2345
Dicranum condensatum Hedw. 2197, 2250, 2354
**Dicranum flagellare* Hedw. 2355
Dicranum montanum Hedw. 2166, 2349, 2303, 2314, 2319
Dicranum scoparium Hedw. 2246, 2251, 2296

Leucobryaceae
Leucobryum glaucum (Hedw.) Angstr. 2195

Pottiaceae
**Molendoa sendtneriana* (Bruch & Schimp.) Limpr. 2243
Syntrichia laevipila Brid. 2285
Tortella humilis (Hedw.) Jenn. 2284
Weissia controversa Hedw. 2183, 2220

Mniaceae
**Plagiomnium affine* (Blandow ex Funck) T.J. Kop. 2072, 2089, 2189, 2234
Plagiomnium ciliare (Mull. Hal.) T.J. Kop. 2356
Plagiomnium cuspidatum (Hedw.) T.J. Kop. 2199, 2290
**Pohlia wahlenbergii* (Web. & Mohr) Andr. 2188
**Rhizomnium punctatum* (Hedw.) T.J. Kop. 2279

Bartramiaceae
Bartramia pomiformis Hedw. 2115, 2261

Orthotrichaceae
Orthotrichum ohioense Sull. & Lesq. 2207
**Orthotrichum pumilum* Sw. 2204
**Orthotrichum strangulatum* P. Beauv. 2289
Ulota hutchinsiae (Sm.) Hamm. 2299, 2310

Hedwigiaceae
Hedwigia ciliata (Hedw.) P. Beauv. 2240, 2333

Aulacomniaceae
Aulacomnium heterostichum (Hedw.) Bruch & Schimp. 2118, 2128, 2269, 2141

Fontinalaceae
**Fontinalis flaccida* Ren. & Card. 2071
**Fontinalis missourica* Card. 2332
**Fontinalis sullivantii* Lindb. 2363

Climaciaceae
Climacium americanum Brid. 2196

Amblystegiaceae
**Amblystegium varium* (Hedw.) Lindb. 2142, 2282
Campylium chrysophyllum (Brid.) J. Lange 2317
Campylium hispidulum (Brid.) Mitt. 2221, 2226, 2309
***Hygroamblystegium fluviatile* (Hedw.) Loeske. 2131, 2295
Hygroamblystegium tenax (Hedw.) Jenn. 2266, 2365

Leskeaceae
Leskea gracilescens Hedw. 2074, 2083, 2287
***Leskea obscura* Hedw. 2211, 2212
***Platylomella lescurii* (Sull.) A.L. Andrews 2124, 2140, 2187, 2327

Thuidiaceae
Thuidium delicatulum (Hedw.) Schimp. BSG 2307, 2173, 2268

Brachytheciaceae
Brachythecium acuminatum (Hedw.) Aust. 2345, 2339
**Brachythecium oxycladon* (Brid.) Jaeg & Sauerb. 2324, 2230, 2238.1
**Brachythecium plumosum* (Hedw.) Schimp. BSG 2121
***Brachythecium rotaeanum* De Not. 2308
Brachythecium rutabulum (Hedw.) Schimp. 2364
**Bryhnia graminicolor* (Brid.) Grout 2129
***Bryhnia novae-angliae* (Sull. & Lesq. ex Sull.) Grout 2120
Bryoandersonia illecebra (Hedw.) H. Rob. 2184, 2360, 2067, 2107, 2117
Clasmatodon parvulus (Hampe) Hook. & Wilson ex Sull. 2232, 2208, 2202
Eurhynchium pulchellum (Hedw.) Jenn. 2238, 2242
***Steerecleus serrulatus* (Hedw.) H. Rob. 2176, 2218, 2321, 2136, 2344

Fabroniaceae
**Fabronia ciliaris* (Brid.) Brid. 2191, 2337

Hypnaceae
Homomallium adnatum (Hedw.) Broth. 2348, 2122, 2135, 2224, 2257
**Platydicta subtile* (Hedw.) Crum 2293
**Taxiphyllum deplanatum* (Bruch & Schimp. ex Sull.) Fleisch. 2091
Taxiphyllum taxirameum (Mitt.) Fleisch. 2315

Hylocomiaceae
Ctenidium molluscum (Hedw.) Mitt. 2108, 2114, 2271, 2316

Entodontaceae
Entodon cladorrhizans (Hedw.) C. Mull. 2264, 2248
**Entodon macropodus* (Hedw.) C. Mull. 2270
Entodon seductrix (Hedw.) Mull. Hall. 2254, 2267, 2320, 2215, 2217

Pylaisiadelphaceae
***Brotherella tenuirostris* (Bruch. & Schimp. ex Sull.) Fl. 2225
Platygyrium repens (Brid.) BSG 2076, 2297, 2174, 2185, 2201, 2203, 2235, 2239, 2252

Sematophyllaceae
Sematophyllum demissum (Wilson) Mitt. 2068, 2123, 2168, 2298, 2302, 2329

Leucodontaceae
Leucodon julaceus (Hedw.) Sull. 2206, 2291, 2088

Anomodontaceae
Anomodon attenuatus (Hedw.) Hub. 2109, 2222, 2177, 2219, 2212
**Anomodon rostratus* (Hedw.) Schimp. 2273, 2274, 2294
Anomodon tristis (Ces.) Sull. & Lesq. 2178, 2236, 2077
**Schwetschkeopsis fabronia* (Schwaegr.) Broth. 2231, 2283, 2292

Theliaceae
Thelia asprella Sull. 2082
Thelia hirtella (Hedw.) Sull. 2081
Thelia lescurii Sull. 2070, 2312

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