

Composition and Vascular Flora of a Limestone Glade at Fults Hill Prairie Nature Preserve, Monroe County, Illinois

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ABSTRACT

The limestone glades of Illinois are small, grass-dominated communities on thin soil, mostly within the Ozark and Shawnee Hills Natural Divisions in the southern third of the state. These communities, also known as xeric limestone prairies, are present throughout much of the eastern half of the United States. In Illinois, these prairies are usually a few ha in size, are in rugged terrain, and have a western to southwestern aspect that exposes them to direct sunlight and the drying effects of prevailing westerly winds. On the glade at Fults Hill Prairie Nature Preserve, little bluestem (*Schizachyrium scoparium* (Michx.) Nash.) dominates with an importance value (IV = the sum of the relative density and relative cover) of 31.3, followed by side-oats grama (*Bouteloua curtipendula* (Michx.) Torr., IV of 21.9), and big bluestem (*Andropogon gerardii* Vitman, IV of 13.0). These are followed by the forbs round-fruited St. John's-wort (*Hypericum sphaerocarpum* Michx.), narrow-leaved false foxglove (*Agalinus tenuifolia* (Vahl.) Raf.), Missouri coneflower (*Rudbeckia missouriensis* Engelm. ex Boynt. & Beadle), sand coreopsis (*Coreopsis lanceolata* L.), and wild petunia (*Ruellia humilis* Nutt.), all with IV's between 9.0 and 12.5. One threatened species (*Rudbeckia missouriensis* Engelm. ex Boynt. & Beadle) and four Illinois endangered taxa were encountered: *Draba cuneifolia* Nutt., *Galium virgatum* Nutt., *Heliotropium tenellum* (Nutt.) Torr., and *Matelea decipiens* (Alex.) Woodson.

Key words: Hill prairies, Ozarks, *Schizachyrium*, xeric limestone prairies, endangered species

INTRODUCTION

Limestone glades are grass-dominated communities on thin soil overlying limestone bedrock (Lawless et al. 2004). These communities are commonly known as "limestone glades" in Illinois (White and Madany 1978, Kurz 1981, McClain and Ebinger 2002, 2014). Limestone glades in Illinois are sometimes associated with loess hill prairies and are the results of erosional events associated with the prairie margins. These communities are distinguished from other grasslands by their thin soil, exposed limestone bedrock, sparse vegetative cover, and rare, sometimes endemic, plant species (Bartgas 1993, Baskin and Baskin 1975, Ludwig 1999, McClain and Ebinger 2014).

Recent studies of limestone grasslands on thin soils separate sloping, little bluestem (*Schizachyrium scoparium* (Michx.) Nash.) and side-oats grama (*Bouteloua curtipendula* (Michx.) Torr.) dry limestone communities from flat, seasonally wet, glades characterized by red cedar (*Juniperus virginiana* L.) and herbaceous, native, annual drop-

seed (*Sporobolus*) grasses (Baskin & Baskin 2004, Lawless et al. 2004, Baskin et al. 2007). The sloping, dry limestone bedrock grassland, known as a glade, characterizes the Fults site. Seasonally wet, flat limestone, red-cedar dominated glade communities are not known from Illinois.

The limestone glades of Illinois are mostly less than a few ha in size, are in rugged terrain, and have a sloping western to southwestern aspect that exposes them to direct sunlight and the drying effects of prevailing westerly winds (Nelson and Ladd 1980, McClain and Ebinger 2002, McClain and Ebinger 2014). The sloping topography promotes rapid precipitation runoff, and the thin soil and exposed rock surfaces retain little moisture. These features result in very xeric conditions during the growing season, even in times of normal precipitation. Plants grow on thin soil or are restricted to bedrock cracks while shrubs and trees are stunted or absent.

There were no studies of limestone glades in Illinois until late in the last

century when field personnel from the Illinois Natural Areas Inventory compiled frequency data and a species list for 32 sites (White 1978). This study located 23 glades in Hardin, Johnson, Pope, and Saline Counties in the extreme southeastern part of Illinois, five along the Mississippi River in Jersey, Monroe, St. Clair, and Union counties, and four on uplands above the Illinois River in Calhoun and Pike counties. The study by Kurz (1981) was the first to describe the floristic composition of limestone glades in Illinois. This publication discussed their distribution and included a species list and frequency data for vascular plants. However, little information was presented concerning their vegetative composition and structure. Other publications included brief descriptions of these communities, such as grass-covered forest openings having bedrock at or near the soil surface (White and Madany 1978). The hill prairie study of Evers (1955) sometimes refers to rock (or rocky) prairies or rock pavement, particularly in the "Annotated List of Species," but this publication did not describe

limestone glades, and made use of the term “glade” just a few times. Ozment (1967) studied limestone ledges within southern Illinois, and prepared an extensive species list, but also did not mention limestone glades.

Warm-season, clump-forming grasses commonly associated with limestone glades in Illinois are little bluestem and side-oats grama, sometimes in combination with smaller amounts of Indian grass (*Sorghastrum nutans* (L.) Nash) and big bluestem (*Andropogon gerardii* Vitman). These communities are common in the Ozark and Shawnee Hills Natural Divisions in the southern third of the state (Schwegman et al. 1973), with Kurz (1981) reporting 206 plant taxa for 32 limestone glades. McClain and Ebinger (2002) compared the vascular flora of three limestone glades in Calhoun County, and later described two xeric limestone prairies in Monroe County (McClain and Ebinger 2014). The purpose of the present study is to describe a limestone glade within Fults Hill Prairie Nature Preserve in Monroe County, Illinois, and to compare its plant species composition with a loess hill prairie.

METHODS

Study Site. Fults Hill Prairie Nature Preserve is located in Monroe County in the Northern Section of the Ozarks Natural Division (38.16005° N, 90.18734° W). This region is known for rugged topography and numerous outcrops of St. Louis limestone, especially along streams and major rivers. The terrain is mostly forested, but loess hill prairies, glades, and open woodlands characterize the bluffs of the Mississippi River which form the western boundary of the region (Evers 1955, Schwegman et al. 1973).

The study site is characterized by a west/southwest aspect, sloping topography, and abundant, loose, small, flat slabs of limestone. Relatively large expanses of exposed rock are present, and a thin layer of Lacrescent flaggy silt loam (loamy-skeletal, mixed, superactive, mesic Typic Hapludolls) covers much of the St. Louis limestone

bedrock surface (DeVera 2010). This soil, which is uncommon on hillsides in the Ozark Region of northwestern Monroe County, is well-drained and derived from coarse, wind-blown loess (Leeper 2004). A total of 28 ha of this soil is present in Fults Hill Prairie Nature Preserve, representing 10 % of the approximately 280 ha within the entire Northern Section of the Illinois Ozarks Natural Division (Schwegman et al. 1973).

Management. Periodic prescribed fire has been used in the management of the site, most recently in 2015. Woody vegetation has continued to encroach on prairies throughout the entire site despite these efforts, resulting in significant size reductions for glade and hill prairie communities, including the study site. Encroaching trees were removed along the periphery of the study site in the spring of 2017, but additional work is needed, especially to contain the spread of the invasive tree-of-heaven (*Ailanthus altissima* (Mill.) Swingle).

Vegetation Sampling. The limestone glade at Fults Hill Prairie Nature Preserve was visited during the growing seasons of 2015 through 2017 to observe and collect vascular plant species, and to study the composition and structure of the plant community. Voucher specimens were collected, identified, and deposited in the Stover-Ebinger Herbarium (EIU) of Eastern Illinois University in Charleston (Appendix 1). Threatened and endangered species follows Illinois Endangered Species Protection Board (2015); exotic species were identified using Gleason and Cronquist (1991) and Mohlenbrock (2014), while nomenclature follows Mohlenbrock (2014).

Quantitative sampling was conducted in late summer of 2016 using 1 m² quadrats located at one m intervals along two randomly placed 25-m transects oriented perpendicular to the west-facing slope (n = 25 per transect). Even-numbered quadrats were placed to the right, odd-numbered quadrats to the left of each transect. A random

numbers table was used to determine the number of meters (0-9) a quadrat was placed from a transect line. Percent cover of each species encountered was determined using the Daubenmire cover class system (Daubenmire 1959) as modified by Bailey and Poulton (1968): class 1 = 0-1%; class 2 = 1-5%; class 3 = 5-25%; class 4 = 25-50%; class 5 = 50-75%; class 6 = 75-95%; class 7 = 95-100%. From these data, frequency (%), mean cover (%), relative frequency, and relative cover. Importance values (IV, total 200, Table 1) represent the sum of the relative density and relative cover values for each taxon (Mueller-Dombois & Ellenberg 1974).

RESULTS

A total of 149 vascular plant species, representing 55 families and 117 genera, were documented for the study area, including 3 fern species in 3 families, 1 gymnosperm species, 35 monocot species in 7 families, and 110 dicots species in 45 families (Appendix 1). The most common families were the Asteraceae (20 species), Poaceae (21 species), and Fabaceae (8 species). One Illinois threatened species, Missouri coneflower (*Rudbeckia missouriensis* Engelm. ex Boynt. & Beadle) was discovered during the study along with four Illinois endangered taxa: wedge-leaved whitlow grass (*Draba cuneifolia* Nutt.), dwarf bedstraw (*Galium virgatum* Nutt.), slender heliotrope (*Heliotropium tenellum* (Nutt.) Torr.) and climbing milkweed (*Matelea decipiens* (Alex.) Woodson). Exotics accounted for eight species, none of which were encountered in the plots, mostly being restricted to marginal areas (Appendix 1).

Three common clump-forming prairie grasses were prominent in the glade community: Little bluestem dominated (Importance Value of 31.3), followed by side-oats grama (IV of 21.9), and big bluestem (IV of 13.0). These grasses were followed in IV by prairie forbs, including round-fruited St. John's-wort (*Hypericum sphaerocarpum* Michx.), narrow-leaved false foxglove (*Agalinus tenuifolia* (Vahl.) Raf.), Missouri coneflower (*Rudbeckia missouriensis* (Engelm. ex Boynt. & Beadle), sand

Table 1. Frequency (%), mean cover (% of total cover), relative frequency, relative cover, and importance value (I.V.) of ground layer species encountered during the August 2015 survey at Fults Hill Prairie Nature Preserve, Monroe County, Illinois. (*exotic species)

Species	Freq.	Mean Cover	Rel. Freq.	Rel. Cover	I. V.
<i>Schizachyrium scoparium</i>	88	19.56	6.9	24.4	31.3
<i>Bouteloua curtipendula</i>	92	11.80	7.2	14.7	21.9
<i>Andropogon gerardii</i>	56	6.85	4.4	8.6	13.0
<i>Hypericum sphaerocarpum</i>	70	5.66	5.5	7.0	12.5
<i>Agalinis tenuifolia</i>	44	6.04	3.5	7.6	11.1
<i>Rudbeckia missouriensis</i>	66	4.66	5.2	5.8	11.0
<i>Coreopsis lanceolata</i>	42	4.81	3.3	6.0	9.3
<i>Ruellia humilis</i>	72	2.69	5.6	3.4	9.0
<i>Eragrostis spectabilis</i>	54	1.74	4.2	2.2	6.4
<i>Symphotrichum patens</i>	44	2.09	3.5	2.6	6.1
<i>Hedyotis nigricans</i>	40	1.66	3.1	2.1	5.2
<i>Dalea candida</i>	42	1.29	3.3	1.6	4.9
<i>Sporobolus neglectus</i>	30	1.70	2.3	2.1	4.4
<i>Chamaecrista fasciculata</i>	32	0.75	2.5	0.9	3.4
<i>Croton monanthogynus</i>	34	0.22	2.7	0.3	3.0
<i>Poisetia dentata</i>	32	0.16	2.5	0.2	2.7
<i>Carex muhlenbergii</i>	20	0.78	1.6	1.0	2.6
<i>Helianthus hirsutus</i>	18	0.77	1.4	1.0	2.4
<i>Erigeron strigosus</i>	26	0.18	2.0	0.2	2.2
<i>Galium virgatum</i>	26	0.13	2.0	0.2	2.2
<i>Dichanthelium oligosanthes</i>	22	0.31	1.7	0.4	2.1
<i>Glandularia canadensis</i>	22	0.21	1.7	0.3	2.0
<i>Sporobolus neglectus</i>	16	0.52	1.2	0.7	1.9
<i>Triodanis perfoliata</i>	12	0.74	0.9	0.9	1.8
<i>Solidago petiolaris</i>	14	0.37	1.1	0.5	1.6
<i>Acalypha gracilens</i>	18	0.09	1.4	0.1	1.5
<i>Galium circaezans</i>	18	0.09	1.4	0.1	1.5
<i>Symphotrichum oblongifolium</i>	14	0.22	1.1	0.3	1.4
<i>Galactia regularis</i>	14	0.07	1.1	0.1	1.2
<i>Penstemon pallidus</i>	2	0.75	0.2	0.9	1.1
<i>Dalea purpurea</i>	12	0.11	0.9	0.1	1.0
<i>Dichanthelium villosissimum</i>	12	0.11	0.9	0.1	1.0
<i>Opuntia macrorhiza</i>	12	0.11	0.9	0.1	1.0
<i>Quercus muhlenbergii</i>	8	0.33	0.6	0.4	1.0
Others (36 species)	--	2.37	12.2	3.1	15.3
Totals	--	79.94	100.0	100.0	200.0
Bare Ground		42.52			
Rocks		45.08			

coneflower (*Coreopsis lanceolata* L.), and wild petunia (*Ruellia humilis* Nutt.), all with IV's between 9.0 and 12.5 (Table 1). A total of 70 species were recorded for the sample plots. Vegetation cover was 79% while bare ground and litter was 42% and exposed rock was 45% (Table 1).

DISCUSSION

Since 2000 we have examined five limestone glade communities on the bluffs of the Mississippi and Illinois rivers. McClain and Ebinger (2002) compared the vascular flora of three limestone glades in Calhoun County along the Illinois River bluffs. Of the 124 taxa observed on these three sites, side-oats grama was the dominant species on two sites, while little bluestem dominated one, was second on another, and fourth on the third. Big bluestem and Indian grass were present in low numbers on one site. On these glades the forbs wild petunia, slender-leaved bluets (*Hedyotis nigricans* (Lam.) Fosb.), tall boneset (*Eupatorium altissimum*

L.), and capitate croton (*Croton capitatus* Michx.) usually were among the top species in importance value, though oblong-leaved aster (*Symphotrichum oblongifolium* (Nutt.) G. L. Nesom), daisy fleabane (*Erigeron strigosus* Muhl.), and pale beardstongue (*Penstemon pallidus* Small) were important on one site. These glades are privately owned, grazed in the past, and two had been enlarged by brush removal.

More recently, McClain and Ebinger (2014) examined two limestone glades located near the bluff line of the Mississippi River on the property of Mr. and Mrs. Ralph Buettner in Monroe County, Illinois. A total of 174 vascular plant species were recorded with side-oats grama, little bluestem, and big bluestem dominating the grass component. The order of importance was not the same on both glades, with big bluestem dominating and side-oats grama second on one site. Also, the importance of the forb species varied with wild petunia, spreading aster (*Symphotrichum patens* (Ait.) G. L. Nesom), partridge pea (*Chamaecrista fasciculata* (Michx.) Greene), and American agave (*Manfreda virginica* (L.) Rose) dominating on one site and elm-leaved goldenrod (*Solidago ulmifolia* Muhl.), oblong-leaved aster, purple-top grass (*Tridens flavus* (L.) Hitchc.), and round-fruited St. Johns-wort the important forbs on the second. According to the owners these two sites have not been grazed for many years and are maintained by brush removal and occasional prescribed fire.

Loess hill prairies and glades share plant species, primarily taxa of the Poaceae and Asteraceae, families known for their prominence in grassland communities. These similarities have caused some to suggest a strong floristic overlap between these two community types. However, Miles Hill Prairie, a loess hill prairie community near the study site, shares only 65 species (46.3 %) with Fults glade, and 71 (47.7 %) taxa with the Buettner glades that are located near the study site. Most of these species were members of the Asteraceae and Poaceae (32 species). The limestone glades studied also differ from loess hill prairies within the same natural division by having 5 fern species representing four families, and a high number of annual plant species: 23 for Buettner glades and 27 for this study compared to just 9 taxa for Miles loess hill prairie. Three glades in Calhoun County, Illinois have three fern species and 17 annual vascular plant taxa compared to no ferns and just 6 annual species at two loess hill prairies within Pere Marquette State Park in adjacent Jersey County, sites within the same natural division (Driftless Section of the Middle Mississippi Border Division) that are separated by approximately 10 km (Schwegman et al. 1973).

Rock outcrop communities such as glades are well known for rare plant species. Two endangered annual vascular plant species present within the limestone glade at Fults Hill Prairie Nature Preserve, cuneate Whitlow grass and dwarf bedstraw, do not grow elsewhere in Illinois. Both species were previously considered to be restricted to narrow rock outcrops along cliff margins, but these plants were

present throughout the glade, a site far removed from cliff ledges. Annual vascular plants appear to be prominent in limestone glade communities (this study and McClain and Ebinger 2002, 2014). Annual plants were most prominent in areas of thin soil overlying bedrock where the plant species varied from dwarf bedstraw and cuneate Whitlow grass in spring to an annual dropseed grass (*Sporobolus neglectus* Nash) in late summer and fall. These studies suggest, despite their small size, that limestone glades are unique and biologically diverse plant communities in Illinois.

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APPENDIX I begins on next page.

APPENDIX I. Vascular plant species encountered at the Fults Hill Prairie Nature Preserve, Monroe County, Illinois are listed alphabetical by family under major plant groups. Collecting numbers preceded by an M are those of William McClain. Species observed, but not collected, are listed as observed. Specimens are deposited in the Stover/Ebinger Herbarium (EIU), Eastern Illinois University, Charleston, Illinois. (*exotic species)

FERNS AND FERN-ALLIES

Aspleniaceae

Asplenium platyneuron (L.) Oakes, M3276

Dryopteridaceae

Woodsia obtusa (Spreng.) Torr., M3207,
M3300

Pteridaceae

Pellaea atropurpurea (L.) Link, M3176

GYMNOSPERMS

Cupressaceae

Juniperus virginiana L., M3265

MONOCOTS

Commelinaceae

Commelina erecta L., M3247
Tradescantia virginiana L., M3197

Cyperaceae

Carex cephaloidea (Dewey) Dewey, M3190
Carex laxiflora Lam., M3196
Carex meadii Dewey, M3205
Carex muhlenbergii Schk., M3204
Carex umbellata Schk., M3301
Cyperus lupulinus (Spreng.) Marcks, M3246

Hyacinthaceae

Camassia scilloides (Raf.) Cory, M3194

Iridaceae

Sisyrinchium albidum Raf., M3188

Juncaceae

Juncus dudleyi Wieg., M3277
Juncus effusus L., M3252

Liliaceae

Allium stellatum Ker., M3178

Orchidaceae

Spiranthes magnicamporum Sheviak, M3287

Poaceae

Andropogon gerardii Vitman, M3260
Aristida oligantha Michx., M3175
Aristida purpurascens Poir., M3296
Bouteloua curtipendula (Michx.) Torr.,
M3162
**Bromus arvensis* L., M3216
Chasmanthium latifolium (Michx.) Yates,
M3261
Dichanthelium acuminatum (Sw.) Gould &
Clark, M3167
Dichanthelium boscii (Poir.) Gould & Clark,
M3254, M3364

Dichanthelium dichotomum (L.) Gould,
M3228
Dichanthelium oligosanthes (Schult.) Gould,
M3165, M3202, M3264
Dichanthelium villosissimum (Nash) Frekm.,
M3156
Elymus virginicus L., M3179, M3225
Eragrostis spectabilis (Pursh) Steud., M3161,
M3263
Koeleria macrantha (Ledeb.) Spreng., M3230
Melica nitens (Scribn.) Nutt., M3201
Muhlenbergia sobolifera (Muhl.) Trin.,
M3262, M3297
Panicum flexile (Gatt.) Scribn., M3245
Schizachyrium scoparium (Michx.) Nash,
M3159, M3290
Sorghastrum nutans (L.) Nash, M3288
Sporobolus neglectus Nash, M3286
Vulpia octoflora (Walt.) Rydb., M3212

DICOTS

Acanthaceae

Ruellia humilis Nutt., M3369

Anacardiaceae

Rhus aromatica Ait., M3187
Rhus copallina L., M3283
Rhus glabra L., M3218, M3355

Apiaceae

Polytaenia nuttallii DC., M3195
Sanicula canadensis L., M3220
**Torilis arvensis* (Huds.) Link, M3219

Aquifoliaceae

Ilex decidua Walt., M3268

Aristolochiaceae

Endodeca serpentaria (L.) Raf., M3366

Asclepiadaceae

Asclepias verticillata L., M3169, M3227,
M3353
Asclepias viridiflora Raf., M3226
Matelea decipiens (Alex.) Woodson, M3154

Asteraceae

**Achillea millifolium* L., M3200
Ageratina altissima (L.) R.M. King & H.
Robins, M3294
Ambrosia artemisiifolia L., M3257
Antennaria plantaginifolia (L.) Hook., M3253
Coreopsis lanceolata L., M3203
Erigeron strigosus Muhl., M3229
Eupatorium altissimum L., M3266
Helianthus divaricatus L., M3279
Lactuca canadensis L., M3361
Liatris aspera Michx., M3367

Packera plattensis (Nutt.) W. A. Weber,
M3192
Pseudognaphalium oblongifolium (L.) Hillard
& Burt., M3289
Rudbeckia missouriensis Engelm. ex Boynt.
& Beadle, M3172
Silphium integrifolium Michx., M3347
Solidago drummondii Torr. & Gray, M3182
Solidago nemoralis Ait., M3291b
Solidago petiolaris Ait., M3285
Solidago ulmifolia Muhl. ex Willd., M3267,
M3291a
Symphotrichum oblongifolium (Nutt.) G. L.
Nesom, M3284, M3298
Symphotrichum patens (Ait.) G. L. Nesom,
M3293, M3349

Boraginaceae

**Buglossoides arvensis* (L.) I.M. Johnson,
M3171
Lithospermum canescens (Michx.) Lehm.,
M3189

Brassicaceae

Draba cuneifolia Nutt., M3183a
Draba reptans (Lam.) Fern., M3215
**Thlaspi arvensis* L., M3183b

Cactaceae

Opuntia macrorhiza Engelm., M3214

Caesalpiniaceae

Cercis canadensis L., M3273
Chamaecrista fasciculata (Michx.) Greene,
M3181

Caprifoliaceae

Symphoricarpos orbiculatus Moench., M3299
Viburnum rufidulum Raf., M3251

Celastraceae

Euonymus atropurpureus Jacq., M3344

Cornaceae

Cornus drummondii C.A. Mey., M3362
Cornus florida L., M3250

Ebenaceae

Diospyros virginiana L., M3240

Euphorbiaceae

Acalypha gracilens Gray, M3157
Acalypha virginica L., M3295
Croton glandulosus L., M3249
Croton monanthogynus Michx., M3248
Euphorbia corollata L., M3242
Poinsettia dentata (Michx.) Kl. & Garcke,
M3168

Fabaceae

Dalea candida (Michx.) Willd., M3231
Dalea purpurea Vent., M3170
Desmodium glutinosum (Muhl. ex Willd.)
Wood, M3238
Galactia regularis (L.) BSP., M3208
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