

Lycopodium Flabelliforme
in Central Indiana and Illinois

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Introduction

Lycopodium flabelliforme (Fern.) Blanch., the common Ground Pine, is a wide ranging species found throughout northeastern United States and adjacent Canada, and has been reported from as far north as Newfoundland and Quebec, from as far south as Georgia and Louisiana, and from as far west as Iowa (7). Though it has an extensive range, it was considered extremely rare in the midwest, and until 25 years ago was known from only one county in Illinois (9), and seven counties in Indiana (3).

This taxon was first reported in Illinois from a sandstone ledge above Lusk Creek in Pope County (10), and until recently this was considered the only known site for this species in Illinois (4, 9). Since that time it has been reported from scattered localities throughout the state. These include three sites in Cook and DuPage Counties (5), one native station in Ogle County (14), an adventive colony in Crawford County (16), and associated with *Liparis liliifolia* in northern Illinois (18). In most of these reports the Ground Pine was considered an adventive, being associated with conifer plantations. Recently, this species was considered to be native to sandstone ledges in Pope and Ogle Counties, and adventive under conifers in Cook, DuPage, and several southern Illinois counties (15). By 1940 this taxon was known from seven counties in Indiana, being extremely local and restricted to moist, rocky slopes (3). Recently it was listed as an adventive in Spencer County (13), Brown County (11), and Vigo County (8).

In the last five years the present author and his students have found 57 colonies of Ground Pine in east-central Illinois and adjacent Indiana. Some of these populations are in conifer plantations, but most are associated with the early tree stage of old-field succession. On some of these sites it is becoming a very aggressive species with the population covering an area of 20 m in diameter. During the present study 25 of these sites were studied to try and determine some of the factors responsible for the recent population explosion of this taxon, and to analyze some of its habitat requirements.

Materials and Methods

Each of the 25 populations of *Lycopodium flabelliforme* were visited three times during the growing season of 1976. On the first visit to each site a quadrat 25 m on each side was marked off with the Ground Pine colony centered in the quadrat. In each of these plots the number, size to the nearest 1/10 of an inch, and species of the woody plants above 1 inch d.b.h. was recorded. From this data the number of trees per quadrat, the basal area per quadrat, the average tree

diameter per quadrat, and the importance value (IV) of each species per quadrat was calculated. As used here the IV is the sum of the relative density and the relative dominance (12). Also, the age of the oldest tree was obtained by taking increment borings from the larger trees in each quadrat.

The vines and shrubs present in each quadrat was recorded during one of the visits to each site. Also, the herbaceous species found growing in the colonies of *Lycopodium flabelliforme* was noted during each visit. From this data the frequency of the taxa commonly growing in association with the Ground Pine was determined. Voucher specimens of all species found are deposited in the Stover Herbarium of Eastern Illinois University (EIU), while the taxonomic nomenclature used follows that of Mohlenbrock (15).

The soil characteristics of each site were obtained from surface soil cores 10 cm deep from within each quadrat. Particle size analyses were made on 50 g aliquots by using the hydrometer method (2), and a soil texture diagram was then used for soil class determination (6). Soil pH was obtained by using a Beckman glass electrode pH meter on a 1:1 soil-water paste (17), and the amount of organic material was determined by the moderate temperature, dry-combustion, resistance furnace method (1).

Results and Discussion

A total of 36 species of herbaceous plants were found growing directly in the colonies of *Lycopodium flabelliforme*, while 16 species of shrubs and vines, and 46 species of trees were observed in the quadrats. The most common of these taxa and their frequencies are listed in Table I. A more complete analysis of the woody overstory vegetation, as well as the soil characteristics of the study plots is included in Table II. In this table the texture, organic content, and pH of the A horizon of the soil is given along with the number of woody stems, the basal area, the average diameter, the age of the oldest trees, and the importance values (IV) of the leading dominants found in each of the quadrats.

Soil Characteristics: The soils associated with the 25 colonies of Ground Pine are fairly similar (Table II). All are loam or silt loam soils in which the silt content varies from 42% to 79% and the clay separate is a very minor component (4-17%). In these soils the amount of organic material varies from 2.1% to 3.6%, and averages 2.6% for all the quadrats. The soil pH is more variable, but always acidic, varying from 3.7 to 6.3 with an average of 5.6. This indicates that *Lycopodium flabelliforme* could become established in most upland old-fields with slightly acid, silt or silt loam soils with a moderate organic content.

Herbaceous Vegetation: The herbaceous plants found in the general area of the Ground Pine populations are the typical taxa associated with the pioneer tree stage of upland old-field succession. The most commonly encountered of these taxa found growing in the Ground Pine colonies are listed in Table I, Part A. In all cases there were very few individuals present, being widely scattered throughout the colony. This is probably due to the dense Ground Pine population which may prevent germination and development of many herbaceous species, but it is possibly due to allelopathy conditions created by *Lycopodium flabelliforme*. It was commonly observed that the herbaceous taxa

TABLE I Frequency of the most common species of plants found in the 25 study plots of *Lycopodium flabelliforme*.

A. Herbaceous plants commonly growing in association with colonies of <i>Lycopodium flabelliforme</i> .			
SPECIES			FREQ.
<i>Potentilla simplex</i> Michx.			80
<i>Panicum lanuginosum</i> Ell.			64
<i>Asplenium platyneuron</i> (L.) Oakes.			52
<i>Achillea millefolium</i> L.			44
<i>Desmodium paniculatum</i> (L.) DC.			44
<i>Galium circaezans</i> Michx.			36
<i>Solidago canadensis</i> L.			36
<i>Pycnanthemum tenuifolium</i> Schrad.			32
<i>Solidago nemoralis</i> Ait.			32
<i>Schizachyrium scoparium</i> (Michx.) Nash.			28
<i>Liparis liliifolia</i> (L.) Rich.			28
<i>Daucus carota</i> L.			24
<i>Poa compressa</i> L.			24
<i>Poa pratensis</i> L.			24
B. Shrubs and vines commonly found in the study plots.			
SPECIES			FREQ.
<i>Toxicodendron radicans</i> (L.) Kuntze.			64
<i>Rubus allegheniensis</i> Porter.			60
<i>Rhus glabra</i> L.			56
<i>Vitis aestivalis</i> Michx.			40
<i>Corylus americana</i> Walt.			36
<i>Rosa multiflora</i> Thunb.			24
<i>Rhus copallina</i> L.			20
C. Trees commonly found in the study plots.			
SPECIES	COMMON NAME	SPECIES SYMBOLS	FREQ.
<i>Prunus serotina</i> Ehrh.	Wild Black Cherry	BC	92
<i>Sassafras albidum</i> (Nutt.) Nees.	Sassafras	Sa	92
<i>Acer rubrum</i> L.	Red Maple	RM	80
<i>Ulmus americana</i> L.	American Elm	AE	80
<i>Fraxinus americana</i> L.	White Ash	WA	76
<i>Quercus velutina</i> Lam.	Black Oak	BO	60
<i>Cornus florida</i> L.	Flowering Dogwood	FD	56
<i>Ulmus rubra</i> Muhl.	Slippery Elm	SE	56
<i>Juniperus virginiana</i> L.	Red Cedar	RC	52
<i>Liriodendron tulipifera</i> L.	Tulip Tree	TT	52
<i>Nyssa sylvatica</i> Marsh.	Sour Gum	SG	44
<i>Diospyros virginiana</i> L.	Persimmon	Pe	40
<i>Quercus imbricaria</i> Michx.	Shingle Oak	SO	40
<i>Acer saccharum</i> Marsh.	Sugar Maple	SM	36
<i>Amelanchier arborea</i> (Michx. f.) Fern.	Shadbush	Sh	36
<i>Quercus rubra</i> L.	Red Oak	RO	36
<i>Betula nigra</i> L.	River Birch	RB	12
<i>Ostrya virginiana</i> (Mill.) K. Koch.	Hop Hornbeam	HH	12
<i>Malus ioensis</i> (Wood) Britt.	Iowa Crab Apple	IC	4

TABLE II Soil and Overstory Conditions at *Lycopodium flabelliforme* Sites in Central Indiana and Illinois.

Site	Location	SOIL (A horizon)										OVERSTORY (Trees 1" and above d.b.h.)									
		Texture					Soil Class	% Organic Content	pH	# Per Site	Basal Area Per Site (sq. ft.)	Av. Diam. Inches	Age Oldest Tree	Species First in IV		Species Second in IV		Species Third in IV			
		% Sand	% Silt	% Clay	Sp. I	IV								Sp. I	IV	Sp. I	IV	Sp. I	IV		
CRAWFORD CO. ILL.																					
1	Sect. 4 R12W T5N	45	49	6	loam	2.5	5.2	45	2.67	3.0	23	RB	157	WA	31	RM	5				
2	Sect. 3 R12W T5N	32	50	17	loam	2.5	4.8	55	7.07	3.6	22	BO	47	WA	33	RB	30				
3	Sect. 35 R12W T6N	33	57	10	silt loam	2.2	5.7	43	6.52	4.4	32	Sa	137	RM	39	SO	13				
4	Sect. 25 R12W T6N	47	42	11	loam	2.6	4.3	64	2.85	2.6	32	Sa	144	Pe	39	RM	5				
5	Sect. 7 R10W T5N	48	46	6	loam	2.1	5.2	30	2.45	3.5	9	TT	168	SM	28	BC	4				
6	Sect. 4 R12W T5N	49	45	6	loam	2.1	4.6	45	1.48	2.2	14	HH	51	RB	41	Sa	19				
7	Sect. 36 R12W T6N	14	79	7	silt loam	2.6	5.0	27	1.31	2.7	22	Pe	101	Sa	68	RM	17				
8	Sect. 36 R12W T6N	27	65	8	silt loam	3.4	4.4	72	5.88	3.4	32	RM	85	Sa	60	Pe	24				
9	Sect. 1 R12W T5N	27	64	9	silt loam	2.3	3.7	30	7.81	5.8	50	RO	64	BO	40	SO	33				
10	Sect. 12 R12W T5N	27	63	10	silt loam	2.2	3.9	38	4.70	3.3	56	Sa	91	RM	48	SO	35				
RICHLAND CO. ILL.																					
11	Sect. 2 R9E T12N	38	49	13	loam	2.4	4.8	80	5.99	3.2	19	RM	161	Sa	17	Pe	13				
12	Sect. 2 R9E T12N	37	51	12	loam	2.7	4.5	84	4.22	2.5	23	Pe	74	RM	69	Sa	26				
MONTGOMERY CO. IND.																					
13	Sect. 11 R6W T17N	16	75	9	silt loam	2.7	5.9	55	6.60	3.9	20	TT	63	SM	36	RM	36				
14	Sect. 1 R6W T17N	14	78	8	silt loam	3.0	6.1	67	4.87	2.8	22	TT	77	WA	35	Sa	19				
15	Sect. 1 R6W T17N	16	73	11	silt loam	2.2	6.1	71	4.95	2.8	28	Sa	39	SM	38	TT	33				
16	Sect. 10 R6W T17N	17	74	9	silt loam	2.7	5.4	62	2.06	2.1	26	IC	80	FD	60	Sa	14				
17	Sect. 10 R6W T17N	15	71	14	silt loam	2.7	5.6	38	1.70	2.6	25	FD	112	RM	24	Sa	24				
18	Sect. 10 R6W T17N	16	71	13	silt loam	3.7	5.8	21	4.05	4.8	26	TT	56	RM	30	Sa	29				
PARK CO. IND.																					
19	Sect. 3 R8W T16N	23	63	14	silt loam	2.3	5.7	55	5.06	3.2	22	TT	65	RM	63	Sa	22				
20	Sect. 3 R8W T16N	45	45	10	loam	3.6	5.5	29	1.39	2.5	16	RM	84	TT	58	WA	27				
21	Sect. 28 R7W T17N	14	76	10	silt loam	2.4	5.2	76	6.25	3.4	21	RM	114	TT	42	RC	16				

in the colonies were stunted and less well developed than the individuals that were not associated directly in the Ground Pine.

A total of 36 herbaceous species were found growing in the Ground Pine populations. Of these taxa, none were found in all of the colonies. The most commonly encountered species include *Potentilla simplex* which occurred in 80% of the colonies, *Panicum lanuginosum* in 64%, *Asplenium platyneuron* in 52%, and *Achillea millefolium* and *Desmodium paniculatum*, both in 44% of the colonies. Besides the taxa listed in Table I, Part A, some of the species occasionally encountered include *Agrimonia parviflora* Ait., *Botrychium dissectum* Spreng. var. *obliquum* (Muhl.) Clute., *Cassia fasciculata* Michx., *Danthonia spicata* (L.) Beauv., *Eupatorium perfoliatum* L., *Fragaria virginiana* Duchesne., *Geum canadense* Jacq., and *Panicum microcarpon* Muhl.

Woody Vegetation: A total of 16 species of shrubs and vines were found in the quadrats. The most commonly encountered of these taxa and their frequencies are listed in Table I, Part B. Besides these species listed, some of the taxa occasionally encountered include *Celastrus scandens* L., *Hydrangea arborescens* L., *Lonicera japonica* Thunb., *Rhus typhina* L., and *Viburnum prunifolium* L.

Forty-six tree species were also found within the quadrats studied. Of these taxa, only 31 have individuals exceeding 1 inch d.b.h., and the most commonly encountered are listed in Table I, Part C, along with their frequencies. In Table II a more detailed analysis of the overstory is given. For the most part the overstory is that which typically occurs in upland old-fields throughout east-central Illinois and adjacent Indiana. In the quadrats there is an average of 51.5 individuals, the total basal area averages 4.24 square feet, the average diameter rarely exceeds 4 inches d.b.h., while the age of the oldest tree average 26 years (Table II). Also listed in Table II are the taxa that form the dominant overstory (those ranking first, second, or third in IV) in the quadrats. The relative importance of the overstory trees can be determined by considering the number of quadrats on which each species is the leading dominant (highest IV), or ranks second or third. Of the species encountered, *Sassafras albidum*, *Acer rubrum*, and *Liriodendron tulipifera* have the highest IV's in 15 of the quadrats, and rank second or third on most of the other quadrats.

***Lycopodium flabelliforme* Colonies:** The colonies studied vary greatly in size. Two consist of a single individual with a horizontal stem to 5 dm long and a few erect stems. The remaining colonies are much larger, usually circular in outline, and vary from about 1 m to nearly 20 m in diameter. In these colonies the erect stems form a dense mat in which few other taxa grow.

Very little is known concerning the rate of growth of the Ground Pine colonies. However, since the colonies are nearly circular in outline it is likely that they started from a single individual and all subsequent growth is asexual as a result of the creeping, horizontal stems. One colony (site 19) located in the Alle Memorial Woods, Park County, Indiana was first observed during the summer of 1958. At that time the colony was nearly circular in outline and about 1 m in diameter (Dr. Marion Jackson, Indiana State University—personal communication). When this colony was measured during the summer of 1976 it

was still nearly circular in outline, and 15.2 m in diameter. This indicates that the average growth per year was nearly 4 dm. Using this rate of growth, some of the larger colonies examined during the present study are at least 20 years old.

The reason for this invasion of Ground Pine into oldfields in Indiana and Illinois is not known, but is probably the result of an increased planting of pines about 25 years ago. The spores and young plants of *Lycopodium flabelliforme* were probably attached to the roots of the pines, or mixed with the packing material, and became established after planting. Many of the early reports for this species list it as adventive under pines, and many of the sites examined during the present study are in the general area of pine plantations.

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