Natural Area Remnants within the Indiana Army Ammunition Plant, Charlestown, Indiana: The Little Bluestem Glades

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Introduction

In 1975 I began a botanical survey in the Indiana Army Ammunition Plant (IAAP) in Clark County with permission from the U.S. Army (17). Of the ammunition plant's 20,000 acres, the survey covers about 1,400, mostly undeveloped, acres at the north end and both sides of Fourteen Mile Creek. Work with Indiana Natural Heritage Program biologists resulted in the identification of several endangered and threatened species (2,3) and recognition of two little bluestem glades as distinct habitats from the general upland region south of Fourteen Mile Creek. Little bluestem dominates both glades as a xeric, bunch-grass surrounded by patches of rocky pavement. There are other cedar limestone glades in the area; unless noted, the term glades used below refers to the two little bluestem glades. A list of species found follows with discussion of why the glades are of interest.

Methods

Collections and visits have been made throughout the growing season since 1975. Nineteen trips were made to the glades in 1986.

Identification of possible glades within the IAAP were made by the Indiana Division of Natural Resources, Natural Heritage Program, using air photos (1,4,5) followed by ground surveys by Natural Resources ecologists. ICI Americas, Inc. (operating contractor), provided air photos from June 23, 1949, June 8, 1960, and June 13, 1968.

In 1986, 29 quadrat measurements were made. A transect of quadrats was taken on the south facing slope of the west glade as well as were random quadrats. Soil depths of both glades were determined by digging with a ditching spade about every meter downslope along transect lines.

Collection vouchers are deposited in the Indiana University Herbarium at Bloomington (IND). Some species, as noted, were only observed. A voucher list, including some field notes, is available from the author upon request.

Results

Species of the Open Glades — Vascular Plants

Collection dates of vouchers are given. Species occur in the open rocky pavement area between bunches of little bluestem. The nomenclature is from Gleason (13), unless noted.

OPHIOGLOSSACEAE

Ophioglossum engelmannii Prantl. 7 June, 1984.

CUPRESSACEAE

Juniperus virginiana L. 4 Oct., 1985.

POACEAE

Panicum flexile (Gatt.) Scribn. 12 Sept., 1986.

Andropogon scoparius Michx. (*Schizachyrium scoparium* (Michx.) Nash. (18)). 17 Sept., 1979.

Sporobolus vaginiflorus (Torr.) Wood. 4 Oct., 1985.

Sorghastrum nutans (L.) Nash. Oct., 1985.

CYPERACEAE

Eleocharis elliptica Kunth. var. *compressa* (Sull.) Drap. & Mohl. (18) (*E. compressa* Sulliv. (13)). 17 May, 1984.

Carex hirsutella Mack. (18) (*C. camplanata* Torr. & Torr. var. *hirsuta* (Bailey) Gl. (13)). 30 June, 1980.

LILIACEAE

Allium cernuum Roth. 20 July, 1979.

Agave virginica L. 8 Aug., 1984.

IRIDACEAE

Sisyrinchium albidum Raf. 19 May, 1980.

ORCHIDACEAE

Spiranthes magnicamporum Sheviak (18). 10 Oct. 1985.

FAGACEAE

Quercus muhlenbergii Engelm. (18).

RANUNCULACEAE

Thalictrum revolutum DC. 20 July, 1979.

CRUCIFERAE

Draba verna L. 14 March, 1980.

Leavenworthia uniflora (Michx.) Britt. (13). 15 April, 1981.

FABACEAE

Cassia fasciculata Michx. 8 Sept., 1980.

Lespedeza sp. 10 Oct., 1986.

Galactia volubilis (L.) Britt. var. *mississippiensis* Vail. 17 Sept., 1979.

LINACEAE

Linum sulcatum Riddell. 8 Sept., 1980.

POLYGALACEAE

Polygala verticillata L. 6 Aug., 1986.

EUPHORBIACEAE

Croton monanthogynus Michx. 8 Sept., 1980.

Euphorbia corollata L. 15 July, 1986.

RHAMNACEAE

Rhamnus caroliniana Walt. (18)

CACTACEAE

Opuntia compressa (Salisb.) Macbr. June.

PRIMULACEAE

Dodecatheon meadia L. 8 May, 1986.

OLEACEAE

Fraxinus sp. Observed.

GENTIANACEAE

Sabatia angularis (L.) Pursh. 15 July, 1986.

APOCYNACEAE

Apocynum cannabinum L. Observed.

ASCLEPIADACEAE

Asclepias viridiflora Raf. 6 Aug., 1986.

Asclepias verticillata L. 31 July, 1985.

BORAGINACEAE

Heliotropum tenellum (Nutt.) Torr. 26 June, 1981.

Lithospermum canescens (Michx.) Lehm. 1 May, 1979.

VERBENACEAE

Verbena simplex Lehm. 31 July, 1981.

LABIATAE

Isanthus brachiatus (L.) BSP. 1 Sept., 1984.

Scutellaria parvula Michx. var. *leonardii* (Epling) Fern. (18) (*S. leonardi* Epl. (13)). 4 June, 1980.

Salvia lyrata L. 23 Sept., 1977.

Blephilia ciliata (L.) Benth. 4 June, 1980.

Hedeoma hispida Pursh. 4 June, 1980.

SOLANACEAE

Physalis virginiana Mill. 4 June, 1980.

Solanum carolinense L. 13 Aug., 1986.

SCROPULARIACEAE

Conobea multifida (Michx.) Benth. (*Leucospora multifida* (Michx.) Nutt. (18)). 26 July, 1985.

Gerardia tenuifolia Vail. 17 Sept., 1979.

ACANTHACEAE

Ruellia humilis Nutt. 8 Sept., 1980.

RUBIACEAE

Houstonia longifolia Gaertn. var. *ciliolata* (Torr.) Torr. (18) (*H. canadensis* Willd. (13)). 24 May, 1984.

CAPRIFOLIACEAE

Symphoricarpos orbiculatus Moench. Sept. Observed.

CAMPANULACEAE

Lobelia spicata Lam. 17 Sept., 1979.

COMPOSITAE

Ambrosia artemisiifolia L. 1 Sept., 1984.

Aster pilosus Willd. 11 Oct., 1985.

Erigeron strigosus Muhl. June-July. Observed.

Solidago nemoralis Ait. 12 Sept., 1986.

Noted also is the presence of mats of blue-green algae on unshaded rock surface (20) and open rocky pavement. See Quarterman (20) for the role of these algae as well as bryophytes and lichens in cedar glade successcion.

Juniperus virginiana is common on the open glades and sets seed. *Quercus muhlenbergii*, *Rhamnus caroliniana*, *Celtis occidentalis* L., *Quercus coccinea* Muench., *Q. rubra* L., *Fraxinus spp.* (probably blue and green ash), *Acer saccharum* Marsh., and *Cercis canadensis* L. appear in the open glades, but are stunted or do not survive. A few plants of *Rubus* sp. have also come in, but rarely exceed 25 cm and have never flowered.

The following species are believed to be invading the little bluestem glade community from surrounding habitats. Some of these species are included as glade species on published glade lists (1,6,7,8,10): *Anemone virginiana* L., 25 July, 1986; *Chrysanthemum leucanthemum* L. var. *pinnatifidum* LeCoq & Lamotte, 1 Aug., 1986; *Cirsium discolor* (Muhl.) Spreng., 13 Aug., 1986; *Convolvulus spithameus* L., 4 June, 1980; *Daucus carota* L., 1 Aug., 1986; *Eupatorium altissimum* L. Aug.-Oct.; *Euphorbia dentata* Michx., July; *Desmanthus illinoensis* (Michx.) MacM., 1 Aug., 1986; *Dasostoma macrophylla* (Nutt.) Raf. (13) (*Seymeria macrophylla* Nutt. (18)), 23 July, 1986; *Hexalectris spicata* (Walt.) Bernh., 25 July, 1986; *Hypoxis hirsuta* (L.) Coville, May, observed; *Lepidium virginicum* L., May, observed; *Lonicera japonica* Thunb., observed; *Panicum sp.*, Aug., observed; *Smilax sp.* Oct., observed; *Tridens flavus* (L.) Hitchcock (18). Sept.; *Thlaspi arvense* L., May, observed.

Discussion

The glaciated (16) upland region of Clark County to either side of Fourteen Mile Creek is in the Muscatatuck Flats and Canyons Section of the natural regions of Indiana (15). About 25 acres of this region west and south of Fourteen Mile Creek contain shallow wooded ravines, dry wooded sinkholes, open rocky woods and limestone cedar glades (9). The glades include an open meadow grass glade, a disrupted waste glade and the two adjacent little bluestem glades. All the glades contain populations of *Leavenworthia uniflora* Michx., and to my knowledge these are the only sites of *L. uniflora* in Indiana (11,12).

The soil is Crider silt loam, an upland soil formed in loess over weathered, chert-free, thin-bedded limestone (19). The flatter upland portion with deeper soil is disrupted by rampant growth of Japanese honeysuckle. In shallow soils, showing expanses of fossiliferous bare rock and coarse gravel, combinations of cedar glade species appear.

The areas described above, have been, for the most part, greatly disturbed. The little bluestem glades are the least disturbed remnants. Disturbance has been caused by grazing, possibly cultivation, various kinds of construction, wood cutting, conservation group activities, and summer exercises by tanks and armored units from Ft. Knox, Kentucky. These activities have not occurred for several years. The only current disturbance is deer browsing. The most serious damage to these communities has been done by the introduction of alien, noxious species, such as Japanese honeysuckle, tree of heaven, multiflora rose and various fescue grasses.

The little bluestem glades are east of IAAP Gate 26 and Jersey Avenue. The west end of the west glade is separated by the extension of Jersey Avenue and has been disrupted by past construction. The somewhat U-shaped west glade slopes at 19.4-21.3% from SSW through S to SE and covers about 1.8 acres. It contains several tree islands. This glade ends to the south in rocky, mostly cedar woods. Here the soil becomes Corydon stony silt loam on 25 to 70% slopes (19). These steep slopes fall to the rock bed of Lick Creek.

The somewhat rectangular 0.9 acre east glade has a west-facing 18.5% slope. A rocky, intermittent stream lined with cedars separates the 2 glades.

Neither glade shows erosion. The soil is fairly dark, indicating the accumulation of humus. The soil depths of 0-8-12 cm in both is consistent with the Baskins' characterization of the deep-soil community (9).

A comparison of these glades with the Bullitt County, Kentucky, glades shows striking similarity. The Baskins list 15 characteristic cedar glade species with the outcrop classified as an undisturbed cedar glade if 10 of the 15 are present (7). The Bullitt County sites are about 30 miles due south of the little bluestem glades.

Species characteristic of the Bullitt Co. glades from the Baskins' list, but found in the little bluestem glades, are *Ruellia humilis*, *Agave virginica*, *Isanthus brachiatus*, *Ophioglossum engelmannii*, *Sporobolus vaginiflorus*, *Heliotropium tenellum*, *Scutellaria parvula*, *Houstonia canadensis* (13) (*H. canadensis* Willd. = *H. longifolia* Gaert. var. *ciliolata* (Torr.) Torr. (18)), *Sisyrinchium albidum*, *Asclepias verticillata* and *Croton monanthogynus*.

Listed by Baskin and Baskin, but not found in the little bluestem glades, are *Viola egglestonii* and *Leavenworthia exigua* var. *laciniata*, both endemic to southern cedar glades (7). No *Viola* species has been found in the little bluestem glades. The *Leavenworthia* is *L. uniflora*, not *L. exigua*, although Baskin and Baskin (7) note a collection of *L. exigua* in Jefferson County, Kentucky, about 20 miles south of the Clark County glades. Also absent is *Houstonia nigricans* (Lam.) Fern. and *Northoscordum bivalve* (L.) Britt. *Houstonia nigricans* has been found in the Harrison County glades (1), and *N. bivalve* may be more common in southern Indiana than current records show (12), but neither species has been positively determined from the IAAP.

The Baskins collected a total of 77 species from cedar glades in Bullitt County (7). To date, 55 of those have been found and determined from the little bluestem glades. Collections from all IAAP gladelike areas will exceed 77 and I consider this an indication of disturbance.

A comparison of the little bluestem glade species with Harrison County, Indiana, limestone glade species (1), shows a similarity of only about 46%. However, the Harrison County glades are in the Mitchell Plain Physiographic Province (1) (Mitchell Karst Plain Section (15)), a different natural region. Also, several Harrison County species, such as *Anemonella thalictroides*, *Pelea atropurpurea*, *Rhus aromatica*, *Hexalectris spicata*, *Houstonia purpurea*, *Hypoxis hirsuta*, *Menispermum canadense*, *Viburnum rufidulum* and *Viola triloba*, are found in the rocky open woods surrounding the glades. The Harrison County glades are about 60 miles from the IAAP.

Probably of greater importance in comparing the Indiana sites is the absence of a significant composite-prairie component in the IAAP glades. Found in Harrison County (1), but absent at the IAAP are *Andropogon gerardii* (4,8,14,21,22), *Echinacea purpurea*, (8,18) *Eryngium yuccaefolium* (4,8,14,21,22), *Ratibida pinnata* (4,6,7,21), all *Liatris* (4,6,8,14,18,21,22), *Kuhnia eupatorioides* (6,8,14,21) and the prairie rosinweeds (4,7,8,14,18,21). A comparison of these species would seem to show that the IAAP glades have a stronger community affinity with Kentucky and southeastern glades than western prairie types; or that the probable lack of burning in the IAAP glades has eliminated prairie species maintained by fire.

Although knobstone escarpment glades in Clark and Floyd Counties may be closer geographically, the Knobstone Escarpment Section is a different natural region (15) and the checklist (5) indicates a different community structure than the IAAP glades.

The glades as relic components of barrens or prairies of southern Indiana have been discussed by Aldrich, Bacone, and Hutchinson (1).

Succession as observed in the glades and surrounding woods is apparently similar to that described by Quarterman (20) in Tennessee cedar glades. Possible sub-climaxes involve use of the glades as cultivated fields as well as for heavy grazing. The June 23, 1949, air photo shows the area of approximately 25 acres fenced into small fields; one fence remnant is still evident at the south end of the east glade. While it is unlikely slopes containing such submarginal soils were ever farmed, it is possible that this might have occurred with soils eroding down to the bedrock, little bluestem coming in, the community re-established and succession continuing. Little bluestem has been observed growing on discarded chunks of concrete in the west glade. See also Jones' study of abandoned prairie in Ohio (14).

A second sub-climax mentioned by Quarterman involved red cedar becoming established in rock crevices (20). At the IAAP this pioneer role is shared by *Quercus muhlenbergii*, the largest trees in each tree island as well as the rocky woods surrounding the glades. Characteristically some of their roots are above the rocky soil for 1-2 meters from the trunk. From observations over the last few years, we feel the red cedars in the west glade will eventually form a closed stand progressing to the current community of the surrounding rocky woods, a pattern noted by Quarterman (20). We have not observed as much change in the cedars of the east, west-facing glade.

Regardless of the fate of the glades, I believe they are unique to Indiana. Using Baskin and Baskin's criteria species list (7), the little bluestem glades share enough species to be classified as undisturbed. Invasion by alien and weedy species is minimal. The darker soil of the little bluestem glades also indicates a period of humus accumulation and a lack of erosion. The aerial photograph of June 6, 1949, compared with that of June 13, 1968, and our current field observations show a remarkable preservation of the glades proper. The photos taken in June when the leaves are out, enable us to identify marker

oaks to assess glade shrinkage. I certainly recommend that efforts be continued to preserve these natural remnants.

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