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The purpose of ONPS is to encourage the study, protection, propagation, appreciation and use of the native plants of Oklahoma. Membership in ONPS shall be open to any person who supports the aims of the Society. ONPS offers individual, student, family, and life memberships.

Cover photo: *Passiflora incarnata* L., Passionflower by Kim Shannon. “Nature does nothing uselessly.” Aristotle (384 BC-322 BC).

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Forward

In this fifth year of publication we are experiencing a wider interest in *The Oklahoma Native Plant Record*. Subscriptions go to members, libraries, and herbaria, as well as amateur and professional botanists across the nation. We have had the honor of presenting, for our readers, historic and seminal works never before published; works that had only been available as photocopies of research done for Masters' theses and Ph.D. dissertations. With most we have also published current regional floras for comparison with the historic works. Soon we hope to have all these works available for global inquiry when our pages become available on the world wide web.

Along with regional floras we've offered interdisciplinary articles describing human impacts on Oklahoma's vegetation as well as species distribution information of interest to landscapers and naturalists. The wide variety of articles reflects the diversity of membership in the Oklahoma Native Plant Society. It is clear that the journal best serves the purposes of the Society when it cross-communicates between disciplines, geographic borders, professionals, and non-members. We welcome and celebrate the variety of sources offered to our readers.

The pimpled prairie article provides one of those cross-disciplinary research articles. It is an interesting look at one of the causes of Oklahoma's native floral diversity; its complex soil and plant interactions. I think you'll find it intriguing and hopefully, worthy of additional research.

Hoagland and Buthod have once again provided an up-to-date regional flora, this one from Pawnee County. With their work our species lists will eventually cover the entire state.

Crawford and Crawford, a new husband and wife research team, have begun their careers with the thoroughly done flora additions for Garvin County. We look forward to hearing more from them.

In this issue we also pay tribute to Dr. John Taylor, co-author with his wife, Dr. Constance Taylor, of the single most used botanical resource for information regarding Oklahoma's native species, *An annotated list of the ferns, fern allies, gymnosperms and flowering plants of Oklahoma*. We are pleased to include his Masters thesis which began his life-long career as researcher and teacher. John passed away in November of 2004. Connie has done a great job of reformatting his work for present-day publishing standards and we are very grateful for her help.

There is still much research to be done on Oklahoma's native flora and the next generation needs to know where to begin in this awesome yet rewarding task. So please continue to tell others about the *Oklahoma Native Plant Record* and thank you for reading it.

Sheila A. Strawn
2005

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Relationship of Forest Vegetation to Soils on Geological Formations of the Oklahoma Gulf Coastal Plain

Raymond John Taylor, Professor Emeritus, deceased
Southeastern Oklahoma State University

Dissertation submitted to the Graduate Faculty
University of Oklahoma, Norman, Oklahoma, 1967

Portions of this paper were recently presented at the Cross Timbers Symposium at the Botany 2005 Symposium in Austin, Texas. I have come to realize the importance of this data as a baseline for the composition of forests in the Gulf Coastal Plain. Since the data were collected about 40 years ago, many changes have occurred including our expanding population, increase in rural housing, construction of pipelines, and clearing for pasture and cultivation. Many of the sites studied have been modified or completely disappeared. Another important change is the tremendous expansion of *Juniperus virginiana* (red cedar) due to absence of fire. In the sampling of these 13 forests 40 years ago, this species was found in only one stand, and as a sapling. Other invasive plants include *Ligustrum sinense* (privet), an evergreen shrub that can expand into clones by underground roots, and the invasive vine *Lonicera sempervirens* (Japanese honeysuckle) which is controlled in many areas by cattle grazing. Both of these species will continue to expand and affect our native flora.

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INTRODUCTION

In Oklahoma it has been noted that certain types of forest grow on soil derived from sandstone formations or other sandy material, whereas grassland usually develops on soil derived from limestone or clay (Bullard 1926, Bruner 1931, Little 1938, Duck and Fletcher 1945, Gray and Galloway 1959). Various relationships of vegetation types and geological material in Oklahoma are discussed in the following papers: Taylor and Penfound (1961), Buck (1964), Crockett (1964), Dwyer and Santelman (1964) and Hutcheson (1965). Geologists have long realized the value of differences in types of vegetation in

Taylor, R.J.
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geological mapping (Cuyler 1931). The use of aerial photographs in geological mapping today is a standard practice (Gibbs 1950, Olson 1965).

Differences in vegetation may often be related to differences in soil. Rice et al. (1960) found that three species of grass came into revegetating old fields in order of increasing nitrogen and phosphorus requirement. Beals and Cope (1964) found differences in herbaceous vegetation in Indiana forests associated with differences in drainage and soil moisture. Beadle(1966) discussed the role of soil phosphate in the molding of segments of the Australian flora. Mooney (1966) found that a number of soil properties were involved in the altitudinal distribution of two species of *Erigeron*. Porter (1966) found a difference in the distribution of two ecotypes of *Panicum virgatum* associated with a difference in nitrogen requirements.

At the same time it is known that soil is influenced by the type of plants that grow on it. The role of certain legumes and a few other plants in increasing soil nitrogen is well documented. Eyer (1963) notes that quite different soil may develop under grasslands than under forest, even when the two areas lie side by side. Braun (1964) discussed the striking difference in color and texture in some islands of prairie soil that are surrounded by forest. Zinke (1962) found differences in soil under individual forest trees.

Thompson (1958) states that a soil is the product of the interaction of parent material, climate, vegetation, topography, and time. Only a few studies that have dealt with the relationships between vegetation and geological material in Oklahoma have involved soil analysis. In this study the vegetation of 13 forest communities was analyzed. They are located in the Bryan County portion of the Oklahoma Gulf Coastal plain. The soil in which they grew was analyzed and the communities were correlated with soil and geological material.

The geological formations of the old Cretaceous Gulf Coastal Plain is composed of sandstones, limestones, and clays that lie parallel, running east and west, but interrupted by a number of flood plains. Since much of the area is forested, it provides an excellent location for study of forest types and soils on different geological material.

Only communities growing on relatively level land and on soil derived from a particular recognizable geological formation were used. Ten upland and three bottomland communities were selected for investigation. These communities were located on Antlers sand (previously known as Paluxy sand of the Trinity Group (Forgotson 1957, and Redman, 1964), Pawpaw sand, Woodbine sand, Weno formation, Goodland limestone, Duck Creek limestone, Bennington limestone, Kiamichi clay, and alluvium from the flood plains of two rivers. All of these formations except the recent alluvium are Cretaceous in age.

The vegetation analysis included the following parameters: woody species grouped as 1) trees, 2) seedlings and saplings, 3) shrubs and vines; the mean area, frequency, density, size class, basal area, and plants per acre. The soil properties studied included the following: soil texture, pH, organic carbon content, organic matter, nitrogen, phosphorus, volume-weight, and soil color.

The 13 communities enable comparison of 1) communities growing on soils derived from sandstone, limestone, clay, and alluvium; 2) two different stages of succession of alluvium soil (Red River communities); 3) alluvial soil from two stream systems; and 4) communities growing approximately 40 miles apart on the same formations (Pawpaw and Woodbine sands).

DESCRIPTION OF AREA

The Gulf Coastal plain of Oklahoma is located in the northwest portion of the Gulf Coastal Plain Province of Fenneman (1938). It is an area that extends from the Arkansas border westward to western Love County. The maximum north to south distance in Oklahoma is slightly over 35 miles. The main settlement of the area took place in 1832 when the tribes of the Choctaw Indians were resettled in this part of Indian Territory. Continuous cultivation dates from this time or slightly earlier.

The coastal plain is mainly forested, but with occasional strips of grassland mainly along the northern portion and becoming predominantly grassland in the western extent. Bruner (1931) classed the eastern half of the area as composed of an oak-hickory association, but oak-hickory savanna was the important type of vegetation in the western portion. Blair and Hubbell (1938) placed most of this area in their Osage Savanna grassland and allied it with the central part of the state. Duck and Fletcher (1945) listed approximately 3,600 square miles of forest and only 800 square miles of grassland for the Oklahoma Coastal Plain. Their forested areas contain five different types: loblolly pine, oak-pine, oak-hickory, post oak-blackjack oak, and bottomland. Braun (1964) refers to this area as a forest prairie transition. Rice and Penfound (1969) found post oak, blackjack oak, and black hickory to be the most important woody species in the coastal plain area. Kuchler (1964) maps the potential vegetation as oak-hickory-pine, oak-hickory, cross timbers (post oak-blackjack oak), bluestem prairie, and the southern flood plain forest. The vegetation of this area has been subjected to fire and the influences of various kinds of agricultural practices since at least 1832.

CLIMATE

The area in which the stands are located has a moist subhumid climate (Thornthwaite 1948). Average annual precipitation ranges from 36 inches in the southwest to slightly over 40 inches in the east (Wahlgren 1941). Average annual snowfall is 2.4 inches. Rainfall is relatively evenly distributed through the year with April, May, June, and July receiving heaviest amounts (Table I). The average annual temperature is 63.4° F. with an average of 83° F. in July and a low of 42° F. in January. Frost free days are from about March 25 to Nov. 5, giving the county a 230 day growing season.

TOPOGRAPHY

The Gulf Coastal plain in Oklahoma is characterized by low, eroded, gently rolling hills. Local relief is less than 100 feet (30.48 m). There are also extensive areas of slightly undulating surface which are found mainly in the more northern portion. Elevation ranges from approximately 750 feet (228.6 m) in the north to slightly less than 450 feet (137.16 m) in the southwest. Resistant strata form northward facing escarpments with gentle dip slopes toward the south. One of these forms the ridge that crosses the county in an east-west direction near the middle of the study area. A second escarpment has been formed along the contact of the Goodland limestone and the Antlers sand. In general the study area slopes from north to south. Drainage is essentially dendritic, reflecting the relative uniform nature of the bedrock and lack of structural control. The area is drained principally by Island Bayou, Blue River, and White Grasses Creek into the Red River. The northeastern area is drained by Clear Boggy Creek. Several small streams along the west drain into the Washita arm of Lake Texoma. Extensive, relatively level flood plains are found along most of the rivers. Along some streams, natural levees have developed so that the portions of the flood plain farthest from the streams are lowest. As a result, these flood plains are inundated and wet during rainy periods for long periods. This has resulted in extensive swampy bottomland forests in many places. Minor topographical features of the area are bench like terraces which are found mainly along the Red River. There are also high-level terrace remnants, presumably early Pleistocene in origin. The controversial pimple mounds (Melton, 1954) are found in many unplowed grasslands throughout the coastal plain with some in the immediate area of study stands. Another feature which none of the geologists who have worked here have discussed are the hillside seeps or bogs (Taylor and Taylor 1965).

GEOLOGY

Except for quaternary alluvium, only Cretaceous formations of the Comanchean and Gulfian series are recognized as occurring at the surface in the study area. At present no detailed geological study exists that covers all of it. The northern part was studied and mapped by Taff (1902, 1903). The region mapped by Stephenson (1919) covers the southeastern portion of the study area. The legend of the Geologic Map of Oklahoma (Miser 1954) contains much information about the geological studies done here. Hedlund (1962) studied the Red branch member of the Woodbine formation. Recently a very fine study has been completed covering a large portion of Bryan County (Olson 1965). All but five of the stands and all geological formations of this study lie within his area of investigation.

Other investigations dealing with Cretaceous and Quaternary geology of the Gulf Coastal Plain of southeastern Oklahoma are listed: Love County (Bullard 1925); Marshall County (Bullard 1926); Choctaw County (Gibbs 1950); McCurtain County (Heilborn 1949, Skolnick 1949, and Davis 1960); Lower Cretaceous (Miser 1927); Trinity Group (Vanderpool 1928); Woodbine formation (Curtis 1960); and the Goodland Limestone (Blan 1961).

STRATIGRAPHY, SOIL TYPES, AND STAND LOCATIONS

The Cretaceous formations occurring at the surface are considered to belong to two series, the Comanchean and Gulfian. The oldest, the Comanchean, has been further divided into three groups. Oldest to youngest, they are the Trinity, Fredericksburg, and Washita. A generalized columnar representation of the geological material found at the surface is shown in Figure 2. This columnar section is adapted mainly from Olson (1965).

Soil types mapped for each stand were taken from the field data of Mr. Carter Steere, Soil Conservation Service, U.S. Department of Agriculture who was conducting a new soil survey of Bryan County.

Antlers Sand consists of approximately 300 feet (110 m) of loosely consolidated white to yellow cross-bedded pack sand inter-bedded with clay and sandy clay. At places there are moderately indurated layers of iron-cemented sandstone up to 3 feet (0.9 m) thick. The soil formed from this material is generally a sandy or sandy loam with grayish brown surface and yellowish sand clay loam subsoil. Soil type is in the Bowie series. Usually forest vegetation develops on soil from this formation. Stand location is in Sec. 8, T5S-R13E, approximately 9.5 miles northeast of Bennington.

Goodland Limestone is a compact, finely crystalline limestone that becomes nodular near the bottom. Since it overlies the easily eroded Antlers Sand, a low escarpment forms along their contact. It is about 20 feet (6.1 m) thick in the study area. Soil formed from the Goodland is shallow clay to sandy clay loam, reddish black to dark reddish brown, only slightly differentiated in the lower portion. Soil type is in the Claremore series. Several types of vegetation develop on this formation from grassland to forest depending on occurrence of fire. The Goodland limestone stand was located in Sec. 7, T5S-R13E, approximately 9 miles northeast of Bennington.

Kiamichi Clay is mainly a black shaly clay which is thinly bedded with iron-stained laminae. The upper portion is a hard yellowish-brown oyster shell limestone, large slabs of which break off as a result of slumping of the soft underlying clays, forming what is sometimes referred to as edge rock soils. This formation is about 35 feet (10.67 m) thick. Soils that develop from it consist of brown to dark brown clay at the surface with yellowish brown to brown clay subsoils. Soil Type is Denton edge rock series. The usual vegetation type on Kiamichi Clay is grassland. The forest stand studied was located in Sec. 8, T5S-R9E, approximately 6.5 miles northwest of Armstrong.

Duck Creek Limestone consists of approximately 100 feet (30.5 m) of inter-bedded soft cream-colored limestone and bluish-gray shaly clay. The soil that develops on this formation is a very dark gray clay at the surface with a dark gray calcareous subsoil. The soil of the study stand was very shallow with limestone rock at the surface in many places. Soil type is in the San Saba series. Grassland is the usual vegetation on this soil, but in the absence of fire a weedy forest may develop. The Duck Creek stand is located approximately seven miles northwest of Armstrong in Sec. 5, T5S-R9E.

Weno Formation consists of ferruginous sandstone, brownish marls, marly clays, and impure limestone. It is about 100 feet (30.5 m) thick in the study area. The soil has a yellowish-brown to grayish-brown sandy loam surface with a yellow red sandy clay loam subsurface. Its appearance at the surface was very similar to the Pawpaw sand which lies above it. Sometimes it is very difficult to distinguish between them. The vegetation is similar in appearance with no discernable break at their contact. However, this contact is usually marked by a thin limestone ledge, the quarry limestone, which occurs in the upper portion of the Weno. Soil type is in the Ruston series. Vegetation is forest unless cleared. The stand is located in Sec. 11, T5S-R7E, approximately four miles northwest of Mead.

Pawpaw Sand is composed mainly of yellow to red ferruginous sand inter-bedded with yellow to gray sandy clay and is about 50 feet (15.24 m) in depth. Soil formed was essentially like that of the Weno, being somewhat more sandy and more grayish brown at the surface. Soil type is in the Ruston series. Vegetation is forest unless cleared. The Pawpaw East stand is located in Sec. 12, T6S-R12E, approximately 4.5 miles northeast of Bennington. The Pawpaw West is located in Sec. 5, T6S-R8E, approximately 2.5 miles northwest of Silo.

Bennington Limestone consists of 10 to 20 feet (6.1 m) of hard brownish-yellow crystalline limestone. Olson (1965) listed a depth of seven feet (2.1 m) for eastern Bryan County. The soil of the forest stand studied was a shallow dark brown loam only slightly differentiated in the lower portion. Limestone rock occurred at the surface in many places. Soil type was in the Hunt series. An open, weedy, scrubby forest type of vegetation had developed in the absence of fire. The stand is located in Sec. 14, T6S-R12E, approximately two miles northeast of Bennington.

Woodbine Formation is a series of red to tan soft moderately indurated ferruginous sands interbedded with silty clays and carbonaceous shale. It is over 300 feet (91.4 m) thick. The soil that developed in the study area was similar to that of the Pawpaw sand and is also in the Ruston series and supports forest vegetation. Two stands were studied: Woodbine East is located in Sec. 5, T7S-R13E, approximately five miles southeast of Bennington. The western stand is located in Sec. 1, T7S-R7E, approximately 2 miles southwest of Mead.

Red River Alluvium was of two distinct types as indicated by the differences in soils and types of vegetation. The soils of the two **Red River** flood plain stands were similar, containing reddish brown clay in the surface soil with reddish sandy loam in the subsoil. In places, the subsoil had areas of clay several inches thick, and at others almost pure sand occurred. Soil types were in the Yahola series. Bottomland forests prevailed. An early succession forest stand, referred to as young Red River, was located in Sec. 22, T8S-R11E, approximately 3 miles southeast of Albany. The mature forest stand, referred to as old Red River, was located in Sec. 17, T8S-R14E, approximately 14.5 miles southeast of Bennington.

Clear Boggy alluvium had a very dark gray clay at the surface with a slightly lighter gray clay subsoil. The soil type is in the Osage series. The study stand is located in Sec. 8, T5S-R13E, 8.5 miles northeast of Bennington.

The location of the stands and the geology of the study area are shown in Fig. 1. This map is adapted mainly from Miser (1954) and Olsen (1965).

METHODS

After recognizance of the Gulf Coastal Plain strata exposed at the surface where forests occurred, 13 stands were selected for further study. To reduce effects of climate all stands were located in a 25 mile north to south by 40 mile east to west section of Bryan County, Oklahoma. Care was taken to select stands as mature as possible, and well within the area of outcrop of a particular formation. Only stands larger than 40 acres were utilized to permit a satisfactory sample.

The point-centered quarter method was used to obtain data for the vegetation analysis. This method was described and tested by Cottam and Curtis (1956). They found that the types of distance methods commonly used in forest vegetation analysis, the quarter method gives least variable results for distance determinations, provides more data on tree species per sampling point, and is least susceptible to subjective bias. A series of points were established at predetermined intervals along a transect. A total of 25 points (100 quadrants) at 20 pace intervals were taken in each stand. The distance to the nearest individual in each of the four quadrants was determined. Data taken were species identification, d.b.h. (diameter at breast height). Data was also collected on shrubs and vines and seedlings and saplings.

Diameter at breast height was used to compute basal area for each species and total basal area for the stand. Distance to the nearest individuals were averaged to obtain mean distance. The mean of all distances obtained from one stand has empirically (Cottam, Curtis, and Hale 1953) and theoretically (Morisita 1954) been shown to be equal to the square root of the mean area per plant. By dividing 43,560 square feet by the mean area per plant, the number of plants per acre was derived. The mean area and plants per acre for trees, seedlings-saplings, and shrubs-vines, was computed in this manner. The number of points at which a species was encountered divided by the total number of points times 100 was used to obtain species frequency within a stand. Density of a species was determined by taking the number of a species tallied for a stand divided by the number of quadrants times 100. Mean area, number of plants per acre, and mean distance are all related to density. The relative values for frequency, density, and basal area or dominance were computed by the formulas below.

Relative frequency =

$$\frac{\text{frequency of a species}}{\text{total frequency of all species}} \times 100$$

Relative density =

$$\frac{\text{density of a species}}{\text{total density of all species}} \times 100$$

Relative basal area =

$$\frac{\text{basal area of a species}}{\text{total basal area of all species}} \times 100$$

Importance percentage of trees was obtained by adding relative frequency, relative density, and relative basal area and dividing by three. Importance percentage of seedling-saplings and shrubs-vines was obtained by averaging relative frequency and relative density.

Approximately 2,000 specimens of vascular plants have been collected from the study area, including at least one specimen of each species discussed. All were deposited at the Bebb Herbarium, University of Oklahoma, in Norman.

Soil samples were taken from 0-6 inches at 10 stations in each area. Only the 0-6 inch layer was sampled as soil covering most of the limestones was so shallow it was difficult to sample even to this depth in many places. Stations were evenly distributed in stand. A soil auger was used, with care taken to remove all duff before collecting samples. Soil from one area was placed in a single container then throughly mixed, air dried, sifted through a 2 mm. sieve, and stored in a stoppered container. A portion from each of the composite samples was oven dried at 105° C. for 48 hours to obtain the moisture content. All determinations that involved specific quantities of soil are based on oven-dry conditions. After soil pH and soil texture were determined, the remaining portions of each composite sample were ground through a soil mill and stored for further analysis. Soil reaction was determined by a Beckman glass electrode pH meter. A method modified from Bouyoucus (1936) was used for determination of soil texture. Determination of organic carbon was by the method outlined by Piper (1944). The method used for determination of total phosphorus was modified from Shelton and Harper (1941). Total nitrogen was determined by the method of Noggle and Wynd (1941). All determinations were run in duplicate. If the values for the two samples were essentially the same, they were averaged and this value used. If the two samples varied more than a few points, additional samples were analyzed. Volume-weight (soil compaction) was determined by the following method. Ten holes per stand approximately 2 inches in diameter and 3 inches deep were excavated. Soil from each hole was collected and later oven dried. Then each hole was filled with oven-dry quartz sand and the volume recorded. The oven-dry weight of the collected soil was determined and compaction was calculated by dividing this weight in grams by the cubic centimeters of sand. The air dry color of each soil sample was determined with the aid of a Munsell Color Chart.

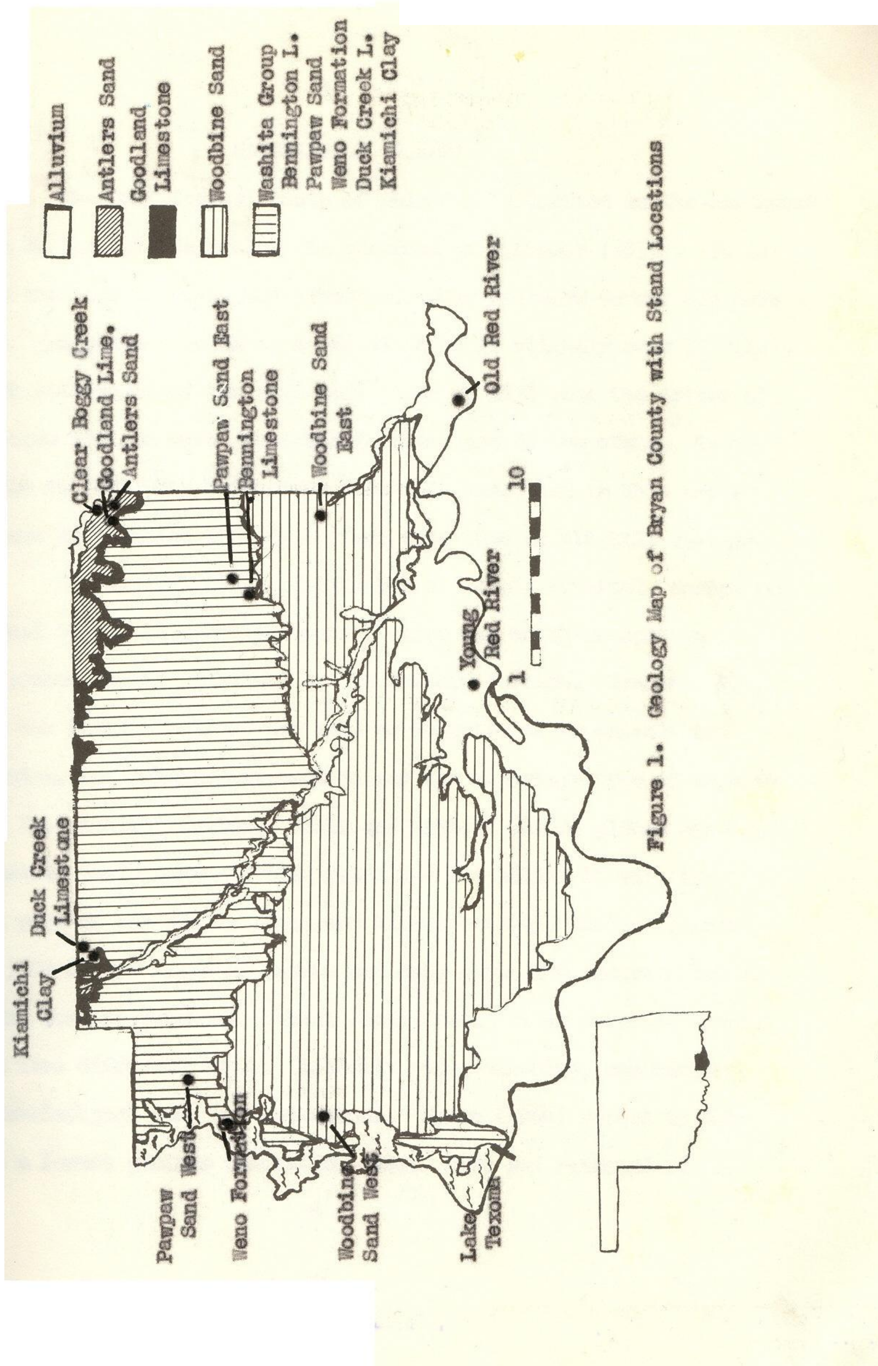

Figure 1. Geology Map of Bryan County with Stand Locations

Age	Series	Group	Formation
Recent			Mainly Alluvium
Pleistocene			Terrace and Alluvium
	Gulfian		Eagle Ford Shale Woodbine Formation
Cretaceous	Comanchean	Washita	Bennington Limestone Pawpaw Sand Weno Formation Denton Clay Fort Worth Limestone Duck Creek Limestone
		Fredericksburg	Kiamichi Clay Goodland Limestone
		Trinity	Antlers Sand

Figure 2 A generalized columnar representation of the geological material found at the surface in the study area

Table I   Mean precipitation and temperature based on 57-60 years of weather data

Month	Average Monthly Precipitation in Inches	Average Monthly Temperature in Degrees F
January	2.24	42.4
February	2.59	45.9
March	2.87	54.6
April	4.52	63.0
May	5.40	70.5
June	3.75	79.0
July	3.21	83.0
August	2.75	83.2
September	3.03	76.3
October	3.77	65.2
November	2.62	53.2
December	2.62	44.3
Yearly Average	39.37	63.4

Data from U. S. Department of Commerce, Weather Bureau, Climatography of the United States No. 86-30. 1965. Durant, Southeastern State College Station.

Table II Importance percentage of trees in the 13 forest stands studied. An x represents a value of less than 5 per cent.

Species	BB	OR	YR	A	WE	WW	PE	PW	WF	GL	BL	DC	KC
Ulmus crassifolia	26									x		67	75
Celtis laevigata	27	35								x	34	x	
Fraxinus pennsylvanica	25	19	11	x									
Maclura pomifera	8		x	x						6	27	25	25
Quercus phellos	9												
Q. nigra	x												
Q. macrocarpa	x												
Ulmus rubra	x	35											
Crataegus spp.	x						x				x		
Carya illinoensis		x	x										
Acer negundo		x	x										
Diospyros virginiana		x			x								
Gleditsia triacanthos		x		x	x						11	x	
Morus rubra		x	x			x				x			
Platanus occidentalis		x											
Populus deltoides			74										
Salix nigra		x	7										
Carya texana				37	9	16	42	31	x	29			
Quercus stellata				27	38	45	17	30	68	20			
Q. velutina				13	13	21	13	11		x			
Q. falcata				x	17		x			9			
Q. marilandica				x	x	12	10	19		x			
Ulmus alata				x	10	x	5	7	13	x	16		
Cercis canadensis				x				x		x			
Ulmus americana				x		x		x			x		
Carya tomentosa				x	x		8			x			
Fraxinus americana									17	5	x		
Quercus shumardii									x	8	x		
Bumelia lanuginosa										x	x	x	
Q. muehlenbergii										x			
Prunus spp.										x			
Q. rubra				x									

BB - Boggy Creek Bottomland
OR - Old Red River Alluvium
YR - Young Red River Alluvium
A - Antlers sand
WE - Woodbine East
WW - Woodbine West
PE - Pawpaw East
PW - Pawpaw West
WE - Weno Formation
GL - Goodland Limestone
BL - Bennington Limestone
DC - Duck Creek Limestone
KC - Kiamichi Clay

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Table III Number of woody plants, basal area, and d.b.h. or trees in the forest stands investigated

Stands	Trees per acre	Mean d.b.h. in Inches	BA/Acre in sq. feet	Seedlings Saplings per acre	Shrubs Vines per acre
Bottomland Stands					
Clear Boggy Creek	111.2	11.91	104.2	2,807	105
Red River Alluvium					
Young Stand	112.6	8.45	51.7	144	3,457
Old Stand	190.0	10.53	142.5	358	3,723
Upland Stands					
Sandstone Formations					
Antlers Sand	244.8	7.32	88.7	6,396	7,169
Woodbine East	171.0	8.90	90.3	6,443	5,556
Woodbine West	254.6	6.69	75.3	1,308	8,377
Pawpaw East	240.4	6.13	65.7	4,229	3,556
Pawpaw West	160.4	8.40	81.9	8,677	3,704
Weno Formation	245.1	6.10	61.6	2.774	3,723
Limestones and Clays					
Goodland Limestone	277.5	6.76	85.1	9,248	2,074
Bennington L.	235.2	6.82	86.8	1,571	259
Duck Creek L.	173.0	5.09	26.0	486	–
Kiamichi Clay	265.4	5.68	62.4	563	511
Stands Average	206.3	7.59	78.6	3,461.8	3,247.2

Table IV Importance percentage of seedlings and saplings in the 13 forest stands studied. An x represents a value of less than 5 per cent.

Species	BB	OR	YR	A	WE	WW	PE	PW	WF	GL	BL	DC	KC
Fraxinus pennsylvanica	56		22	15							12		15
Celtis laevigata	37	26	x	10	x			x	x	14	22	35	18
Ulmus crassifolia	x									x		45	37
Gleditsia triacanthos	x	x			x				x		16	x	
Sapindus drummondii		26											6
Morus rubra		15	10	8		x				x	x		
Ulmus rubra		13											
Maclura pomifera		6	x							x	15	14	10
Acer negundo.		x	x										
Carya illinoensis		x	x							x			x
Sophora affinis		x											
Quercus muehlenbergii		x								x			x
Ulmus americana		x	x							x			
Salix nigra			20										
Populus deltoides			16										
Juniperus virginiana			11								5		
Diospyros virginiana			x		x					x	x		
Cornus florida			x		6			x					
Quercus velutina			x	5	7	17	16	12		x			
Ulmus alata				48	58	52	48	37	39	35	17		
Quercus stellata				18	x	22	17	12	25	5			
Carya texana				7	10	x	8	17	x	5			
Q. marilandica				x		x	x	x					
Q. rubra				x									
Q. falcata				x	8		x			x			
Sassafras albidum				x									
Prunus spp.				x									
Carya tomentosa					x		x						
Cercis canadensis								9	x	6			
Fraxinus americana							x	19		19			
Bumelia lanuginosa								x	x		x		x
Quercus shumardii										x		x	
Crataegus spp.											x		
Q. nigra											x		

BB - Boggy Creek Bottomland
OR - Old Red River Alluvium
YR - Young Red River Alluvium
A - Antlers sand
WE - Woodbine East
WW - Woodbine West
PE - Pawpaw East
PW - Pawpaw West
WE - Weno Formation
GL - Goodland Limestone
BL - Bennington Limestone
DC - Duck Creek Limestone
KC - Kiamichi Clay

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Table V Importance percentage of common shrubs and vines in the13 forest stands studied. An x represents a value of less than 5 per cent.

Species	BB	OR	YR	A	WE	WW	PE	PW	WF	GL	BL	DC	KC
Campsis radicans	19	9											
Ilex decidua	18		x	x	x	x	x	x		x	4		
Parthenocissus quinquefolia	13	49		36	20	33	21	31	x	14	x		
Vitis spp.	13	8		x	11	15	20	21	x	x			
Cretaegus spp.	8			x	x		x	x	21	9	7		11
Rhus toxicodendron	x	7	x	20	32	13	37	x		33	9		
Smilax spp.	x	x		20	x	7		12	53	18	18		
Berchemia scandens	x	x		7	x	x	x			x	18		
Symphoricarpos orbiculatus		8		x	6		x	8	8	x	39		74
Cornus drummondii			42			x				x			
Rubus spp.			34			x							
Cocculus drummondii			x		x	x					x	x	x
Rosa foliolosa				x	x		5						
Rhus copallina					11	x	x	x					
R. glabra					x		x	5	x	x			

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Table VI Physical and chemical soil factors of the study stands. Pounds per acre are based on an acre furrow slice.

Stands	% Sand	% Silt	% Clay	pH	Total Phosphorus Lbs./acre	Total Nitrogen Lbs/acre	Total Carbon Lbs/acre	C/N	Compaction g/cc
Bottomland Stands									
Clear Boggy Creek	20.1	12.9	67.0	8.0	2,273	3,666	34,053	9.29	1.05
Red River Alluvium									
Young Stand	28.6	19.4	52.0	7.6	1,664	1,594	12,688	7.96	0.92
Old Stand	27.2	21.9	50.9	7.4	2,088	2,488	19,458	7.82	0.96
Upland Stands									
Sandstone Formations									
Antlers Sand	86.6	7.0	6.4	7.3	301	442	4,925	11.14	1.13
Woodbine East	77.8	15.2	7.0	7.2	203	260	4,022	15.48	1.08
Woodbine West	88.2	7.3	4.5	6.9	287	350	5,060	14.46	0.98
Pawpaw East	85.6	8.4	6.0	6.2	309	556	5,340	9.60	1.03
Pawpaw West	88.9	5.4	5.7	6.6	541	314	6,470	20.61	1.03
Weno Formation	23.6	55.6	20.8	6.2	1,154	3,615	9,822	7.10	1.38
Limestone Formations									
Goodland Limestone	62.6	13.4	24.0	7.8	1,956	5,450	52,716	9.67	1.17
Bennington Limestone	43.6	45.9	10.5	7.3	1,861	2,768	33,139	11.97	1.27
Duck Creek Limestone	35.6	21.1	43.3	7.6	1,868	4,332	40,471	9.34	1.01
Kiamichi Clay	35.6	14.4	50.0	7.2	2,149	6,074	55,115	9.08	1.2

RESULTS
Vegetation and Soil Relationships in Individual Stands

Clear Boggy Creek Stand

Vegetation in this stand was an open elm-ash-hackberry community. It was not typical of this type in Oklahoma as the species of elm was neither *Ulmus americana* (American elm)nor *U. rubra* (slippery elm), but *U. crassifolia* (cedar elm) (Table II). It was the most open stand but had the next to highest basal area of 104 sq. ft. per acre. The average d.b.h of the stand was 11.9 inches (Table III). This type of community occurred in a number of places elsewhere in the Oklahoma Gulf coastal plain, especially in the western part, but it does not seem to have been previously described for the state. This is cover type 85 of the Society of American Foresters (1931). All further cover types mentioned are from this source. Seedlings and saplings indicate that *Fraxinus pennsylvanica* (green ash) and *Celtis laevigata* (hackberry) were becoming increasingly important, whereas there were only a few seedlings of *U. crassifolia* (Table IV). *Ilex decidua* (deciduous holly) was the most common shrub, while *Campsis radicans* (trumpet vine), *Parthenocissus quinquefolia* (Virginia creeper) and *Vitis* spp. (wild grape) were the more common vines (Table V).

The soil of this stand was a dark gray, moderately alkaline clay. The pH of 8 was the highest soil reaction for any stand, and was rather high in phosphorus, nitrogen, and organic carbon (Table VI). Since it was often inundated for extended periods each year, there were several layers of dark gray black sediment.

Young Red River Stand

vegetation was primarily of *Populus deltoides* (cottonwood) and corresponds to forest type 61 (Table II). It usually succeeds *Salix nigra* (black willow) and *S. interior* (now *S. exigua*, sandbar or coyote willow), and is followed by green ash, species of elm, and hackberry. Of all stands it had the next to lowest basal area of 54 sq. ft. per acre and was one of the most open stands (Table III). The mean d.b.h. for this stand is 8.5 inches. The number of seedlings and saplings indicated that *Fraxinus pennsylvanica* (green ash) had already become an important member although black willow still persisted. Reproduction was largely by black willow, but a number of green ash, red mulberry, eastern red cedar, and an occasional American elm forecast a change to an elm-ash-hackberry community (Table IV). *Cornus* *drummondii* (rough-leaved Dogwood) formed an important part of the understory with *Rubus* spp. (blackberry) and *Rhus toxicodendron* (poison ivy) being the main vines (Table V).

The soil was a light reddish brown, slightly alkaline clay, and was fertile compared with soils of other stands (Table VI). It was interesting to note how closely it resembled the soil of the more mature Red River floodplain stand. Sand is occasionally encountered from a few inches down to a foot or more. At other locations, clay may be found down to the three foot level. Ditches cut by farmers for drainage or other purposes showed almost pure sand was encountered at varying distances below a layer of reddish clay. Where the river moved south in its meanderings, dune areas usually formed north of the sandy bed recently vacated. Before the impoundment of Lake Texoma, these dune areas were periodically inundated by the muddy water of the Red River. Sediment coming mainly from the Permian Red beds farther west was deposited over the dunes, forming the present surface. The soil of the flood plain is one of the most fertile and most productive in southeastern Oklahoma. The effect of the stage of succession or maturity of a forest community on the soil in which it grows was well demonstrated by the difference of total phosphate, total nitrogen, and organic matter (Table VI) between this stand and the Old Red River Stand.

Old Red River Stand was a relatively typical elm-ash-hackberry bottomland forest and corresponded to forest cover type 85. *Ulmus rubra* (slippery elm) was the main species of elm. The forest basal area of 143 sq. ft. per acre was highest of any stand. It had the next highest d.b.h. which averaged 10.5 inches but the stand was relatively open (Table III). The Society of Foresters (1931) considered this type temporary and one which developed after heavy cutting. However, the study stand showed no sign of ever having been lumbered. In the central and west central part of Oklahoma, elm-ash-hackberry is the usual type of most mature bottomland stands (Bruner 1931). Associated species such as *Quercus macrocarpa* (bur oak), *Q. shumardii* (Shumard's red oak), and *Q. muehlenbergii* (chinquapin or chestnut oak) seldom become dominant and usually compose a minor portion of such stands. Further west, near the western border of Oklahoma and in the Panhandle, willow and cottonwood persist without being succeeded by elm-ash-hackberry. Perhaps as one moves away from optimum the stages to which succession can proceed becomes successively lower. Thus willow and cottonwood persist in the Panhandle, elm-ash-hackberry occurs in the central and western two-thirds of the state, and oaks, gums, maples, and cypress are common in the east. The seedlings of *Ulmus rubra* (slippery elm) and *Celtis laevigata* (hackberry) made up a large portion of the reproduction of the stand, with *Fraxinus pennsylvanica* (green ash) comprising only a minor portion (Table IV). The most common shrub was *Symphoricarpos orbiculata* (coral berry, buckbrush) with *Campsis radicans* (trumpet vine), *Parthenocissus quinquefolia* (Virginia creeper), and *Vitis* spp. (wild grape) as the more common vines (Table V).

The physical properties of the soil of this stand were very close to that of the New Red River Stand. It has approximately a forth more total phosphorus and about a third more total nitrogen and carbon per acre (Table VI).

Antlers Sand Stand supported a good upland forest principally of *Quercus stellata* (post oak) and *Carya texana* (black or pignut hickory) (Table II). The basal area of 89 sq. ft. per acre. for this stand was next to the highest for the sandy soils. It was a relatively closed stand with an average d.b.h. of 7.3 inches (Table III). *Ulmus alata* (winged elm) had the highest number of seedlings and saplings. There were also seedlings of *Quercus stellata*, *Celtis laevigata* (hackberry), *Q. velutina* (black oak), and *Fraxinus pennsylvanica* (green ash) (Table IV). Only an occasional shrub was encountered, but *Smilax spp*. (greenbriar), *Rhus toxicodendron* (poison ivy), and *Parthenocissus quinquefolia* (Virginia creeper) were common vines in the understory (Table V).

The surface soil is a light yellowish brown, essentially neutral sand. It is low in fertility and apparently very susceptible to leaching (Table VI).

Woodbine Sand Stands were dominated by *Quercus stellata* (post oak), *Q. velutina* (black oak), and *Carya texana* (black or pignut hickory). *Quercus falcata* (spanish oak) and *Carya tomentosa* (now called *C. alba*, mockernut hickory), occur in the eastern stand with the former having a slightly higher importance percentage than *Q. velutina*; neither were found in the western stand (Table II). The basal area of 90 sq. ft. per acre was highest of any sandstone stand (Table III). *Ulmus alata* (winged elm) had the highest number of seedlings and saplings in both stands as it did in the other sandstone stands and the Goodland limestone and Weno formation stands. However, it formed a minor portion of the tree canopy (Tables III and IV). Shrubs were not common in the understory, but three vines, *Rhus toxicodendron* (poison ivy), *Parthenocissus quinquefolia* (Virginia creeper), and *Vitis* spp (wild grape) were relatively common (Table V).

The surface soil of these two stands, with some slight exceptions, were very much alike, although they were located 40 miles apart. Their color, texture, pH, and phosphorus content were essentially the same (Table VI). The slightly lower nitrogen, carbon, and organic matter content, as well as the slightly lower nitrogen, carbon, and organic matter content, as well as the slightly higher volume weight of the soil of the eastern stand might have been the result of slightly increased leaching. The eastern stand was somewhat more open and occurred in an area with about four inches more annual precipitation. These facts might have contributed to increased leaching in the eastern stand.

Pawpaw Sand Stands had vegetation that was essentially the same with *Carya texana* (black or pignut hickory), *Quercus stellata* (post oak), and *Q. velutina* (black oak) having higher importance percentages in the eastern stand. *Quercus marilandica* (blackjack oak) replaced *Q. velutina* in importance in the western stand. *Quercus falcata* (spanish oak) and *Carya tomentosa* (now *C. alba*, mockernut hickory) were absent from the latter (Table II). The eastern stand had the lowest basal area, 66 sq. ft. per acre (Table III). *Ulmus alata* (winged elm), *Quercus stellata* and *Carya texana* were the common seedlings and saplings in both stands (Table IV). Vines were the more common members of the understory, principally *Parthenocissus quinquefolia* (Virginia creeper), *Rhus toxicodendron* (poison ivy), *Smilax* spp. (green briar) and *Vitis* spp. (wild grape). Species of *Vitis* had their highest importance in the eastern stand, whereas *Smilax* was found only in the western stand (Table V).

Soils of these two stands, like those of the Woodbine stands, were much alike (Table VI). It seems probable that the slight differences in the nutrient content values of the four sandy soils are differences due to chance sampling.

The vegetation and soils of the four stands on the Woodbine and Pawpaw sands were alike in many respects. Of the three black oaks, *Quercus marilandica*, *Q. velutina*, and *Q. falcata*, that occurred in these

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stands, *Q. marilandica* is able to grow in dryer habitats, with the other two oaks in progressively more mesic habitats. Preston (1961) described the habitats of these three species as *Q. marilandica*, dry sites; *Q. velutina*, dry to moist sites; and *Q. falcata* as dry to wet sites. If the relative abundance of these three species and *Carya tomentosa* in a stand is indicative of the degree of xeric conditions in that stand, the Pawpaw stands were slightly more xeric in nature than the Woodbine stands and the eastern stands of both a little more mesic than their western counterpart. (Table II). This might have been simply a response to the lower average annual precipitation in the western part of the area of four inches.

Weno Formation Stand vegetation was composed mainly of *Quercus stellata* (post oak), *Fraxinus americana* (white ash), and *Ulmus alata* (winged elm). This stand had a basal area of 62 sq. ft. per acre which was third lowest. Its mean d.b.h. was 6.1 inches (Table III). This combination of species was similar to a stand discussed by Hutcheson (1965). The community seemed to be maintaining itself as most seedlings and saplings belonged to the three major species. Species of *Cretaegus* (hawthorn) were the most common shrubs and species of *Smilax* (greenbriar) were the common vines.

According to soil surveys and geological descriptions (Olson 1965), the soil from this geological material should have been more like that of the sandy formations than my analysis indicated. Except for its coarse texture and pH values, this soil was certainly more closely allied to soils of the limestone and clay stands, although its nutrient values were generally lower (Table VI). The soil volume-weight was highest of any stand.

Goodland Limestone had several different types of plant communities growing on soils from this formation. In the study stand, *Carya texana* (black or pignut hickory) and *Quercus stellata* (post oak) had the highest importance percentage, but it had the highest species diversity with 17 different tree species counted in the sample. *Quercus falcata* (spanish oak) was the main secondary species (Table II). This stand had the highest number of trees, 277.5 per acre, but since its d.b.h. of 6.8 inches was relatively low, the basal area per acre was only 83 sq. ft. Other stands of similar composition were located in Marshall, Choctaw, and McCurtain Counties. *Ulmus alata* (winged elm), *Fraxinus* *americana* (white ash), and *Celtis laevigata* (hackberry) were reproducing extensively (Table IV). There were a number of species of shrubs, but *Crataegus* spp. (hawthorn) were the most abundant. Common vines were *Smilax* (greenbriar), *Rhus toxicodendron* (poison ivy), and *Parthenocissus quinquefolia* (Virginia creeper) (Table V).

Although the soil had a very high sand content; soil color, PH, the general fertility was much like that of soils from the other limestones and clays (Table VI).

Bennington Limestone Stand vegetation was composed mainly of *Celtis laevigata.* (hackberry), *Maclura pomifera* (osage orange, bois d'arc, horse apple) and species of *Ulmus* (elm). *Gleditsia triacanthos* (honey locust) was also an associate member. In basal area per acre and soil texture this stand, like that of the Goodland limestone, was similar to those of the sandstones. Its major species were those common to the Duck Creek, Kiamichi, and bottomlands. *Celtis* and *Maclura* had the highest number of seedlings and saplings (Table IV). *Symphoricarpos orbiculatus* (coral berry, buckbrush) was the most common shrub, with *Berchemia scandens* (rattan vine) and *Smilax* spp. (greenbriar) the more common vines (Table V).

This soil, like that of the Goodland, had a relatively high sand-silt content. The soil of the Weno formation was the only soil containing a larger percentage of silt. The soil from the Bennington limestone had a slightly lower nitrogen, organic carbon, and organic matter content; but it was still similar to the other limestone and clay soils (Table VI). It was interesting that the soils of the Weno Formation, Goodland and Bennington limestones were all relatively coarse textured, have poorly developed profiles, and were shallow with rock at the surface in places. Dix (1959) pointed out shallow soils often have only A and D horizons. Black (1957) stated that while sand and silt fractions might represent residual unweathered or physically weathered material, the clay was more dependent on the processes of chemical weathering.

Duck Creek Limestone Stand was composed of *Ulmus crassifolia* (cedar elm) and *Maclura pomifera* (bois d'arc). *Ulmus crassifolia* was often encountered growing in tight shallow, stony, clay soil in upland stands, but it was more commonly found in bottomlands. The basal area of 26 sq. ft. per acre was by far the lowest of any stand, largely because of an average d.b.h. of only 5.7 inches. Both major species were maintaining their importance as indicated by seedlings and saplings (Table IV). The only understory species in this stand was *Cocculus carolinus* (snail seed) (Table V).

Much of the soil on this formation is under cultivation or had been cleared of woody species for meadows or pastures. The study stand had evidently developed since cultivation was abandoned about 30 years ago. This dark gray to gray-brown, moderately alkaline, clay loam was relatively high in soil nutrients. It had the lowest volume-weight of the limestone and clay soils (Table VI).

Kiamichi Clay Stand had only two species obtained in the sample of this stand. They were *Ulmus crassifolia* (cedar elm) and *Maclura pomifera* (bois d'arc). A few trees of *Fraxinus pennsylvanica* (green ash) occurred but it was not frequent enough to be included in the sampling. Basal area per acre was 62 sq. ft. and its mean d.b.h. was 5.7 inches. The three above species constituted the major portion of seedlings and saplings (Tables II and IV). Both this sand and that of the Duck Creek are variations of the same forest type. *Symphoricarpos orbiculatus* (coral berry, buckbrush) was the main understory species.

Similarities in the physical properties of the soil of the Kiamichi Clay and Duck Creek Limestone are to be expected, since the former is derived in a large measure from clay and lime cement of the oyster shell limestone, while the Duck Creek is formed mainly from soft chalky limestone and clay. These stands are about one-half mile apart, thus have similar climatic conditions. The soil of the Kiamichi was a gray brown, neutral, rather tight waxy clay that had about the highest fertility of any stand (Table VI). The stands of the last two formations were also shallow with poorly developed profiles.

DISCUSSION

A total of 32 species were encountered in the samples of the 13 stands, with Cretaegus spp. considered as one species, and 49 species of trees are listed in my field notes for Bryan County. Of the 32 species of trees, only 13 had an importance percentage of 15 or more in at least one stand. There were four other species with an importance percentage of less than 15, but more than five.

The species in this study can be placed in three categories: those that occur predominantly in the bottomlands; species that occur mainly on soils derived from sandstone; and those that occur on soils derived from limestones and clays. It is evident that some overlap occurs as the Goodland limestone stand species seem more closely related to the species on the sandstones, while those on the Bennington limestone and clays seemed more closely allied to those of the bottomlands. There were 14 species that had their highest importance percentages or occurred only in stands on predominantly coarse textured soils. Soils predominantly of sand and silt are considered as coarse textured soils (Lyon and Buckman 1943, Black 1957, and Russell 1957). Of the 14 species, there were nine with an importance percentage of at least five per cent in one or more stands. There were 13 species that had their highest importance percentage or occurred only in stands that grew in soils which were mainly fine textured. Lyon and Buckman (1943) stated that a soil with at least 30 per cent clay was considered a clay soil. This would include soil of the three bottomlands, the Duck Creek limestone, and Kiamichi Clay. Of these 13 species, seven had an importance percentaage of 5 per cent or more.

The stands with the largest average tree size and highest basal area were the bottomlands, whereas the highest number of trees per acre occurred on the Goodland Limestone and the Kiamichi clay. The most open stand was the Clear Boggy Creek stand. The average basal area per acre for all stands was 78.6 square feet (23.96 m) per acre. The average for the three bottomland stands was 99.5 (30.32 m), that of the stands on sandstone derived soils was 77.2 (23.53 m), and the average of stands on limestone and clay soils was 65.1 (19.84 m). The bottomland stands were by far the most productive. The basal area per acre of the Goodland and Bennington limestone stands was more like that of sandy soil stands rather than the clay soil stands. If total nitrogen, total phosphorus and organic carbon were used as an index of fertility, stands growing on soils derived from limestone and clay were the least productive, but grew on the most fertile soil.

The average basal area per acre for 13 stands of this study was essentially the same (78.74 sq. ft.) as that found by Taylor (1965) for an 80 acre stand growing on the Antlers Sand. His study was conducted approximately eight miles west of the Antlers sand stand of this study. Rice and Penfound (1959) found an average basal area per acre of only 55.2 sq. ft. for their three Bryan County sands. Two of their stands were on soils derived from the Woodbine sand, while the third was underlain by the

Pawpaw sand. They reported average basal area per acre as follows: *Quercus stellata* (post oak) 23.0; *Q. marilandica* (blackjack oak) 77.7; *Q. velutina* (black oak) 10.2; *Carya texana* (black or pignut hickory) 9.4. The average basal areas per acre of those species in the four stands of this study on the same formations were 26.7, 7.2, 12.8, and 19.3 square feet respectively. The eastern stands of the Woodbine and Pawpaw formations seemed to be slightly more mesic than the western ones on the same formations. The Woodbine stands appeared bo be a little more mesic than the Pawpaw stands.

Using the same criteria for seedlings and saplings as that used for tree species, there were a total of 34 species encountered in all stands. Four of the 34 were not encountered as trees, and two species tabulated as trees were not found as seedlings and saplings. Only 14 species had an importance percentage of 15 or more in at least one stand. Of this number *Morus rubra* (red mulberry) and *Salix nigra* (black willow) had lower percentages as trees. *Sapindus drummondii* (soapberry) was not tallied as a tree for any stand. Seedlings and saplings of *Platanus occidentalis* (sycamore) and *Quercus macrocarpa* (bur oak) were not tallied although they occurred as trees.

There were 14 species of shrubs and 10 vines tallied for all stands, whereas my field notes list 34 shrubs and 18 vines for the Bryan County area. In general vines were much more common than shrubs in the study stands. Only two species of shrubs were found in the Kiamichi clay and none in the Duck Creek Limestone stand. Both had only one species of vine, *Cocculus carolinus* (snail seed).

The types of forest communities of interest encountered in this study were the post oak-white ash-winged elm and the hackberry-cedar elm-green ash. The first has only recently been described from the Arbuckle mountain area by Hutcheson (1965). The latter does not seem to have been reported for Oklahoma.

When the soil factors of the stands were analyzed, it was found that the soils derived from 1) sandstone 2) limestone and clay, and 3) bottomlands differed considerably. Soils of the latter two were much alike in a number of factors and were sharply distinct from the sandstones except for pH and soil volume weight. The Goodland limestone and Bennington limestone had soil textures that were more like those of the sandstones than the other soils. These two, with the soil from the Weno formation, might have been placed in a separate category. The soil reaction (pH) ranged from slightly acid to moderately alkaline (6.2-8.0). The pH of most stands were within or close to the neutral range, 6.6-7.2, for soils (Gray and Galloway 1959), and probably was not sufficiently high or low to be critical in any of the stands. Gray and Galloway (1959) stated that a pH range of 6.1 to 7.3 is optimum for the growth of most organisms. Although the sandstone soils were much lower in fertility, all but the Pawpaw east and Weno formation soils had their colloidal complexes essentially base saturated (Eyre 1963). Black (1957) stated that soil nitrogen increased as the soil texture became finer. If the clay content is used as an index of soil texture, the Goodland limestone with only 24 per cent clay provided an exception. It had the next to highest amount of nitrogen, 5,450 lbs. per acre, whereas the Clear Boggy Creek soil with 67 per cent clay had only 3,666 lbs of nitrogen per acre. When the colloidal portion of organic matter, which may have had an exchange capacity twice that of some clays (Thompson 1952), and the clay portion were considered together, the texture and nitrogen relationship correlated well. The same correlation existed with soil phosphorus. There also seemed to be some correlation between these factors and soil volume weight.

There were nine species of trees that occurred mainly on coarse textured soils, and had their highest importance percentages on sandy soils which were lowest in total nitrogen and phosphorus. They were *Quercus stellata* (post oak), *Q. velutina* (black oak,) *Q. marilandica* (blackjack oak), *Q. falcata* (spanish oak), *Ulmus* alata (winged elm), *Carya texana* (black or pignut hickory), *C. tomentosa* (now *C. alba*, mockernut hickory), *Cercis canadensis* (redbud), and *U. americana* (american elm). *Fraxinus americana* (white ash), Quercus shumardii (Shumard's red oak), and *Q. muehlenbergia* (Chinquepin oak) may also belong in this group although they occurred on soils with relatively high soil fertility as did *Q. stellata*, *Carya texana*, and *U. alata*.

Four species, *Celtis laevigata* (hackberry), *Fraxinus pennsylvanica* (green ash), *Maclura pomifera* (bois d'arc), and *Ulmus crassifolia* (cedar elm) had their highest importance percentages on fine-textured soils, both in bottomlands and uplands. All but *U. crassifolia* had seedlings on most of the coarse textures soils. A number of the remaining species appeared to be restricted to bottomlands with an occasional occurrence in upland stands. Anderson (1954) suggested that a number of species of trees, such as elms, sycamore, and honey locust, which are usually found in bottomlands, occasionally occurred in uplands where some kind of disturbance laid bare the topsoil. Bottomlands that flood seasonally were areas continually disturbed by inundation and deposition of silt and clay. The shallow soils of the Bennington limestone, Duck Creek limestone, and Kiamichi clay are probably very susceptible to disturbance. A number of pioneer species, which often become weedy, are known to have a wide ecological amplitude (Harlan and deWet 1965), Foote and Jackobs (1966) found *Cassia fasciculata* (partridge pea), for example, on soils with a wide range of ecological conditions. This may also be the case of such tree species as *Celtis laevigata*, *Diospyros virginiana* (persimmon), *Fraxinus pennsylvanica*, *Gleditsia triacanthos*, *Maclura pomifera*, *Ulmus alata*, and *U. crassifolia*. The committee on forest types (1931) listed some of these species in both bottomland and upland communities, some of which occurred on dry limestone hills. If this hypothesis is correct, it would help to explain why some of the tree species could be important components in both bottomland and dry uplands. *Ulmus crassifolia*, near the northern edge of its range, was found as a tree mainly on soils containing more than 30 per cent clay, whereas *U. alata* occurred as a tree on soils having less clay. Although both species occurred in many kinds of habitats, both bottomland and upland, *U. crassifolia* apparently prefer red fine-textured soils, *U. alata* coarse-textured soils.

In general the distribution of seedlings and saplings corresponded to the soils on which trees of that species also occurred. The number of seedlings and saplings was low in the two Red River stands, the Duck Creek limestone, and Kiamichi clay. Shrub and vine species in the study did not seem to be restricted to any soil type. This agreed with the findings of Hutcheson (1965)

The one soil factor which seemed to be most influential in the distribution of species of trees as found in this study was soil texture. Soil texture, however, either directly or indirectly affected most other soil factors, including rate of water infiltration, available water, soil aeration, and soil nutrient content (Black 1957). Soil texture, as well as a number of other soil properties, were known to be related to the geological material from which it was formed (Gray et al. 1959). Usually coarse-textured soils developed from sandstone, and other sandy material, whereas fine-textured soils developed from such materials as clays, marls, and soft limestone. Quarterman and Keever (1962) found sandy surfaced soils developed above a number of different kinds of materials including limestone. They found no correlation between soil fertility and types of forest stands. In this study coarse-textured soils were found on the sandstone formations, Weno formation, Bennington limestone, and Goodland limestone; whereas fine-textured soils were found on the alluvium, Duck Creek limestone and Kiamichi clay.

SUMMARY

In this study the vegetation of 13 forest communities were analyzed. The soil in which they grew was also studied and the communities correlated with soil and geological material. They were all located in the Bryan County portion of the Oklahoma Gulf Coastal Plain. These forest stands were established on the following geological formations: Clear Boggy Creek alluvium, Red River alluvium, Antlers sand, Pawpaw sand, Woodbine sand, Weno formation, Goodland limestone, Bennington limestone, Duck Creek limestone and Kiamichi clay.

Extensive reconnaissance resulted in the selection of 13 forest stands on the above formations. Sampling was accomplished by the point-centered quarter method, with the number of plants, basal area of trees, and importance percentage as the most useful vegetation parameters. Soil factors studied included soil texture, soil reaction, amounts of organic carbon, total nitrogen, and total phosphorus, and the degree of soil compaction.

Of the 13 stands, three grew in bottomlands, six grew on sandy substrates, and four occurred on limestone or clay derived soils. In addition these stands allowed comparison of forest communities growing on the same formations 40 miles apart, and two different stages of succession.

In the bottomland communities, the species with the highest importance percentages were *Celtis laevigata* (hackberry), *Fraxinus pennsylvanica* (green ash), *Populus deltoides* (cottonwood), *Ulmus crassifolia* (cedar elm), and *U. rubra* (slippery elm). The most important species growing in stands on coarse textured soils, including the Goodland limestone stand, were *Carya texana* (black or pignut hickory), *Quercus falcata* (Spanish oak), *Q. marilandica* (black jack oak), *Q. stellata* (post oak), *Q. velutina* (black oak), and *Ulmus alata* (winged elm).

The dominant species on the Kiamichi clay, Bennington and Duck Creek limestones were *Celtis laevigata*, *Maclura pomifera* (bois d'arc), and *Ulmus crassifolia*. On the basis of basal area, the bottomlands were the most productive, sandy soils intermediate, and upland fine-textured soils least productive, although with the highest nutrient content.

In comparing the two stands representing early and late stages of succession, it was found that physical properties of their soils were very similar, but that the soil of the mature stand was more fertile and more productive. The soil properties of the Pawpaw and Woodbine sand formations were similar both in physical and chemical properties, although they were 40 miles apart. The eastern stands were slightly more mesic.

As a general rule, seedlings and saplings of the overstory species were abundant in all stands except the cottonwood stand on the Red River alluvium. Shrubs and vines were common, but not abundant in all stands. Vines were more numerous in most communities than shrubs.

Based on the results of this study, the most important soil factor influencing the distribution of trees and forest communities was soil texture. No correlation between soil type and either shrubs or vines was observed.

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A VEGETATION ANALYSIS OF A PIMPLED PRAIRIE IN NORTHEASTERN OKLAHOMA

A thesis for the Department of Life Sciences The University of Tulsa 1974

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The effect of pimple mound microrelief on the vegetation of a tall grass prairie was considered. Taxonomic analysis of the vegetation affirmed the observation that mound and intermounds support communities with differing species composition. The difference in the percent cover by living vegetation on mounds and intermounds was determined not to be statistically significant. The physical composition of the soil in the two regions was found to be similar. Two factors are suggested as influencing the differences in mound and intermound vegetation: that mound soils can provide more available water to plants than can intermound soils, and that mounds, but not intermounds, contain the burrows of small mammals and are modified by their presence.

INTRODUCTION

Pimple Mounds are low, regular domes of soil that establish a microrelief pattern common on prairies in eastern Oklahoma (Figs. 1, 2). Similar mounds occur throughout the United States (Fig. 3), on both level and gently sloping terrain (Knechtel 1952). Mounds have also been described from South America (Scheffer 1958) and Australia (Prescott, 1931). They are variously called natural mounds and hog wallow relief in California (Branner, 1905), Mima mounds in Washington (Dalquest and Scheffer, 1942), and pimpled prairies in the South including Oklahoma (Knechtel, 1952; Barclay, 1938). The pimpled prairies of Oklahoma are no older than late Pleistocene (Knechtel, 1952).

Mounds have been examined with basal diameters ranging from 10 feet (3.05 m) to 130 feet (39.6 m) (Ross et al., 1968) and heights ranging from two feet (0.61 m) to seven feet (2.13 m) (Dalquest and Scheffer, 1942). The dimensions of eastern Oklahoma mounds correspond to the lower figures of these ranges (Knechtel, 1952).

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Figure 1 Study site showing pimpled microrelief, April 1972

Figure 2 Pimple mound, demonstrating greener vegetation than the surrounding prairie, late June 1972

Pimple mounds typically consist of unstratified soil, variously characterized as "loess-like" (Knechtel, 1952) or extremely loose and friable (Ross et al., 1968); this dark material is responsible for most of the height of the mound and often rests on a clay pan which is lighter in color (fig. 4). Between the mounds is an intermound furrow system. The interface between the soil and the subsoil does not demonstrate the pimpled microrelief; thus the mounds are features of the soil and not of the underlying strata; the soil of mound and intermound areas is similar in texture and composition (Melton, 1954).

Reference in scientific literature to natural mounds

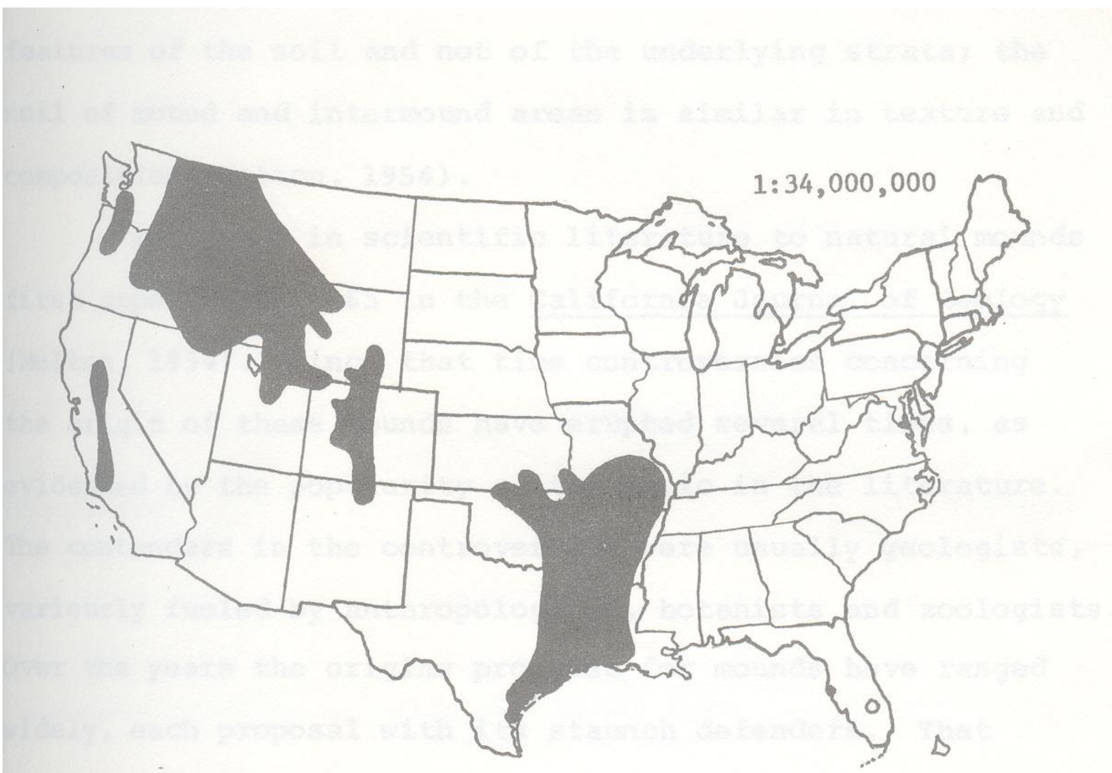

Figure 3 Shaded areas indicate the major regions in which pimple mounds occur in the United States (after Fenneman, 1931)

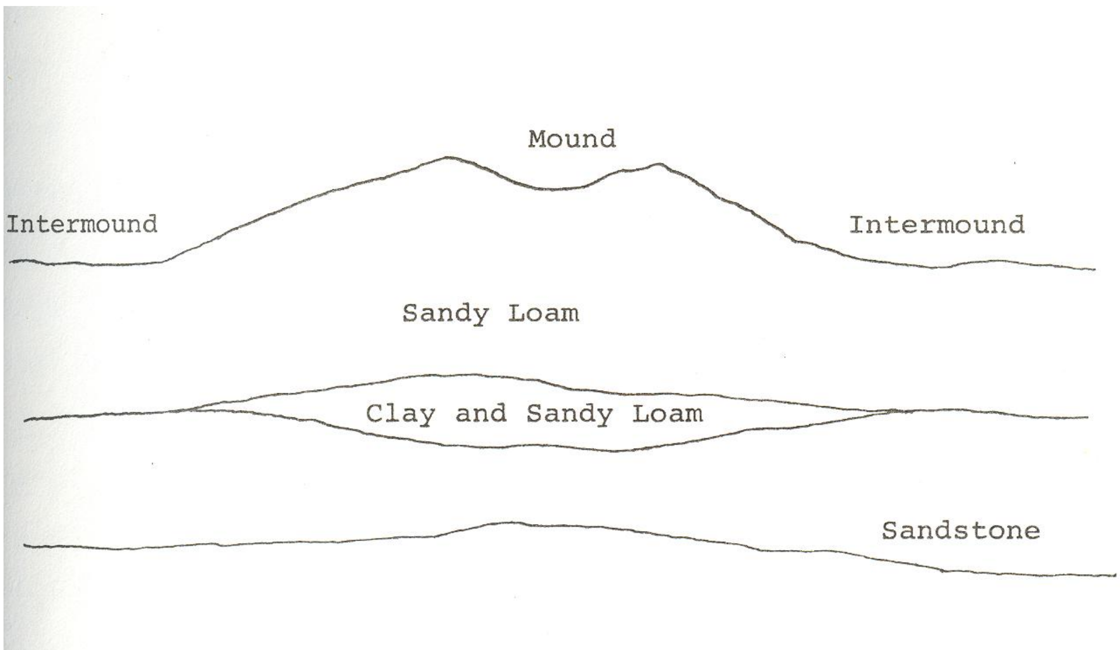

Figure 4 Stylized profile of a mound showing general shape and distribution of soil types. Note depression in mound center, probably due to disturbance by small mammals. Composite sketch from various authors (Scale 1:90)

first appeared in 1865 in the *California Journal of Geology* (Melton, 1954). Since that time controversies concerning the origin of these mounds have erupted several times, as evidenced by the popularity of the topic in the literature. The contenders in the controversies were usually geologists, variously fueled by anthropologists, botanists and zoologists. Over the years the origins proposed for mounds have ranged widely, each proposal with its staunch defenders. That fact that similar mounds occur in regions which vary greatly in geologic history, present geologic forces, climate, and flora and fauna has made it difficult to ascribe one origin to all mounds, as most authors have attempted to do. A discussion of the more prominent scientific hypotheses advanced for the origin of pimpled mounds is in order.

Campbell (1906) reviewed the suggestion that the pimple mounds were Indian burial mounds; the artifacts which usually characterize such sites have been found in a few mounds excavated in the South. However, artifacts are absent in most of the mounds throughout the country (Melton, 1954).

Veatch (1906) proposed that ants or termites construct pimple mounds. The town ant, *Atta texana*, may create soil mounds in the south (Cain, 1974). These mounds are smaller in height and larger in diameter than typical pimple mounds; ants do not inhabit mounds in other regions of the country and evidence of previous occupations has not been found (Melton, 1954).

Some authors have suggested that mounds result from animal disturbance of an area. Dalquest and Scheffer (1942) and Scheffer (1958) asserted that, over long periods of time, pocket gophers; both recent and historic, form pimple hills. Ross et al. (1968) extended this view to include toads, ground squirrels and badgers as mound constructors. The primary basis for this proposed origin was, in each instance, the modified soil characters, i.e., lower bulk density, lack of soil structure, increased water permeability and particle size in mounds, when compared to the surrounding prairie. These authors maintain that these changes are possible with the normal activities of the suggested animals. Grant (1948) systematically discredits this proposal; his rejection of the hypothesis is based on the subjective interpretation of the pocket gopher behavior and the inconsistencies in

Scheffer’s assertions. It seems reasonable that, rather than constructing a mound to avoid a high water table, as Ross et al. (1968) suggest, rodents utilized an existing mound structure, formed by some other means.

A series of physical explanations for the creation of pimple mounds has been advanced, including suggestions that the mounds: are coppices or sand dunes; result from fossil mud lumps; are protected from erosion by cap rock; are the work of glaciers; are concretionary depositions of minerals from ground water; results from spring and gas vents. Melton (1954) discussed these and other at length, discrediting each as an origin which is generally applicable, though each may have influenced mound formation in a specialized locale.

Two physical hypotheses of pimple mound origin are noted as widely acceptable; both are based on the observation that pimple mounds are found in regions with at least a moderate rainfall. Krinitsky (1949) proposed that mounds are deposited by river currents during periods of high water, forming ridges; vegetation invades when the water recedes, establishes a soil and maintains the mound. This proposed origin is supported by observations that mounds lack the well defined soil profile common in prairies, and that mounds are often found along ridges; however, Cain (1974) asserted that mounds do not occur along creeks or rivers or in alluvium.

Erosion is one of the simpler and more popular explanations for soil mounds (LeConde, 1974); Melton, 1929); Knechtel, 1952, Cain, 1974). Knechtel (1952) proposed that erosion is preceded and enhanced by the division of soil into prismatic blocks, due to seasonal desiccation and freezing. The blocks would then be worn down and rounded by erosion to produce pimple mounds. Melton (1954) suggested that weak, sandy soil erodes readily to produce gullies with walls which collapse easily and are rounded by rain and slumping to produce mounds. Aronow (1972) favored a two-phased formative process; firstly, a pluvial period marked by high run-off to initiate mounds; secondly, a period of low rainfall and high local winds, so that vegetation on the mounds traps the blowing soil, thus creating the thick A-horizon which is characteristic of pimple hills. Cain (1974) postulated that erosion around tree cover produces pedestal trees; with demise of the trees, the eroded tree pedestals remain, forming small pimple mounds.

Melton (1954) concluded that one is brought by default to erosion as the creative force behind pimple hills, since none of the other proposed phenomena is sufficiently widespread or continuous to account for the number of pimple mounds.

The vegetation of pimpled prairies has been examined and analyzed by several workers who provide varying descriptions. Melton (1954) discussed and concurred with Campbell's (1906) observations; both ascribed to intermounds a greater fertility, evidence by a darker color, higher water content, and higher stands of vegetation when compared to mounds.

McGinnies (1960) took the opposing view that mounds are more fertile. He documented this assertion with experimental results of the herbage production of five species of grasses on mounds and intermounds in Colorado. McGinnies found that mounds yielded twice the dry weight herbage of the intermounds. Ross et al. (1968)) observed that prairie mounds were dominated by either shrubs, forbs, or grasses, depending on the size of the mound and the amount of soil disturbance by animal burrowing. Barclay (1938) reported some difference in the species of plants which occur on the mounds and intermounds in southeastern Oklahoma; notably, the genus *Drosera* occurs only between the mounds.

The purpose of this investigation was to study the effect of pimple mound microrelief on vegetation, particularly on species composition and on percentage cover. The study site selected is a tall grass prairie in the Cherokee Prairie Biotic District of Blair and Hubbell (1938). The prairie is approximately two miles West of Inola and four miles East of the Verdigris River on Oklahoma Highway 33, NW 1/4, S6, T 19N, R17E, Rogers County, Oklahoma (Fig. 5). At the time of the study the prairie was owned by K. V. Spainhower, who assured the author that for more than sixty years the prairie had been mowed but neither grazed nor plowed. This prairie was thus deemed to be in an undisturbed state, when compared to other sites available for study, and particularly amenable to a vegetation study.

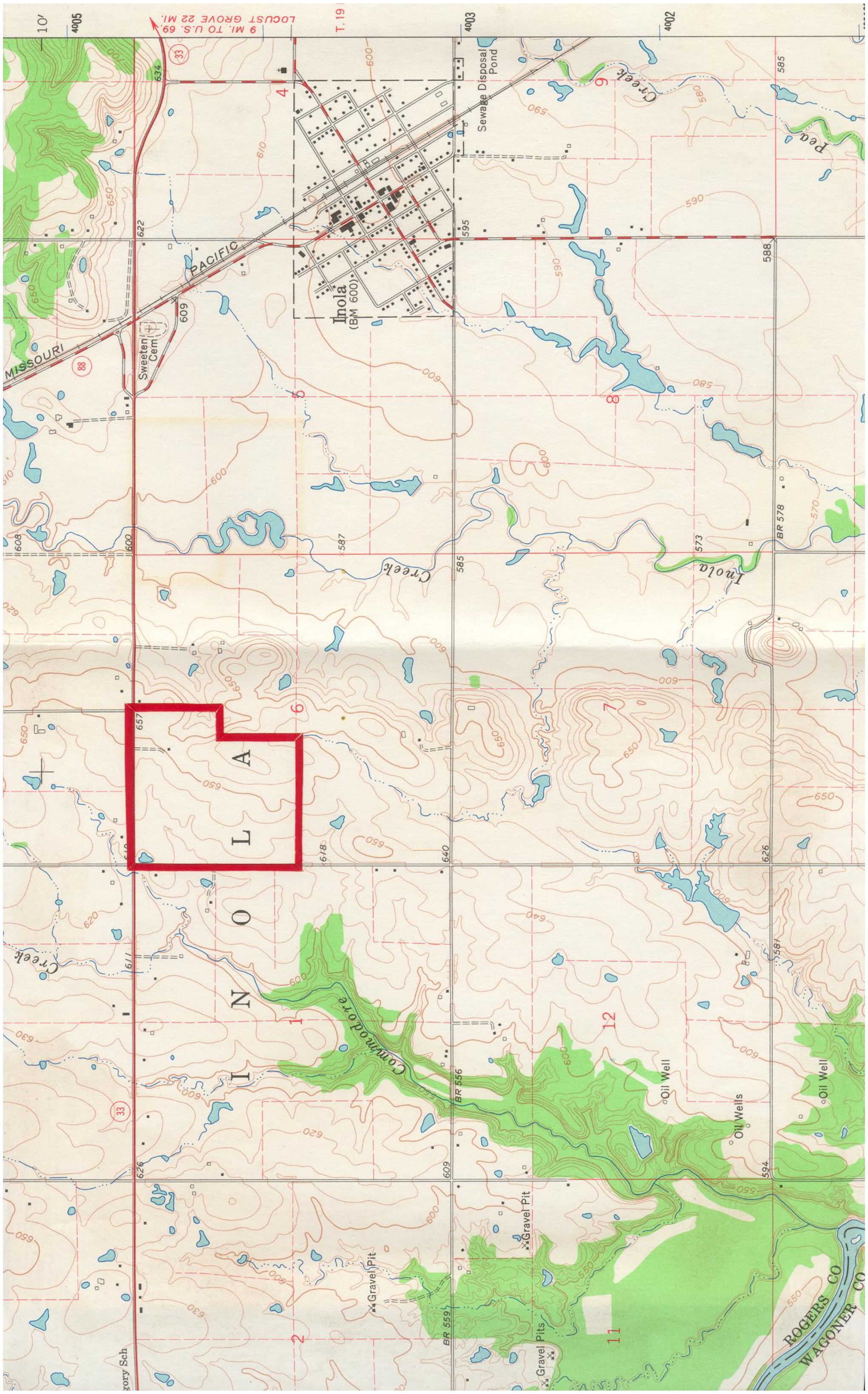

Figure 5 Location of study site with reference to the town of Inola and the Verdigris River. United States Geological Survey Topographic Map.

METHODS AND MATERIALS

The vegetation of mounds and intermounds was analyzed by the inclined point quadrat method (Tinney et al., 1937) using the basal contact modification (Whitman and Siggeirsson, 1954). The method was applied to each pimple mound in the following manner. The point frame was placed halfway up the eastern slope of a mound and readings taken from the ten pins; then the frame was moved five paces in a clockwise direction, again placed on the mound slope and read. This procedure was repeated ten times for a total of one-hundred points per mound. The different positionings of the frame formed a pattern which resembled the spokes on a wheel.

Similarly, data were gathered from the intermound region, which concentrically surrounded each mound considered. The frame was again positioned ten times, at ten pace intervals, providing one-hundred points per intermound region sampled.

Data were collected from eighteen mounds and intermound areas using the point frame, in April, June and July, 1972. The mounds considered were selected randomly. These data were tabulated and used to determine percentage cover by vegetation.

Vascular plants of the study site were collected weekly, from mid-march to mid-July, 1972; when possible, plants were collected while blooming. Nomenclature follows Waterfall (1969). Upon collection, it was noted whether each species occurred on mounds, intermounds, or both. All plant specimens are contained in The University of Tulsa Herbarium.

The spatial relationship between the mounds on the prairie was mapped. The fence marking the southern boundary of the study site was designated as the primary reference line; mounds were mapped in relationship to this fence. The information for the map was obtained using a Brunton compass, corrected to true North. The heights of the mounds were measured in relation to each other and to the intermound surface. The slope of the intermound surface was also measured with the compass, and distances between the mounds with a metal tape.

Soil samples were collected from the surface to bedrock, from three mounds and corresponding intermound areas, using a hydraulic soil auger two inches in diameter. The auger was provided and operated by Doc Polone of the Rogers County Soil Conservation Service, Claremore, Oklahoma. Soil cores collected in this manner were placed intact in troughs made of plastic pipe; the pipes, 2.5 inches (6.4 cm) in diameter, had been split lengthwise to accommodate the samples. Soil horizons were identified as definitively as possible, considering the color and macroscopic character of the soil. Fifty grams of soil from each horizon was characterized as to its physical composition, percentages of sand, silt and clay, by the hydrometer method (Bouyoucos, 1936).

The climatological data presented were provided by the United States Weather Bureau Office at Tulsa International Airport. Precipitation is based on records dating back to 1950 (Curry, 1970).

The statistical tests used were the point biserial correlation to analyze the percent cover data (Downie and Heath, 1974); and the two-factor mixed design analysis of variance to analyze the data relating to the physical composition of the soils (Winer, 1962).

RESULTS

Seventy-six species of vascular plants were collected from the study site. This collection represents a total of twenty-eight families and sixty-three genera; species are listed phylogenetically in Table I. From this collection, twenty-five species (33%) were found only in mound habitats, twenty-nine species (38%) were collected only from intermound habitats, and twenty-two species (29%) occurred in both habitats. This relationship between species and habitat is presented in Table II. Of the species common to both habitats in the prairie, seven species (33%) were grasses; one-half the grasses were restricted to one habitat or the other.

Percent cover of the prairie by living vegetation in the two habitats is compared in Fig. 6. The percent cover value presented for each date is the mean value for the data collected on that date. By inspection, the data reveal that higher values of percent cover were obtained for mounds than for intermounds. This information was submitted to the point biserial statistic. The t statistic indicated that the relationship between the type of terrain, i.e., mound or intermound, and the percent cover values was not statistically significant $t = 1.64$, $df = 32$, $p < .10$).

The low precipitation for the period preceding and during this study in 1972 is presented and compared with that of the previous twenty years in Fig. 7.

The spatial relationship between the pimple mounds on the prairie considered in this study is shown in Fig. 8. The mounds were found primarily along a ridge, from which the prairie sloped westwardly with approximately 10% slope. In this prairie the mounds ranged from 16 feet (4.876 m) to 50 feet (15.24 m) in diameter and from 1.5 feet (0.457 m) to 3.0 feet (0.914 m) in height. Mounds varied in shape from irregularly eggshaped [40 feet(12.19 m) by 50 feet 15.24 m)] to nearly circular [26 feet (7.924 m) by 27 feet (8.229 m)]. There was generally noted a slight alignment down slope.

Soil depth and the approximate thickness of each horizon from three mounds and corresponding intermound areas are compared in Fig. 9. The physical composition of the soil from each horizon is summarized in Table III. The difference in the amount of sand in the three horizons was statistically significant ($F = 6.999$; $df = 2.8$; $p < .02$). Horizon C had less sand than either A or B. The difference in the amount of silt at the three horizons was statistically significant ($F = 47.794$; $df = 2.8$; $p < .001$). Horizon A had more silt than either B or C. The difference in the amount of clay in the three horizons was statistically significant ($F = 7.335$; $df = 2.8$; $p < .02$). Horizon C had more clay than either A or B. When comparing soil from mounds with that of intermound areas, the difference in the percentages of sand, silt and clay was not statistically significant (Sand: $F = 1.813$; $df = 1.4$; $p < .25$), (Silt: $F = 3.460$; $df = 1.4$; $p < .15$), (Clay: $F = 1.041$; $df = 1.4$; $p < .4$).

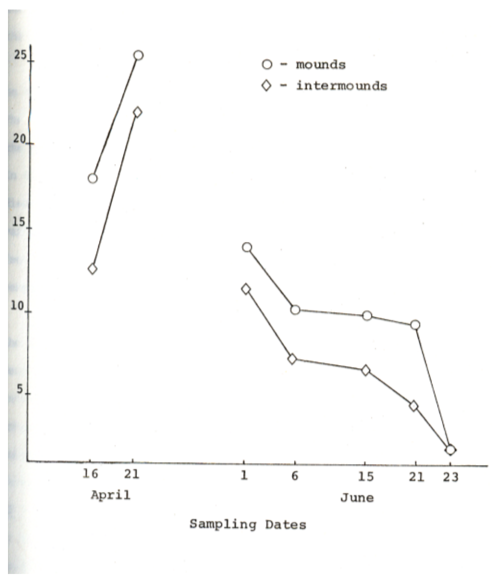

Figure 6 The percentage of cover by living vegetation of mounds (O), and intermounds (<>), determined with a point frame, basal contact modification.

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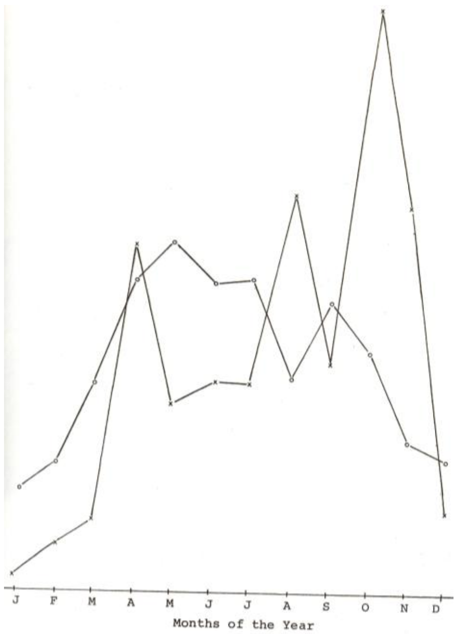

Figure 7 Monthly precipitation figures for 1972 (x), compared with monthly means calculated from 1951-1970 (o) for Tulsa County. From U.S. Weather Bureau.

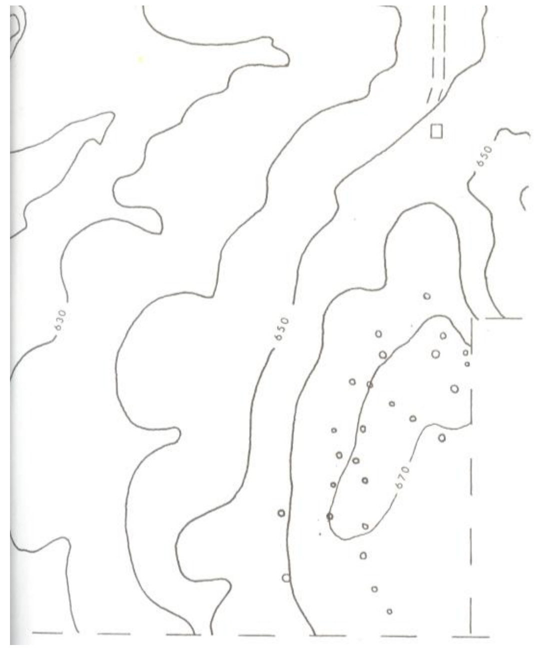

Figure 8 Distribution of mounds in the prairie studied. Note that the distribution pattern generally follows the higher contour lines. (Scale 1:17,352)

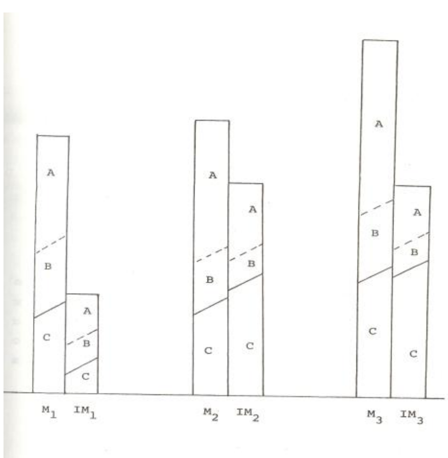

Figure 9 Comparison of soil depths and soil horizons for three mounds and corresponding intermound regions.

DISCUSSION

One factor to be considered to interpreting the data presented is the distribution of the rainfall for the duration of the experiment; for this period, the precipitation was lower than average which produced a marked effect on the vegetation. Many plants appeared vegetatively but growing tip shriveled and turned brown before flowers bloomed; therefore, many of these plants were not identified. It is possible that the low rainfall for this early summer period reduced the number of species recorded for the prairie.

In both mound and intermound habitats the small forbs dried in May and June, leaving a vegetation consisting mainly of grasses. Although this phenomenon is common in prairies, it usually occurs later in the growing season and after plant reproductive cycles have been completed. This early desiccation of the prairie and its vegetation is reflected in the percent cover figures, which steadily decreased through June until cover was recorded as one percent in mid-June (Fig. 6). Generally, the intermound vegetation evidenced desiccation before that on the mounds. The low rainfall may have accentuated the difference recorded in mound and intermound vegetation cover, which will be discussed later. The rainfall is probably partially responsible for the low range of percent cover when these figures are compared to those of other studies (Drew, 1944); Whitman and Siggeirsson, 1954).

The method of plant collection rendered the information unsuitable for statistical analysis of the interaction between species occurrence and habitat (Table II). Upon inspection, there is no obvious distribution of certain families to either mounds or intermound regions. It is noted that some genera within a family and some members of a genus were distributed, one in mound habitats, another in intermound habitats. The distribution, as recorded, reflects the interaction of the microhabitat conditions most favorable to each species. Determination of these conditions would require extensive research on the physiological growth requirements for each species. As mentioned above, some species never bloomed, due to drought; perhaps in a more pluvial year, when a greater number of representatives from each family bloomed, more conclusive remarks could be made about the distribution of plant families in the mound and intermound habitats.

Analysis of the difference in the percent cover data of mounds and intermounds revealed this difference to be statistically insignificant (Fig.6). Thus it is concluded that the variation of the percent cover was possible due to chance alone, and that the vegetation on mounds and intermounds is one plant population, not two. The inclined point quadrat method was used in this study with the basal contact modification, attempting to reduce the quantity of data and yet provide an accurate assessment of the percent cove in the two habitats. Perhaps it would be possible to arrive at the conclusion that the two habitats support different populations, if the inclined point quadrat method were used without the basal modification. This would provide indirect information on the herbage production of the two habitats, in addition to the information collected with the basal contact modification. It was observed that the vegetation on the mounds was more luxuriant than in intermound areas (Fig. 2); perhaps this modification of the experiment as performed would accentuate the difference recorded into one significant both statistically and biologically.

Summarizing the soil analysis data, mounds and intermounds did not vary significantly in physical composition. Alternatively, it is possible that the soils varied chemically, but such determinations were not made. The soils of mounds and intermounds did vary in depth (Figs. 9 and 10). The difference noted in the percent cover on mounds and intermounds may possibly be attributed to the available water held in each soil. Perhaps the deeper mound soil provided for more extensive root growth, a cooler soil, and greater soil area for storage of available water; in response, mound vegetation exhibited a somewhat higher percent cover and particular species composition. Conversely, the soil depth of intermounds allowed less root growth; provided a warmer soil and less soil space for water storage; thus intermound vegetation was lower in percent cover and contained species adapted to these conditions. If soil depth and its corresponding available water are influential in determining vegetation, it is possible that the difference noted in mound and intermound vegetation was greater this dry year than might normally be the case.

One difference between mounds and intermounds which may be significant is that most mounds were observed to contain the burrows of numerous animals; skunks, field mice and snakes were observed to inhabit mounds. The presence of these animals could influence the vegetation in numerous ways, by providing organic fertilizer to the mounds, changing the carbon dioxide levels of the mound soil, varying the compaction of the soil and displacing the root systems, especially tap roots. Depending on the extent of animal disturbance, the mounds could provide a habitat which varied greatly from intermound habitats, a difference which could easily be mirrored by vegetation.

The observations and data support some of the general ideas offered in the introduction concerning pimple hills and refute others. The mound soil considered here was definitely not loess-like, but a sandy loam. The soil of mounds and intermounds was physically similar, and revealed similar horizons. There was no evidence to suggest that mounds were formed by animal activity, though animals were present on the study site. That the mounds studied occurred on upland ridges, were composed of sandy soil, and were aligned downslope, support the hypothesis that erosion creates and maintains mounds. Whether this erosion was enhanced by frost or desiccation fissures or tree pedestals were not determined. Trees do not now occur along the ridges considered; whether they once initiated mound formation might be elucidated by sectioning the mound to determine residual evidence of roots. Such sections, which would also have aided in estimating the extent of animal activity, were not made on the insistence of the property owner.

Thus it may be said that the prairie considered exhibited a microrelief feature of pimple mounds and intermound regions, but the two soils did not vary in physical composition. These mounds were found to lie in an irregular pattern along an upland ridge with a slight alignment downslope. Mounds supported vegetation which differed in species composition from the vegetation of intermound regions; there was no significant difference in the percent cover by vegetation of these two prairie habitats, though the unassessed data suggested that the mounds were more productive than the intermound prairie. The abnormally low rainfall through the experimental period doubtlessly influenced the results of the vegetation study. Perhaps repetition of the vegetation study, with the modifications proposed herein, during a growing season with more normally distributed precipitation, would produce more reliable results, providing for more conclusive remarks about the vegetation of mounds and intermounds than can be extended here.

TABLE 1
LIST OF THE VASCULAR PLANTS COLLECTED FROM MARCH THROUGH JULY, 1972, AT THE STUDY SITE LISTED BY FAMILIES (Nomenclature according to U.T. Waterfall (1969); common names according to Gleason (1963) and Rechethin (1954)

Scientific Name	Common Name
Gramineae	
Andropogon Gerardi	**Big blue stem**
Andropogon scoparius	**Little blue stem**
Andropogon ternaries	**Splitbeard blue stem**
Bouteloua curtipendula	**Side-oats grama**
Bromus japonicus	**Japanese brome grass**
Cynodon Dactylon	**Bermuda grass**
Festuca octoflora	**Sixweeks fescue**
Hordeum pusillum	**Little barley**
Lolium multiflorum	**Italian rye grass**
Manisuris cylindrica	**Carolina jointtail**
Panicum oligosanthes* var. *Scribnerianum	**Scribners panicum**
Panicum Ravenelii	**--**
Panicum sphaerocarpon	**Roundseed panicum**
Panicum virgatum	**Switchgrass**
Sorghastrum nutans	**Indian grass**
Sporobolus cryptandrus	**Sand dropseed**
Cyperaceae	
Carex caroliniana	**Carolina sedge**
Cyperus filiculmis	**Slenderleaf sedge**
Liliaceae	
Camassia scilloides	**Wild hyacinth, Atlantic camas**
Erythronium albidum	**Dogtooth violet, white fawn lily**
Nothoscordum bivalve	**Yellow false-garlic**
Amaryllidaceae	
Hypoxis hirsute	**Stargrass, common goldstar**
Orchidaceae	
Spiranthes vernalis	**Upland ladies tresses**
Santalaceae	
Commandra Richardsoniana	**Bastard toad-flax**
Polygonaceae	
Eriogonum longifolium	**Longleaf wild-buckwheat**
Portulacaceae	
Claytonia virginica	**Spring beauty**
Caryophyllaceae	
Arenaria patula	**Pitchers sand wort**
Cerastium vulgatum* var. *vulgatum	**Mouse-ear chickweed, Big chickweed**

Ranunculaceae	
Anemone virginiana	Virginia anemone, wind-flower
Delphinium tricornis forma *albiflora*	Rock larkspur
Ranunculus hispidus	Bristly buttercup
Cruciferae	
Selenia aurea	Yellow selenia
Saxifragaceae	
Saxifraga texana	Texas saxifrage
Leguminoseae	
Dalea purpurea	--
Lotus americanus	Deervetch
Schrankia uncinata	Catclaw sensitive briar
Tephrosia virginiana var. *holosericea*	Goats rue, Virginia tephrosia
Oxalidaceae	
Oxalis corniculata	Wood sorrel, creeping oxalis
Oxalis dillenii	Sheep sorrel, wood sorrel
Polygalaceae	
Polygala incarnate	Pink milkwort
Polygala sanguinea	Blood milkwort
Umbelliferae	
Eryngium yuccafolium var. *synchaetum*	Yucca-leafed eryngo
Polytaenia Nuttallii var. Nuttallii	Prairie parsley
Gentianaceae	
Sabatia campestris forma *campestris*	Prairie rosegentian
Asclepiadaceae	
Asclepias stenophylla	Slimleaf milkweed
Asclepias veridis	Milkweed
Hydrophyllaceae	
Phacelia strictiflora	Prairie phacelia
Labiatae	
Scutellaria parvula var. *Leonardi*	small skullcap
Solanaceae	
Solanum carolinense forma *carolinense*	Carolina horse nettle
Scrophulariaceae	
Buchnera Americana	American blueheart
Castelleja coccinea var. *coccinea*	Painted cup, Indian paintbrush
Linaria canadensis var. *texana*	Old-field toadflax
Penstemon tubaeflorus	Beard tongue, tube penstemon

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Acanthaceae	
Ruellia humilis	Low ruellia
Plantaginaceae	
Plantago aristata	Bottlebrush plantain
Plantago elongate	--
Plantago media	--
Plantago Purshii var. *Purshii*	Wooly plantain
Plantago virginica	Paleseed plantain
Rubiaceae	
Hedyotis crassifolia	Tiny bluet
Valerianaceae	
Valerianella Nuttallii	Nuttall cornsalad
Campanulaceae	
Lobelia spicata var. *leptostachys*	Palespike lobelia
Specularia perfoliata	Clasping Venus' lookingglass
Compositae	
Achillea lanulosa	Western yarrow
Antennaria neglecta	Everlasting, pussytoes
Aster ericoides	Wild aster, heath aster
Coreopsis grandiflora	Tickseed, big-flower coreopsis
Echinacea pallida	Coneflower, pale echinaceae
Erigeron strigosus	Daisy fleabane, prairie fleabane
Erigeron tenuis	Slender fleabane
Gnaphalium purpureum	Cudweed, everlasting, purple cudweed
Hieracium longipilum	Longbeard hawkweed
Krigia dandelion	Tuber dwarf dandelion
Liatris pychnostachya	Blazing star, Kansas gayfeather
Rudbeckia hirta	Coneflower, blackeyed susan
Solidago mollis	Ashy goldenrod

TABLE II
PLANTS COLLECTED, NOTING WHETHER THE SPECIES OCCURRED ON MOUNDS, IN INTERMOUND REGIONS, OR BOTH (ASTERISK DESIGNATES IN WHICH HABITAT A SPECIES FIRST BLOOMED)

Mound Species

Achillea lanulosa **forma** ***lanulosa***
Bromus japonicus
Cerastium vulgatum **var.** ***vulgatum***
Claytonia virginica
Delphinium tricorne **forma** ***albivlora***
Echinacea pallida
Erigeron strigosus
Eriogonum longifolium
Hieracium longipilum
Lolium multiflorum
Manisuris cylindrical
Oxalis dillenii
Panicum oligosanthes var. ***Scribnerianum***
Panicum Ravenelii
Panicum virgatum
Phacelia strictiflora
Plantago aristata
Plantago elongate
Plantago Purshii **var.** ***Purshii***
Rudbeckia hirta
Solanum carolinense **forma** ***carolinense***
Solidago mollis
Specularia perfoliata
Tephrosia virginiana **var.** ***holosericea***
Valerianella Nuttallii

Intermound Species

Antennaria neglecta
Arenaria patula
Asclepias stenophylla
Bouteloua curtipendula
Bucchnera Americana
Camassia scilloides
Castilleja coccinea **forma** ***coccinia***
Dalea purpura
Erigeron tenuis
Eryngium yuccafolium **var.** ***synchaetum***
Erythronium albidum **var.** ***albidum***
Hordeum pusillum
Hypoxis hirsute
Krigia dandelion
Liatris pychnostachya
Lotus americanus
Nothoscortum bivalve
Oxalis corniculata
Panicum sphaerocarpon
Penstemon tubaeflorus
Plantago media
Plantago virginica
Polygala incarnate
Polygala sanguinea
Polytaenia Nuttallii **var.** ***Nuttallii***
Saxifraga texana
Scutellaria parvula **var.** ***Leonardi***
Selenia aurea
Spiranthes vernalis

Mound and Intermound Species

Andropogon Gerardi
Andropogon scoparius
Andropogon ternaries
Anemone virginiana ***M**
Asclepias viridis
Aster ericoides ***IM**
Carex caroliniana
Comandra Richardsoniana
Coreopsis grandiflora
Cynodon dactylon
Cyperus filiculmis
Festuca octoflora ***IM**
Gnaphalium purpureum
Hedyotis crassifolia
Linaria canadensis **var.** ***texana*** ***IM**
Lobelia spicata **var.** ***leptostachys***
Ranunculus hispidus
Ruellia humilis
Sabatia campestris **forma** ***campestris***
Schrankia uncinata
Sorghastrum nutans
Sporobollus cryptandrus

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TABLE III
COMPARISON OF THE PHYSICAL COMPOSITION OF THE SOIL FROM MOUND AND INTERMOUND REGIONS, DETERMINED BY THE BOUYOUCOS METHOD (MOUNDS AND INTERMOUNDS ARE DESIGNATED BY Numbers 1,2,3. Soil horizons are noted as A, B, C)

MOUND		Average		Average		Average
	% Sand	% Sand	% Silt	% Silt	% Clay	% Clay
1A	85.2		10.7		4.1	
2A	78.4	80.5	14.8	13.7	6.8	5.8
3A	77.9		15.6		6.5	
1B	85.7		9.4		4.9	
2B	79.4	83.4	9.7	8.9	10.9	7.7
3B	85.2		7.6		7.2	
1C	79.0		11.3		9.7	
2C	71.4	71.5	11.6	11.4	17.0	17.1
3C	64.2		11.3		24.5	

INTERMOUND		Average		Average		Average
	% Sand	% Sand	% Silt	% Silt	% Clay	% Clay
1A	79.6		11.5		8.9	
2A	78.4	77.9	15.3	14.9	6.3	7.2
3A	75.7		17.9		6.4	
1B	82.0		12.5		5.5	
2B	71.6	75.3	15.4	15.9	13.0	8.8
3B	72.2		19.7		8.1	
1C	81.8		11.3		6.9	
2C	50.8	58.5	13.9	14.3	35.5	27.2
3C	42.8		17.8		39.4	

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Vascular flora of a site along the Arkansas River, Pawnee County, Oklahoma

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This article reports the results of an inventory of the vascular plants from a site in north-central Oklahoma. Three hundred thirty-eight species of vascular plants in 224 genera and 78 families were collected. The most species were collected from the families Asteraceae (56), Poaceae (50), and Fabaceae (27). One hundred fifteen species were annuals, 221 perennials, and 2 were biennials. Forty-nine species of woody plants were present. Twenty-seven exotic species were collected representing 8% of the flora. No species listed as threatened or endangered by the U.S. Fish and Wildlife Service were encountered. However, four species tracked by the Oklahoma Natural Heritage Inventory (2005); *Fraxinus quadrangulata* (G5S2S3), *Penstemon oklahomensis* (G3S3), *Symphyotrichum dumosum* (G5S1), and *Urtica chamaedryoides* (G5G4S?) were present.

INTRODUCTION

Biotic inventories are the foundation of conservation biology and biogeographic research. Botanical study of Pawnee County began on 15 July 1905, when A. H. Van Vleet collected *Oxalis stricta*. Van Vleet collected 13 additional species (*Agrimonia pubescens, Arnoglossum atriplicifolium, Astragalus carolinianus, Bidens bipinnata, Chamaecrista nictitans, Eryngium yuccifolium, Euphorbia cyathophora, Fraxinus pennsylvanica, Helenium amarum, Mimulus alatus, Pycnanthemum tenuifolium, Rudbeckia triloba,* and *Vitis vulpina*) between 25-27 July 1905 (Hoagland et al. 2005). Prior to 1998, 172 species were reported from Pawnee County (Hoagland et al. 2005). To enhance floristic data, collections were made at locales throughout the county by Hoagland and McCarty in 1998 (93 specimens) and by the current authors (Hoagland & Buthod 2003) (149 specimens). As a result, the species count for Pawnee County increased to 377. The current project was initiated on the assumption that focused collection effort at a given site would yield additional county records, thus filling a gap in floristic data for central Oklahoma.

STUDY AREA

The study area encompasses 64.7 ha in Pawnee County (Fig.) along the Arkansas River. Latitudinal extent ranges from 36.286°N to 36.296°N and longitudinal extent from 96.550°W to 96.532°W. The study area is located within the subtropical humid (Cf) climate zone (Trewartha 1968). Summers are warm (mean July temperature = 27.6°C) and humid, whereas winters are relatively short and mild (mean January temperature = 1.8°C). Mean annual precipitation is 99.6 cm, with periodic severe droughts (Oklahoma Climatological Survey 2005). Physiographically, the study area is located within the Osage Plains section of the Central Lowlands province (Hunt 1974) and the Eastern Sandstone Cuesta Plains province of

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Oklahoma (Curtis and Ham 1979). The surface geology is primarily Pennsylvanian sandstone with Quaternary silt, sand, and clay along the Arkansas River floodplain (Branson and Johnson 1979). Elevation ranges from 286.5 m to 219.4 m. The primary soil associations are the Port-Yahola-Dale-Brewer silt loam deep bottomland soils and the Darnell-Talihina-Stephenville fine sandy loams soils on rough uplands (Galloway et al. 1959). The predominant potential vegetation types are *Quercus stellata-Q. marilandica* forest and woodlands, bottomland forests, and tallgrass prairies (Duck and Fletcher 1943).

METHODS

Collections were made during monthly visits from March through October 2004. The predominant vegetation association at the site were ascribed according to Hoagland (2000) and attributed to each collection. Vouchers for species exotic to North America were made from naturalized populations only, thus excluding cultivated and ornamental plants. Specimens were processed at the Robert Bebb Herbarium of the University of Oklahoma (OKL) following standard procedures. Manuals used for specimen identification included Waterfall (1969), Great Plains Flora Association (1986), and Diggs et al. (1999). Origin, either native or introduced, was determined by using Taylor and Taylor (1991) and US Department of Agriculture-Natural Resources Conservation Service (USDA-NRCS; 2005). Nomenclature follows the (USDA-NRCS 2005). Voucher specimens were deposited at OKL.

RESULTS AND DISCUSSION

Three hundred thirty-eight species of vascular plants in 224 genera and 78 families were collected (appendix 1). The most species were from the families Asteraceae (56), Poaceae (50), and Fabaceae (27). The largest genera were *Symphyotrichum* (8 species), *Juncus* (7), *Cyperus*, *Quercus*, and *Eragrostis* (each with 6 species). There were eight species of ferns, one gymnosperm, 85 monocots, and 245 dicots (Table). One hundred fifteen species were annuals, 221 perennials, and 2 were biennials. Forty-nine species of woody plants were present. This study contributed an additional 183 species to the flora of Pawnee County for a total of 560 species.

Twenty-seven species, non-native to North America, were collected representing 8.3% of the flora. The families with the greatest number of introduced species were Poaceae (8) and Fabaceae (3). These values are consistent with other floristic studies from Oklahoma, in which exotic species constitute 9% - 15% of the flora (Hoagland and Buthod 2003, Hoagland and Buthod 2004, Hoagland and Johnson 2001, Hoagland and Johnson 2004a, Hoagland and Johnson 2004b, Hoagland and Wallick 2003, Hoagland et al. 2004a, Hoagland et al. 2004b). An exception is Red Slough and Grassy Slough, where exotic species constituted 6.6% (Hoagland and Johnson, 2004b).

No species listed as threatened or endangered by the U.S. Fish and Wildlife Service were encountered. However, there were four species tracked by the Oklahoma Natural Heritage Inventory (2005); *Fraxinus quadrangulata* (G5S2S3), *Penstemon oklahomensis* (G3S3), *Symphyotrichum dumosum* (G5S1), and *Urtica chamaedryoides* (G5G4S?). Species are ranked by the ONHI according to level of imperilment at the global [G] and state [S] level on a scale of 1-5; with 1 representing a species that is imperiled and 5 a species that is secure [Groves et al. 1995]).

Vegetation associations at the study area with a brief list of associated species.

1. *Platanus occidentalis - Acer negundo* forest association occurred in a narrow strip along the Arkansas River floodplain. Associated species included *Apios americana, Bidens frondosa, Brickellia eupatorioides, Bromus pubescens, Cardiospermum halicacabum, Chasmanthium*

latifolium, Commelina erecta, Eupatorium rugosum, Fraxinus pennsylvanica, Impatiens capensis, Laportea canadensis, Leucospora multifida, Panicum anceps, Rorippa islandica, Sanicula canadensis, and *Teucrium canadense.*

2. *Quercus muehlenbergii - Quercus shumardii* forest association occurred along mesic slopes above the Arkansas River. The geomorphology was characterized by large sandstone boulders and shallow soils. Associated species included *Acalypha gracilens, Agrimonia rostellata, Arisaema triphyllum, Botrychium virginianum, Celastrus scandens, Desmodium glutinosum, Dichanthelium malacophyllum, Elephantopus carolinianus, Elymus canadensis, Erythronium mesochoreum, Fraxinus quadrangulata, Geum canadense, Phryma leptostachya, Quercus rubra, Scrophularia marilandica, Sicyos angulatus, Solidago nemoralis, Symphyotrichum drummondii, Urtica chamaedryoides,* and *Woodsia obtusa. Fraxinus quadrangulata, Symphyotrichum dumosum*, and *Urtica chamaedryoides* are species tracked by the ONHI found in this habitat.

3. *Quercus stellata-Q. marilandica-Carya texana* forest association occurred on uplands with sandy soils. Associated species include *Amelanchier arborea, Amphicarpaea bracteata, Antennaria parlinii, Carex albicans, Carya texana, Danthonia spicata, Helianthus hirsutus, Hieracium longipilum, Hypericum hypericoides, Juniperus virginiana, Lespedeza procumbens, Muhlenbergia sobolifera, Passiflora lutea, Smilax rotundifolia, Solidago ulmifolia, Symphoricarpos orbiculatus, Symphyotrichum patens,* and *Viburnum rufidulum*.

4. *Andropogon gerardii - Sorghastrum nutans* herbaceous association occurred on upland sandy-loam soils. Most of the grasslands were cut for hay and intergraded with old-fields. Associated species included *Achillea millefolium, Apocynum cannabinum, Aristida oligantha, Asclepias viridis, Bouteloua curtipendula, Buchnera americana, Castilleja indivisa, Chamaecrista fasciculata, Cirsium undulatum, Coreopsis grandiflora, Cyperus echinatus, Desmodium sessilifolium, Dichanthelium acuminatum, Eragrostis hirsuta, Euphorbia corollata, Fimbristylis puberula, Helianthus mollis, Lespedeza capitata, L. virginica, Liatris aspera, Lithospermum incisum, Nothoscordum bivalve, Polygala incarnata, Polytaenia nuttallii, Ptilimnium capillaceum, Ruellia humilis, Salvia azurea, Scleria ciliata, Spermolepis divaricata, Symphyotrichum ericoides, Tradescantia ohiensis, Tridens flavus*, and *Vernonia baldwinii*. *Penstemon oklahomensis* is a species tracked by the ONHI found in this habitat.

5. Wetland and aquatic vegetation was of restricted to human-made ponds. Associated species included *Amorpha fruticosa, Bidens aristosa, Cephalanthus occidentalis, Ceratophyllum demersum, Echinochloa crus-galli, Eclipta prostrata, Juncus diffusissimus, Justicia americana, Ludwigia alternifolia, Lycopus americanus, Mimulus alatus, Neeragrostis reptans, Nelumbo lutea, Penthorum sedoides, Pluchea camphorata, Polygonum hydropiperoides, P. lapathifolium, P. pensylvanicum, P. punctatum, Potamogeton nodosus, Rorippa palustris, Sagittaria calycina, S. graminea, Scirpus pendulus, Symphyotrichum subulatum*, and *Typha domingensis*

6. Disturbed areas and old-field vegetation included roadsides, and areas exhibiting signs of physical disruption. Associated species included *Amaranthus palmeri, Ambrosia artemisiifolia, A. trifida, Arenaria serpyllifolia, Bothriochloa ischaemum, Bromus catharticus, Buglossoides arvensis, Chamaesyce maculata, Conyza canadensis, Croton glandulosus, Geranium carolinianum, Helenium amarum, Hordeum pusillum, Lespedeza cuneata, Melilotus officinalis, Oenothera laciniata, Pseudognaphalium obtusifolium, Torilis arvensis,* and *Viola bicolor.*

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Table Summary of floristic collections from a study site in Pawnee County, Oklahoma*

Taxonomic group	Species	Native spp.	Introduced spp.
Pteridophyta	8	8	0
Coniferophyta	1	1	0
Magnoliophyta			
Magnoliopsida	245	227	19
Liliopsida	84	76	8
Total	338	312	27

* Table format follows Palmer et al. (1995).

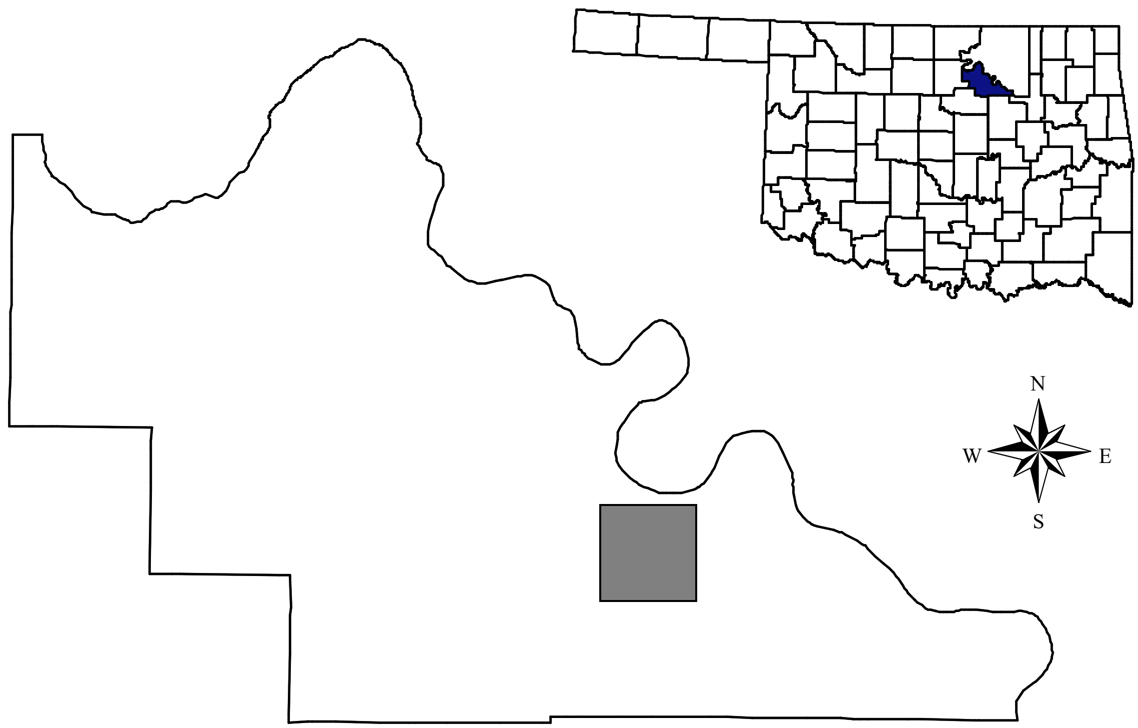

Figure Location of Pawnee County study area. Exact location withheld.

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APPENDIX 1
Annotated species list.

The first entry is habitat (PO-AN = *Platanus occidentalis - Acer negundo* forest association, QM-QS = *Quercus muehlenbergii - Quercus shumardii* forest association, QS-CT, = *Quercus stellata-Q. marilandica-Carya texana* forest association, AG-SN = *Andropogon gerardii - Sorghastrum nutans* herbaceous association, WETL = wetland and aquatic vegetation, DAOF = disturbed areas and old-field vegetation), followed by life history (A=annual, B=biennial, P=perennial), and collection number. Exotic species are denoted with an asterisk. Voucher specimens were deposited at the Robert Bebb Herbarium at the University of Oklahoma (OKL).

PTERIDOPHYTA

Aspleniaceae
Asplenium platyneuron (L.) B.S.P. - QS-CT; P; AB-4868
Aslpenium rhizophyllum L. - QM-QS; AB-4499

Dryopteridaceae
Woodsia obtusa (Spreng.) Torr. - QM-QS; P; AB-4680

Ophioglossaceae
Botrychium virginianum (L.) Sw. - QM-QS; P; AB-4688
Ophioglossum engelmannii Prantl - QS-CT; P; AB-4515

Polypodiaceae
Pleopeltis polypodioides (L.) Andrews & Windham - QM-QS; P; AB-5043

Pteridaceae
Cheilanthes lanosa (Michx.) D.C. Eat. - QS-CT; P; AB-4498
Pellaea atropurpurea (L.) Link - QS-CT; P; AB-4876

PINOPHYTA

Cupressaceae
Juniperus virginiana L. - QS-CT; P; AB-4843

MAGNOLIOPHYTA

MAGNOLIOPSIDA

Acanthaceae
Justicia americana (L.) Vahl - WETL; P; AB-6411
Ruellia humilis Nutt. - AG-SN; P; AB-4874

Aceraceae
Acer negundo L. - PO-AN; P; AB-5035

Amaranthaceae
Amaranthus palmeri S. Wats. - DAOF; A; AB-6439a
Amaranthus rudis Sauer - DAOF; A; AB-6385

Anacardiaceae
Rhus copallinum L. - QS-CT; P; AB-4887

Apiaceae
Chaerophyllum tainturieri Hook. - DAOF; A; AB-4685
Polytaenia nuttallii DC. - AG-SN; P; AB-4851
Ptilimnium capillaceum (Michx.) Raf. - AG-SN; A; AB-4855
Sanicula canadensis L. - PO-AN; B; AB-4866
Spermolepis echinatata (Nutt. ex DC.) Heller - AG-SN; A; AB-4849
Spermolepis divaricata (Walt.) Raf. ex Ser. - AG-SN; A; AB-4850
Torilis arvensis (Huds.) Link* - DAOF; A; AB-4880

Apocynaceae
Apocynum cannabinum L. - AG-SN; P; AB-5037

Asclepiadaceae
Asclepias stenophylla Gray - AG-SN; P; AB-5141
A. tuberosa L. - AG-SN; P; AB-4856
A. viridis Walt. - DAOF; P; AB-5142

Asteraceae
Achillea millefolium L. - AG-SN; P; AB-4675
Ambrosia artemisiifolia L. - DAOF; A; AB-6380
A. psilostachya DC. - AG-SN; P; AB-6091
A. trifida L. - DAOF; P; AB-6353
Antennaria parlinii Fern. - QS-CT; P; AB-4519
Bidens aristosa (Michx.) Britt. - WETL; A; AB-6426
B. bipinnata L. - PO-AN; A; AB-6390
B. frondosa L. - PO-AN; A; AB-6415
Brickellia eupatorioides (L.) Shinners - PO-AN; P; AB-6407

Chrysopsis pilosa Nutt. - AG-SN; A; AB-4859
Cirsium altissimum (L.) Hill- QM-QS; P; AB-6096
C. undulatum (Nutt.) Spreng. - AG-SN; P; AB-4847
Conoclinium coelestinum (L.) DC. - PO-AN; P; AB-6381
Conyza canadensis (L.) Cronq. - DAOF; A; AB-6072
Coreopsis grandiflora Hogg ex Sweet - AG-SN; P; AB-4711
C. tinctoria Nutt. - AG-SN; A; AB-5052
Eclipta prostrata (L.) L. - WETL; A; AB-5055
Elephantopus carolinianus Raeusch. - QM-QS; P; AB-6389
Erigeron annuus (L.) Pers. - QM-QS; A; AB-5147
E. strigosus Muhl. Ex Willd. - PO-AN; A; AB-4019
E. tenuis Torr. & Gray - AG-SN; P; AB-4710
Eupatorium rugosum Houtt. - PO-AN; P; AB-6372
E. serotinum Michx. - QM-QS; P; AB-6082
Euthamia gymnospermoides Greene - QS-CT; P; AB-6369
Evax verna Raf. - DAOF; A; AB-4712
Gamochaeta purpurea (L.) Cabrera - QS-CT; P; AB-5153
Grindelia papposa Nesom & Suh - AG-SN; A; AB-6093
Helenium amarum (Raf.) H. Rock - DAOF; A; AB-6068
Helianthus hirsutus Raf. - QS-CT; P; AB-5003
H. mollis Lam. - AG-SN; P; AB-5056
Hieracium longipilum Torr. - QS-CT; P; AB-5005
Krigia caespitosa (Raf.) Chambers - QS-CT; A; AB-4704
Lactuca floridana (L.) Gaertn. - DAOF; A; AB-6383
L. ludoviciana (Nutt.) Riddell - DAOF; A; AB-5020
Liatris aspera Michx. - AG-SN; P; AB-6403
L. punctata Hook. - AG-SN; P; AB-6083
Oligoneuron rigidum (L.) Small - QS-CT; P; AB-6360
Pluchea camphorata (L.) DC. - WETL; P; AB-6079
Pseudognaphalium obtusifolium (L.) Hilliard & Burtt - DAOF; A; AB-6432
Pyrrhopappus grandiflorus (Nutt.) Nutt. - QS-CT; P; AB-4686
Ratibida columnifera (Nutt.) Woot. & Standl. - AG-SN; P; AB-4857
Solidago canadensis L. - AG-SN; P; AB-6424
S. missouriensis Nutt. - AG-SN; P; AB-6103
S. nemoralis Ait. - QM-QS; P; AB-6425
S. ulmifolia Muhl. ex Willd. - QS-CT; P; AB-6102
Symphyotrichum drummondii (Lindl.) Nesom - QM-QS; P; AB-6370
S. dumosum (L.) Nesom; QM-QS; P; AB-6107
S. ericoides (L.) Nesom - AG-SN; P; AB-6365
S. lanceolatum (Willd.) Nesom - QM-QS; P; AB-6434
S. oolentangiense (Riddell) Nesom - QS-CT; P; AB-6374
S. patens (Ait.) Nesom - QS-CT; P; AB-6070
S. subulatum (Michx.) Nesom - WETL; A; AB-6106
S. turbinellum (Lindl.) Nesom - QM-QS; P; AB-6429
Taraxacum officinale G.H. Weber ex Wiggers* - DAOF; P; AB-4517
Tragopogon dubius Scop.* - DAOF; A; AB-4672
Vernonia baldwinii Torr. - AG-SN; P; AB-5021

Balsaminaceae
Impatiens capensis Meerb. - PO-AN; A; AB-5034

Boraginaceae
Buglossoides arvensis (L.) I.M. Johnson - DAOF; A; AB-4696
Heliotropium indicum L.* - PO-AN; A; AB-6393
Lithospermum incisum Lehm. - AG-SN; P; AB-4499

Brassicaceae
Arabis canadensis L. - QS-CT; B; AB-5023
Cardamine parviflora L.. - DAOF; A; AB-4504
Draba brachycarpa Nutt. ex Torr. & Gray - DAOF; A; AB-4518
D. cuneifolia; Nutt. ex Torr. & Gray - DAOF; A; AB-4523
Lepidium densiflorum Schrad.* - DAOF; A; AB-4734
L. virginicum L. - DAOF; A; AB-5123
Lesquerella gracilis (Hook.) S. Wats. - AG-SN; A; AB-4726
Rorippa islandica (Oeder) Borbas - PO-AN; A; AB-5012
R. palustris (L.) Bess. - WETL; A; AB-4735

Cactaceae
Opuntia macrorhiza Engelm. - QS-CT; P; AB-5125

Campanulaceae
Triodanis perfoliata (L.) Nieuwl. - QM-QS; A; AB-4877

Caprifoliaceae
Symphoricarpos orbiculatus Moench - QS-CT; P; AB-4890
Viburnum rufidulum Raf. - QS-CT; P; AB-4865

Caryophyllaceae
Arenaria serpyllifolia L.* - DAOF; A; AB-4511
Cerastium glomeratum Thuill.* - DAOF; A; AB-5054
Stellaria media (L.) Vill.* - DAOF; A; AB-4512

Celastraceae
Celastrus scandens L. - QM-QS; P; AB-6382

Ceratophyllaceae
Ceratophyllum demersum L. - WETL; P; AB-5054

Chenopodiaceae
Chenopodium album L.* - DAOF; A; AB-6392
C. berlandieri Moq. - AG-SN; A; AB-6401
C. ambrosioides L.* - QS-CT; A; AB-6409

Cistaceae
Lechea mucronata Raf. - QS-CT; P; AB-5000
L. tenuifolia Michx. - QS-CT; P; AB-4861

Clusiaceae
Hypericum hypericoides (L.) Crantz - QS-CT; P; AB-4879
H. punctatum Lam. - AG-SN; P; AB-5010

Cornaceae
Cornus drummondii C.A. Mey. - QS-CT; P; AB-4884

Crassulaceae
Penthorum sedoides L. - WETL; P; AB-5053

Cucurbitaceae
Sicyos angulatus L. - QM-QS; A; AB-6412

Ebenaceae
Diospyros virginiana L. - QS-CT; P; AB-5149

Euphorbiaceae
Acalypha gracilens Gray - QM-QS; A; AB-5006
A. monococca (Engelm. ex Gray) L. Mill. & Gandhi - PO-AN; A; AB-5024
Chamaesyce maculata (L.) Small - DAOF; A; AB-6097
C. nutans (Lag.) Small - DAOF; A; AB-6101
Croton capitatus Michx. - AG-SN; A; AB-6076
C. glandulosus L. - DAOF; A; AB-5049
C. willdenowii G. L. Webster - AG-SN; A; AB-5016
Euphorbia corollata L. - AG-SN; P; AB-6069
E. dentata Michx. - DAOF; A; AB-6362
E. marginata Pursh - AG-SN; A; AB-6073
E. spathulata Lam. - DAOF; A; AB-4681

Fabaceae
Albizia julibrissin Durazz.* - QM-QS; P; AB-4894
Amorpha canescens Pursh - AG-SN; P; AB-5040
A. fruticosa L. - WETL; P; AB-6416
Amphicarpaea bracteata (L.) Fern. - QS-CT; A; AB-6414
Apios americana Medik. - PO-AN; P; AB-6357
Astragalus canadensis L. - QS-CT; P; AB-5022
Cercis canadensis L. - QS-CT; P; AB-4513
Chamaecrista fasciculata (Michx.) Greene - AG-SN; A; AB-6087
C. nictitans (L.) Moench - AG-SN; A; AB-6074
Desmanthus illinoensis (Michx.) MacM. Ex B.L. Robins. & Fern. - PO-AN; P; AB-6112
Desmodium ciliare (Muhl. ex Willd.) DC. - QM-QS; P; AB-6095
D. glutinosum (Muhl. ex Willd.) Wood - QM-QS; P; AB-5122
D. paniculatum (L.) DC. - AG-SN; P; AB-5126
D. sessilifolium (Torr.) Torr. & Gray - AG-SN; P; AB-5026
Galactia volubilis (L.) Britt. - PO-AN; P; AB-6423
Gymnocladus dioicus (L.) K. Koch - QM-QS; P; AB-5046
Lespedeza capitata Michx. - AG-SN; P; AB-6065
L. cuneata (Dun.-Cours.) G. Don* - DAOF; P; AB-6076
L. procumbens Michx.- QS-CT; P; AB-5027
L. stuevei Nutt. - AG-SN; P; AB-6019
L. virginica (L.) Britt. - AG-SN; P; AB-6078
Melilotus officinalis (L.) Lam.* - DAOF; A; AB-4682
Neptunia lutea (Leavenworth) Benth. - AG-SN; P; AB-5039
Pediomelum linearifolium (Torr. & Gray) J. Grimes - AG-SN; P; AB-4867
Robinia pseudoacacia L. - DAOF; P; AB-4892
Stylosanthes biflora (L.) B.S.P. - AG-SN; P; AB-4578
Trifolium campestre Schreb.* - DAOF; A; AB-4703

Fagaceae
Quercus marilandica Muenchh. - QS-CT; P; AB-4891
Q. muehlenbergii Engelm. - QM-QS; P; AB-4684
Q. palustris Muenchh. T, P; AB-4274
Q. rubra L. - QM-QS; P; AB-4714
Q. shumardii Buckl. - QM-QS; P; AB-4713
Q. stellata Wangenh. - QS-CT; P; AB-4893

Gentianaceae
Sabatia campestris Nutt. - AG-SN; A; AB-4852

Geraniaceae
Geranium carolinianum L. - DAOF; A; AB-4736

Grossulariaceae
Ribes aureum Pursh - QS-CT; P; AB-4500

Juglandaceae
Carya cordiformis (Wangenh.) K. Koch - QM-QS; P; AB-5015
C. illinoinensis (Wangenh.) K. Koch - QM-QS; P; AB-5161
C. texana Buckl. - QS-CT; P; AB-5162

Lamiaceae
Hedeoma hispida Pursh - AG-SN; A; AB-4673
Lamium amplexicaule L.* - QM-QS; A; AB-4503
Lycopus americanus Muhl. Ex W. Bart - WETL; P; AB-5011
Prunella vulgaris L. - QM-QS; P; AB-4896
Salvia azurea Michx. ex Lam. - AG-SN; P; AB-6363
Stachys tenuifolia Willd. - QM-QS; P; AB-5025
Teucrium canadense L. - PO-AN; P; AB-4888

Linaceae
Linum pratense (J.B.S. Norton) Small - AG-SN; A; AB-4725
L. rigidum Pursh - AG-SN; A; AB-4853

Lythraceae
Rotala ramosior (L.) Koehne - WETL; A; AB-6080

Menispermaceae
Cocculus carolinus (L.) DC. - QM-QS; P; AB-4868
Menispermum canadense L. - PO-AN; P; AB-4669

Molluginaceae
Mollugo verticillata L. - DAOF; A; AB-5047

Nelumbonaceae
Nelumbo lutea Willd. - WETL; P; AB-5032

Oleaceae
Fraxinus americana L. - QM-QS; P; AB-5160
F. pennsylvanica Marsh. - PO-AN; P; AB-4715
F. quadrangulata Michx. - QM-QS; P; AB-4713

Onagraceae
Gaura longiflora Spach - AG-SN; A; AB-6104
Ludwigia alternifolia L. - WETL; P; AB-5001
L. glandulosa Walt. - WETL; P; AB-5014
Oenothera laciniata Hill - DAOF; P; AB-4694
O. linifolia Nutt. - DAOF; A; AB-4691

Oxalidaceae
Oxalis stricta L. - DAOF; P; AB-4693
O. violacea L. - QS-CT; P; AB-4692

Passifloraceae
Passiflora incarnata L. - DAOF; P; AB-4844
P. lutea L. - QS-CT; P; AB-5044

Phytolaccaceae
Phytolacca americana L. - DAOF; P; AB-5041

Plantaginaceae
Plantago aristata Michx. - DAOF; A; AB-4867
P. heterophylla Nutt. - QS-CT; A; AB-4731
P. major L. - PO-AN; P; AB-6396
P. patagonica Jacq. - AG-SN; A; AB-4846
P. virginica L. - QS-CT; A; AB-4709

Plantanaceae
Platanus occidentalis L. - PO-AN; P; AB-6364

Polygalaceae
Polygala incarnata L. - AG-SN; A; AB-4845

Polygonaceae
Polygonum hydropiperoides Michx. - WETL; P; AB-6098
P. lapathifolium L. - WETL; A; AB-6399
P. pensylvanicum L. - WETL; A; AB-6368
P. punctatum Ell. - WETL; A; AB-5004
P. virginianum L. - PO-AN; P; AB-6359

Portulacaceae
Claytonia virginica L. - AG-SN; P; AB-4527

Primulaceae
Samolus valerandi L. - WETL; P; AB-6394

Rosaceae
Agrimonia rostellata Wallr. - QM-QS; P; AB-5028
Amelanchier arborea (Michx. f.) Fern. - QS-CT; P; AB-5036
Geum canadense Jacq. - QM-QS; P; AB-5051
Rosa multiflora Thunb. Ex Murr.* - QS-CT; P; AB-4707
Potentilla recta L.* - DAOF; P; AB-4870
Prunus angustifolia Marsh. - AG-SN; P; AB-4666
Rubus aboriginum Rydb. - QM-QS; P; AB-4708

Rubiaceae
Cephalanthus occidentalis L. - WETL; P; AB-5057
Diodia teres Walt. - DAOF; A; AB-5002
Galium aparine L. - QS-CT; A; AB-4668
Galium circaezans Michx. - QM-QS; P; AB-4889
Houstonia pusilla Schoeph - DAOF; A; AB-4525
Sherardia arvensis L.* - DAOF; AB-4524

Salicaceae
Populus deltoides Bartr. ex Marsh. - PO-AN; P; AB-4674
Salix nigra Marsh. - WETL; P; AB-4883

Sapindaceae
Cardiospermum halicacabum L. - PO-AN; A; AB-6384
Sapindus saponaria L. - PO-AN; P; AB-6354

Sapotaceae
Sideroxylon lanuginosum Michx. - QS-CT; P; AB-4667

Scrophulariaceae
Buchnera americana L. - AG-SN; P; AB-4842
Castilleja indivisa Engelm. - AG-SN; A; AB-4676
Leucospora multifida (Michx.) Nutt. - PO-AN; A; AB-6377
Lindernia dubia (L.) Pennell - WETL; A; AB-6373
Mimulus alatus Ait. - WETL; P; AB-6398
Nuttallanthus texanus (Schelle) D.A. Sutton - AG-SN; A; AB-4732
Penstemon oklahomensis Pennell - AG-SN; P; AB-4689
P. tubiflorus Nutt. - AG-SN; P; AB-4862
Scrophularia marilandica L. - QM-QS; P; AB-6356
Veronica arvensis L.* - DAOF; A; AB-4526

Solanaceae
Physalis angulata L. - DAOF; A; AB-6089
Solanum ptychanthum Dunal - DAOF; A; AB-6371

Ulmaceae
Celtis laevigata Willd. - QM-QS; P; AB-5145
Ulmus rubra Muhl. - QM-QS; P; AB-4881

Urticaceae
Boehmeria cylindrica (L.) Sw. - QM-QS; P; AB-5050
Laportea canadensis (L.) Weddell - PO-AN; P; AB-6435
Parietaria pensylvanica Muhl. Ex Willd. - QM-QS; A; AB-4873
Urtica chamaedryoides Pursh - QM-QS; A; AB-5017

Valerianaceae
Valerianella radiata (L.) Dufr. - AG-SN; A; AB-4514

Verbenaceae
Glandularia canadensis (L.) Nutt. - AG-SN; P; AB-4508
Phryma leptostachya L. - QM-QS; P; AB-6367
Phyla lanceolata (Michx.) Greene - WETL; P; AB-5008
Verbena urticifolia L. - WETL; P; AB-6430

Violaceae
Viola bicolor Pursh - DAOF; A; AB-4522
V. nephrophylla Greene - PO-AN; P; AB-4520

Vitaceae
Ampelopsis cordata Michx. - PO-AN; P; AB-5045
Cissus trifoliata (L.) L. - QS-CT; P; AB-4875
Parthenocissus quinquefolia (L.) Planch. - QM-QS; P; AB-4670
Vitis cinerea (Engelm.) Millard - QS-CT; P; AB-4727
V. vulpina L. - QS-CT; P; AB-5156

LILIOPSIDA

Alismataceae
Sagittaria calycina Engelm. - WETL; P; AB-6081
S. graminea Michx. - WETL; P; AB-5007

Araceae
Arisaema triphyllum (L.) Schott - QM-QS; P; AB-4679

Commelinaceae
Commelina erecta L. - PO-AN; P; AB-5124
Tradescantia ohiensis Raf. - AG-SN; P; AB-4864

Cyperaceae
Carex albicans Willd. ex Spreng. - QS-CT; P; AB-4510
Cyperus echinatus (L.) Wood - AG-SN; P; AB-5150
C. erythrorhizos Muhl. - WETL; A; AB-6397
C. odoratus L. - PO-AN; A; AB-6400
Cyperus pseudovegetus Steud. - WETL; P; AB-5128
C. squarrosus L. - WETL; A; AB-5121
C. strigosus L. - WETL; P: AB-6105
Fimbristylis puberula (Michx.) Vahl - AG-SN; P; AB-4872
F. vahlii (Lam.) Link - PO-AN; A; AB-6437a
Isolepis carinata Hook. & Arn. Ex Torr. - DAOF; A; AB-4697
Rhynchospora harveyi W. Boott - AG-SN; P; AB-5131
Scirpus pendulus Muhl - WETL; P; AB-4700
Scleria ciliata Michx. - AG-SN; P; AB-4698

Iridaceae
Sisyrinchium angustifolium P. Mill - AG-SN; P; AB-4690

Juncaceae
Juncus acuminatus Michx. - WETL; P; AB-6431
J. brachycarpus Engelm. - WETL; P; AB-5132
J. bufonius L. - WETL; A; AB-5127
J. diffusissimus Buckl. - WETL; P; AB-5157
J. interior Wieg. - AG-SN; P; AB-4701
J. marginatus Rostk. - WETL; P; AB-5129
J. nodatus Coville - WETL; P; AB-5133

Liliaceae
Erythronium mesochoreum Knerr - QM-QS; P; AB-4516
Nothoscordum bivalve (L.) Britt - AG-SN; P; AB-4506
Polygonatum biflorum (Walt.) Ell. - QM-QS; P; AB-5013

Poaceae
Andropogon gerardii Vitman - AG-SN; P; AB-6063
A. ternarius Michx. - AG-SN; P; AB-6142
A. virginicus L. - AG-SN; P; AB-6422
Agrostis elliottiana J.A. Schultes - QM-QS; P; AB-4722
Aira elegans Willd. ex Kunth* - AG-SN; A; AB-4705
Aristida oligantha Michx. - AG-SN; A; AB-6100
Bothriochloa ischaemum (L.) Keng - DAOF; AB-5154
B. saccharoides (Sw.) Rydb. - AG-SN; P; AB-6428
Bouteloua curtipendula (Michx.) Torr. - AG-SN; P; AB-5033
B. hirsuta Lag. - AG-SN; P; AB-6110
Bromus catharticus Vahl.* - DAOF; A; AB-4671
B. japonicus Thunb. Ex Murr.* - AG-SN; A; AB-4723
B. pubescens Muhl. ex Willd. - PO-AN; P; AB-5042
B. secalinus L.* - DAOF; A; AB-4858
Buchloe dactyloides (Nutt.) Engelm. - AG-SN; P; AB-4683
Cenchrus longispinus (Hack.) Fern. - DAOF; A; AB-6084
Chasmanthium latifolium (Michx.) Yates - PO-AN; P; AB-6379
Danthonia spicata (L.) Veauv. Ex Roemer & J.A. Schultes - QS-CT; P; AB-4871
Dichanthelium acuminatum (Sw.) Gould & C.A. Clark - AG-SN; P; AB-6378
D. linerifolium (Scribn. Ex Nash) Gould - QS-CT; P; AB-4706
D. malacophyllum (Nash) Gould - QM-QS; P; AB-5143
D. oligosanthes (J.S. Schultes) Gould - AG-SN; P; AB-4719
D. villosissimum (Nash) Greckmann - PO-AN; P; AB-4848
Digitaria cognata (J.A. Schultes) Pilger - PO-AN; P; AB-6417
D. ischaemum (Schreb.) Schreb. ex Muhl.* - DAOF; A; AB-6419
Echinochloa crus-galli (L.) Beauv.* - WETL; A; AB-5135
Elymus canadensis L. - QM-QS; P; AB-4860
E. virginicus L. - QS-CT; P; AB-4863
Eragrostis barrelieri Daveau* - DAOF; A; AB-4816
E. hirusta (Michx.) Nees - AG-SN; P; AB-6111
E. intermedia A.S. Hitchc. - AG-SN; P; AB-6440a
E. secundiflora J. Presl - AG-SN; P; AB-5134
E. spectabilis (Pursh) Steud. - AG-SN; P; AB-6018
E. trichodes (Nutt.) Wood - AG-SN; P; AB-6433
Hordeum pusillum Nutt. - DAOF; A; AB-4695
Leptochloa panicea (Retz.) Ohwi - WETL; A; AB-6440a
Muhlenbergia racemosa (Michx.) B.S.P. - QM-QS; P; AB-5139
M. sobolifera (Muhl. Ex Willd.) Trin. - QS-CT; P; AB-6402
Neeragrostis reptans (Michx.) Nicora - WETL; A; AB-6404
Panicum anceps Michx. - PO-AN; P; AB-6067
P. dichotomiflorum Michx. - QM-QS; A; AB-6413
P. virgatum L. - WETL; P; AB-6391
Pasplaum floridanum Michx. - WETL; P; AB-6088
P. leave Michx. - AG-SN; P; AB-6099
P. setaceum Michx. - AG-SN; P; AB-5138
Poa annua L.* - QM-QS; A; AB-4505
Setaria parviflora (Poir.) Kerguelen - DAOF; P; AB-5151
Sorghastrum nutans (L.) Nash - AG-SN; P; AB-6075
Tridens flavus (L.) A.S. Hitchc. - AG-SN; P; AB-5137
Vulpia octoflora (Walt.) Rydb. - QS-CT; A; AB-4737

Potamogetonaceae
Potamogeton nodosus Poir. - WETL; P; AB-5159

Smilacaceae
Smilax rotundifolia L. - QS-CT; P; AB-5146
Smilax tamnoides L. - QS-CT; P; AB-4882

Typhaceae
Typha domingensis Pers. - WETL; P; AB-4886
T. latifolia L. - WETL; P; AB-4885

Additions to the Flora of Garvin County, Oklahoma: Including a Complete Vascular Plant Checklist

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A species list created from the Oklahoma Vascular Plants Database (OVPD) indicated that Garvin County, Oklahoma had been neglected by botanists. Our objective was to collect all vascular plant species encountered during three growing seasons to increase our botanical knowledge of the county. A total of 387 species were collected; 174 of these species had not been previously recorded for Garvin County in the OVPD. As a result, 14 families and 62 genera were added to the known flora of Garvin County. The majority of the species collected during this survey are assigned to five families of flowering plants: Poaceae (70 species), Asteraceae (63), Fabaceae (39), Cyperaceae (17), and Euphorbiaceae (16). Forty eight species (representing 13% of the taxa collected during this study) were not native to the United States; the families Poaceae and Fabaceae (with 18 and 10 species, respectively) exhibited the greatest number of introduced species collected in this survey. Five taxa on the Oklahoma Natural Heritage Inventory working list of rare Oklahoma plants were encountered. This collection effort increased the total number of vascular plant species recorded in the Oklahoma Vascular Plants Database for Garvin County to 628 species.

INTRODUCTION

During the last few decades there has been a decline in the number of plant specimens deposited in herbaria across the U.S. (Prather et al. 2004). This trend in plant collecting has been evident in Oklahoma as well (Hoagland et al. 2004). Certain areas, such as Black Mesa, Wichita Mountains, Arbuckle Mountains, LeFlore and McCurtain Counties, and the counties housing universities are well represented in the floristic collections of the state. Inconveniently located and less glamorous regions of Oklahoma have been ignored by the majority of botanists depositing plants in the state's herbaria, creating gaps in the known geographic distribution of taxa within the state. The objective of our research was to fill an apparent gap in floristic data for south-central Oklahoma. G. W. Stevens made the first collections in Garvin County in 1913, and episodes of plant collecting in Garvin County have occurred in each decade since the 1960s (Figure 1). However, no single effort was made to collect all of the species found in a variety of habitats in Garvin County. Prior to our collection effort only 456 species were documented in the Oklahoma Vascular Plants Database (OVPD) for Garvin County, Oklahoma, compared to over 900 species recorded for neighboring McClain County (Hoagland et al. 2004). We believed that the relatively short OVPD species list for Garvin County was most likely due to a deficiency of plant collecting, rather than a lack of floristic diversity in the county.

STUDY AREA

The study area consisted of a privately owned farm and cattle ranch which covers 906.5 hectares (2240 acres) in the western portion of Garvin County, approximately 14.5 km (9 mi) south of Lindsay, Oklahoma (Fig. 2). Latitudinal extent ranges from 34.72°N to

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34.68°N and longitudinal extent from 97.56°W to 97.52°W. The elevation ranges from 295-365 m (975-1195 ft). Rush Creek, which was straightened in this area in the early 1900s, transects the northernmost portion of the study site, which has been continuously managed for livestock and crop production since 1904. The study site is in the Prairie Parkland Province of the Central Great Plains (Bailey 1995), although approximately 150 hectares (371 acres) has been cleared for cropland or "improved" pasture. Physiographically, the study site is located in the Central Redbed Plains. The soils that dominate the site are loamy alluvium in the floodplain, loamy in the bottomland forest, and loamy clay soils in the upland (Kichler et al. 1982). The parent material is of Permian age and is dominated by shallow-marine, deltaic, and alluvial deposits of red sandstone and shale (Johnson et al. 1972). The study area is located within the Subtropical Humid (cf) climatic zone (Trewartha 1968). Mean annual precipitation is 93.5 cm (36.8 in) with May, June, September, and October being the wettest months (21.6, 10.7, 10.2, and 9.7 cm respectively). The mean annual temperature is 15.8°C (60.4°F); July and August are the hottest months, with average temperatures above 26.7°C (80°F). Temperatures exceed 32°C (90° F) approximately 70 days each year (Oklahoma Climatological Survey 2005).

METHODS

We conducted our survey during the growing seasons of 2001, 2003, and 2004. Although collections were made throughout the study site, areas for collection focus were selected with field reconnaissance and we returned to those specific areas at regular intervals during the growing season. A few collections were also made randomly throughout the county. The habitat type in which each plant was found was recorded, as was its relative abundance within the study site [see Palmer et al. (1995) for a detailed description of the abundance scale].

Specimens were identified using the following manuals: Waterfall (1969), Great Plains Flora Association (1986), Diggs et al. (1999), and Tyrl et al. (2002). Specimens from the Robert Bebb Herbarium at the University of Oklahoma (OKL) were consulted to confirm the identification of some collections. Nomenclature follows the National PLANTS Database (USDA, NRCS 2004). Voucher specimens for all species and, in certain cases, subspecific specimens were collected and deposited in the Robert Bebb Herbarium. Species were identified as native (originating in North America), introduced (originating outside of North America), or cultivated (species generally found only in cultivation; USDA, NRCS 2004). All non-native and agricultural species were collected from populations that had naturalized or were escaped from cultivation. Rarity status was determined using the Oklahoma Natural Heritage Inventory's list of rare plants of Oklahoma (Oklahoma Natural Heritage Inventory 2003). We compared our species list with the plant collection records for Garvin County found in the OVPD (Hoagland et al. 2004).

RESULTS and DISCUSSION

We collected 471 specimens representing 387 species of vascular plants; 174 of these species were not previously recorded in the OVPD for Garvin County (Appendix I). As a result, 14 families and 62 genera were added to the known flora of Garvin County. The greatest number of species collected during this study are assigned to the Poaceae (70 species), Asteraceae (63), Fabaceae (39), Cyperaceae (17), and Euphorbiaceae (16); these five families represented over 53% of the taxa collected at the study site. The remaining 83 families were each represented by 10 or fewer species. We combined our data with the floristic data found in the OVPD to produce a species list for Garvin County. There have been 628 species collected in Garvin County since 1913 (Table 1). The Asteraceae (98), Poaceae (89), and Fabaceae (63) are the three families with the largest number of species collected. These three families represent 40% of the species known to occur in the county.

We encountered no federally listed threatened or endangered species. However, we found several species tracked by the Oklahoma Natural Heritage Inventory: *Eriogonum alatum* (G5 S2S3); *Muhlenbergia bushii* (G5 S1S2); *Quercus sinuata* var. *breviloba* (G5GT S?); *Quercus stellata* (G5 S?); and *Rhynchospora nivea* (G4 S2). Species are ranked according to their imperilment at both the global (G) and state (S) levels; on the 5-1 scale, 5 indicates a species is secure and 1 indicates it is imperiled (Oklahoma Natural Heritage Inventory 2003).

Because older botanical work generally ignores introduced or "weedy" plants, we expected our collection to have a significantly higher proportion of these species than those of previous collectors. Prior to our study, only 46 species of introduced plants were represented in the OVPD for Garvin County, comprising 10% of the taxa known to occur there. Our collection included 48 introduced species (including 26 species not previously recorded in the OVPD for Garvin County), representing 13% of the taxa collected during this study. Poaceae (18) and Fabaceae (10) were the families with the greatest number of introduced species.

We defined eight general habitat types found within the study area. Habitat type was recorded for each species (Appendix I). A brief description of each habitat type follows.

Bottomland Forest (BF)

Bottomland forest occurred in the floodplain of Rush Creek and along its principal tributaries. Hardwood trees such as *Carya illinoinensis*, *Celtis laevigata*, *Fraxinus pennsylvanica*, *Quercus macrocarpa*, *Q. muehlenbergii*, *Q. velutina*, and *Ulmus americana* dominated the canopy. The shrub layer consisted of many woody vines, including *Passiflora* spp., *Parthenocissus quinquefolia*, *Smilax* spp. and *Vitis* spp. *Viola affinis*, *Chasmanthium latifolium*, and *Elymus canadensis* were often found in the herbaceous layer of the bottomland forest.

Upland Forest (UF)

Upland forests differed from the bottomland forest by having a more open canopy and inhabiting coarser soils with less available moisture. Tree species dominating this forest were: *Gleditsia triacanthos*, *Quercus marilandica*, *Q. stellata*, and *Sideroxylon lanuginosum*. Common small trees and shrubs were: *Cercis canadensis*, *Cocculus carolinus*, *Maclura pomifera*, *Morus rubra*, *Prunus mexicana*, *Sapindus saponaria* var. *drummondii*, *Symphoricarpos orbiculatus*, and *Viburnum rufidulum*.

Native Pasture (NP)

Native Pasture occurred in upland areas that were originally open grasslands or areas of Cross Timbers that had been cleared of much of the woody vegetation. Native grasses dominated this habitat type: *Andropogon gerardii*, *Bouteloua* spp., *Eragrostis* spp., *Schizachyrium scoparium*, and *Sorghastrum nutans*. Common forb species of the native pasture were *Ambrosia psilostachya*, *Amphiachyris dracunculoides*, *Desmanthus illinoensis*, and *Tetraneuris linearifolia*. Some native prairie plants found were *Asclepias tuberosa*, *Dalea enneandra*, *Gaillardia aestivalis*, *Liatris squarrosa*, *Ratibida columnifera*, and *Sabatia campestris*. Small patches of the woody shrubs *Prunus gracilis* and *Rhus glabra* could be found within the native pasture, as well as two species of cacti (*Escobaria missouriensis* and *Opuntia macrorhiza*). Outcroppings of native sandstone hosting a different suite of species occurred within this habitat; many of these species (including *Ceanothus americanus*, *Eriogonum alatum*, *Euphorbia longicruris*, *Oenothera macrocarpa* ssp. *oklahomensis*, and *Pellaea atropurpurea*) were only observed in association with these rock outcrops (RO).

Cultivated Pasture (CP)

Cultivated pasture was typically found in areas previously inhabited by bottomland forest. These areas were cleared of woody vegetation and planted in row crops in the late 1800s and early 1900s, and were planted with a monoculture of *Cynodon dactylon* (Bermuda grass) in the mid-1900s. Many "weedy" and introduced plants could be found within this habitat type. Other grasses encountered included *Bromus* spp., *Cenchrus spinifex*, and *Setaria viridis*. Typical forbs found in the cultivated pasture were *Capsella bursa-pastoris*, *Galium aparine*, *Geranium carolinianum*, and *Lamium amplexicaule*.

Disturbed (D)

Disturbed areas occurred throughout the study site and included roadsides, edges of cultivated fields, mowed lawns, areas experiencing heavy cattle usage (near feeding areas, stock tanks, or shade trees) and other areas exhibiting signs of physical disturbance. Disturbed areas share many species with the cultivated pasture habitat. Common forb species encountered were *Ambrosia trifida*, *Cirsium undulatum*, *Conyza canadensis*, *Cucurbita foetidissima*, *Grindelia papposa*, and *Solanum elaeagnifolium*. *Aegilops cylindrica*, *Eragrostis cilianensis*, *Poa annua*, and *Sorghum halepense* were grasses typical of disturbed areas, as were the escaped cultivated plants *Secale cereale* and *Triticum aestivum*.

Riparian (R)

The riparian zone was found along Rush Creek and its principal tributaries. *Acer negundo*, *Celtis laevigata*, *Salix nigra*, and *Ulmus americana* were the most abundant arborescent species in the riparian zone; *Tamarix chinensis* and *Salix exigua* were common along Rush Creek. Fruticose and herbaceous species abundant in the riparian zone included *Amorpha fruticosa*, *Cephalanthus occidentalis*, *Erigeron philadelphicus*, *Eupatorium serotinum*, *Symphyotrichum oolentangiense*, and *Teucrium canadense*.

Seeps (S)

Seeps occur sporadically within the native pasture, in areas where sloping rock strata carrying ground water from higher elevations intersect the soil surface. The flora of these seeps was conspicuously different from that of other wetland areas within the study site and that of the surrounding pastureland. This flora was dominated by graminoids, including several genera of sedges and rushes (*Cyperus*, *Eleocharis*, *Fuirena*, *Juncus*, *Rhynchospora*, *Schoenoplectus*, and *Scirpus*). A few grass species also occurred in this habitat (*Andropogon glomeratus*, *Panicum anceps*, and *P. virgatum*), as did several dicotyledonous forbs (*Lobelia siphilitica*, *Marshallia caespitosa*, and *Valerianella amarella*).

Wetland and Aquatic (WA)

Wetland and aquatic habitats were formed in and around farm ponds, beaver ponds on small drainages, springs, and in small depressions in native and cultivated pastures. Farm ponds and small depressions in pastures were typically bordered by a narrow fringe of herbaceous species common to frequently-flooded and disturbed habitats, and were subject to frequent trampling by cattle. The flora of these areas included *Alopecurus carolinianus*, *Ammannia coccinea*, *Echinochloa crus-galli*, *Eclipta prostrata*, *Leucospora multifida*, *Mollugo verticillata*, *Phyla lanceolata*, and *Symphyotrichum subulatum*. The few springs within the study site and several small impoundments created by beavers (*Castor canadensis*) on unnamed tributaries of Rush Creek were relatively undisturbed; these areas were flanked by woody vegetation similar to that of the above-described riparian zone. The beaver ponds were bordered by a narrow fringe of herbaceous vegetation, including *Bidens frondosa*, *Equisetum hyemale*, *E. laevigatum*, *Leersia oryzoides*, *L. virginica*, *Leptochloa fusca*, *Polygonum* spp., and *Ranunculus sceleratus*. The springs were vegetated with the aquatic plants *Potamogeton nodosus*, *Rorippa nasturtium-aquaticum*, and *Samolus valerandi*.

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Table 1 Summary of Garvin County floristic collections since 1913

Taxonomic Group	Families	Genera	Native Spp.	Exotic Spp.	Total Spp.
Filicopsida	4	5	6	0	6
Equisteopsida	1	1	3	0	3
Pinopsida	1	1	1	0	1
Magnoliopsida	79	273	413	41	454
Liliopsida	16	73	143	21	164
TOTALS	101	353	566	62	628

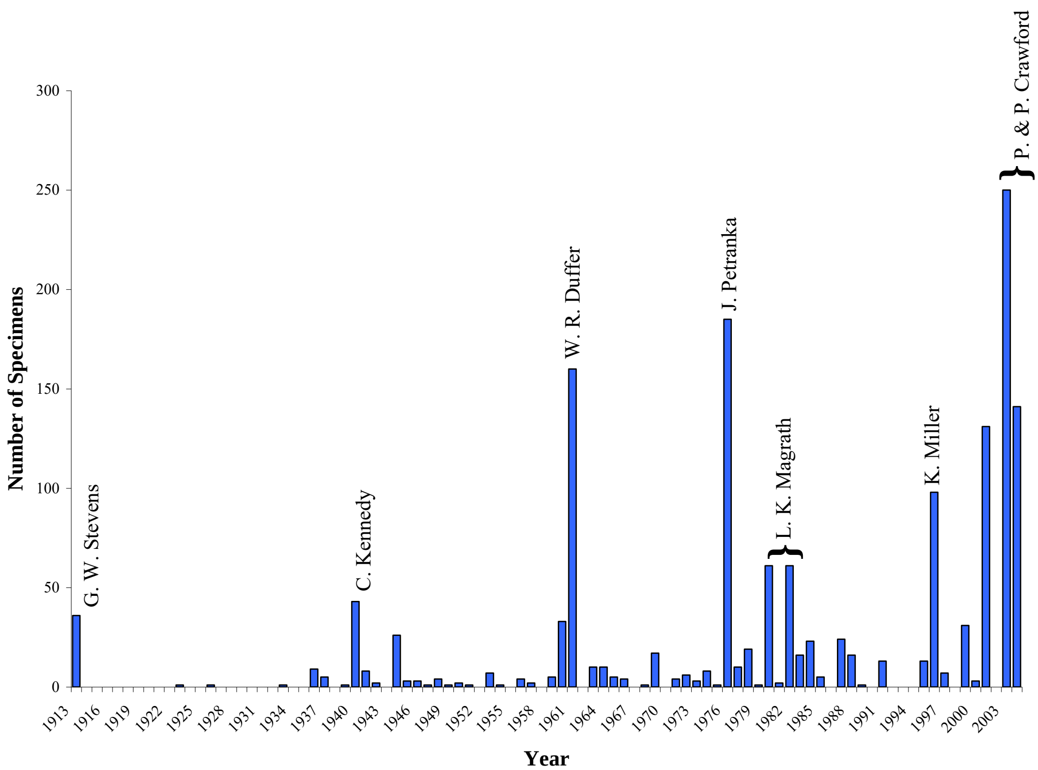

Figure 1 Number of specimens collected per year in Garvin County as represented in the Oklahoma Vascular Plants Database (Hoagland et al. 2004). Collectors responsible for the majority of the collections are listed above the bars.

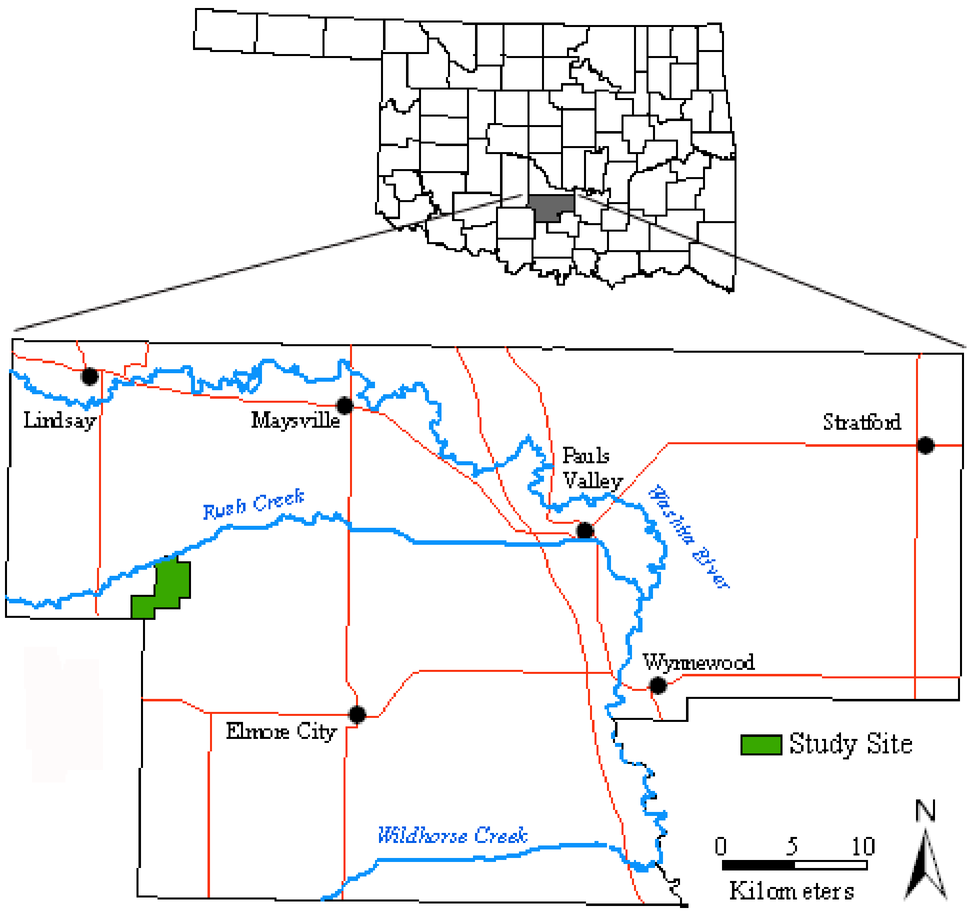

Figure 2 Location of the study site in Garvin County, Oklahoma

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APPENDIX 1. Annotated species list for Garvin County, Oklahoma

After taxon, the collection number is listed. The herbarium symbol is listed for those species collected in the county by individuals other than Crawford and Crawford and deposited in those herbaria.

*** Taxon not previously recorded in the OVPD for Garvin County**
[1] BRIT = Herbarium at the Botanical Research Institute of Texas; OCLA = Herbarium at University of Science and Arts of Oklahoma; OKL = Bebb Herbarium, University of Oklahoma; OKLA = Herbarium at Oklahoma State University.
[2] BF = bottomland forest; CP = cultivated pasture; D = disturbed; NP = native prairie; R = riparian; RO = rock outcrop [within the native pasture habitat]; S = seep; UF = upland forest; and WA = wetland/aquatic.
[3] 5 = abundant, 1 = rare, see Palmer et al. (1995) for a detailed description of scale; n/a indicates the taxon was collected outside of the study site and abundance could not be determined.
[4] n = native; i = introduced, c = cultivated (USDA, NRCS 2004).
[5] see Oklahoma Natural Heritage Inventory (2005) for detailed description of rarity rankings.

Taxon	Co#/Herb[1]	Habitat[2]	Abundance[3]	Origin[4]	**Rarity[5]**
EQUISETOPSIDA					
EQUISETACEAE					
Equisetum hyemale L. var. *affine* (Engelm.)	OKL			n	
A.A. Eat.	1513*	WA	2	n	
Equisetum laevigatum A. Braun	1470*	WA	2	n	
Equisetum X ferrissii Clute (pro.sp.)	OKLA			n	
FILICOPSIDA					
DRYOPTERIDACEAE					
Woodsia obtusa (Spreng.) Torr.	1102*	UF	3	n	
MARSILEACEAE					
Marsilea vestita Hook. & Grev.	OKLA			n	G5 S1
OPHIOGLOSSACEAE					
Botrychium biternatum (Sav.) Underwood	1552*	BF	n/a	n	
Botrychium virginianum (L.) Sw.	1215*	BF	1	n	
Ophioglossum engelmannii Prantl	1216*	BF	1	n	
PTERIDACEAE					
Pellaea atropurpurea (L.) Link	1087*	NP (RO)	2	n	
PINOPSIDA					
CUPRESSACEAE					
Juniperus virginiana L.	1183	UF	3	n	
MAGNOLIOPSIDA					
ACANTHACEAE					
Justicia americana (L.) Vahl	OKLA			n	
Ruellia humilis Nutt.	1329	NP	4	n	
Ruellia strepens L.	1131	BF	2	n	
ACERACEAE					
Acer negundo L.	OKL			n	
Acer negundo L. var. *texanum* Pax	1335	BF	3	n	

Taxon	Co#/Herb[1]	Habitat[2]	Abundance[3]	Origin[4]	Rarity[5]
AIZOACEAE					
Trianthema portulacastrum L.	OKLA			n	
AMARANTHACEAE					
Amaranthus palmeri S. Wats.	1340	D	4	n	
Froelichia floridana (Nutt.) Moq.	OCLA			n	
Gossypianthus lanuginosus (Poir.) Moq.	OKL			n	
Iresine rhizomatosa Standl.	1577*	R	1	n	
ANACARDIACEAE					
Rhus aromatica Ait.	1212	NP (RO)	4	n	
Rhus copallinum L.	OKL			n	
Rhus glabra L.	1293	NP	4	n	
Rhus lanceolata (Gray) Britt.	OKL			n	G4G5 S1S2
Rhus trilobata Nutt.	OKLA			n	
Toxicodendron pubescens P. Mill.	1496*	UF	2	n	
Toxicodendron radicans (L.) Kuntze	1547	D, BF, UF	4	n	
APIACEAE					
Ammoselinum butleri (Engelm. ex S. Wats.) *Coult.. & Rose*	OKL			n	
Ammoselinum popei Torr. & Gray	OKLA			n	
Chaerophyllum tainturieri Hook.	OKL			n	
Chaerophyllum tainturieri Hook. var. *tainturieri*	1209	CP, UF	4	n	
Cicuta maculata L.	OKLA			n	
Daucus pusillus Michx.	1301	NP	2	n	
Eryngium leavenworthii Torr. & Gray	OKLA			n	
Eryngium yuccifolium Michx.	OCLA			n	
Lomatium foeniculaceum (Nutt.) Coult. & Rose	1084	NP (RO)	2	n	
Polytaenia nuttallii DC.	1310	NP	2	n	
Ptilimnium nuttallii (DC.) Britt.	OKLA			n	
Sanicula canadensis L.	OKLA			n	
Spermolepis echinata (Nutt. ex DC.) Heller	OKLA			n	
Torilis arvensis (Huds.) Link	1300*	BF, UF	4	i	
Torilis japonica (Houtt.) DC.	OKLA			i	
Zizia aurea (L.) W.D.J. Koch	OKLA			n	
APOCYNACEAE					
Apocynum cannabinum L.	1245	S	2	n	
ARISTOLOCHIACEAE					
Aristolochia tomentosa Sims	1440	BF	2	n	
ASCLEPIADACEAE					
Asclepias amplexicaulis Sm.	OCLA			n	
Asclepias asperula (Dcne.) Woods.	1309	NP	3	n	
Asclepias asperula (Dcne.) Woods. ssp. *capricornu* (Woods.) Woods.	OCLA			n	
Asclepias stenophylla Gray	OKL			n	
Asclepias tuberosa L.	OCLA			n	
Asclepias tuberosa L. ssp. *interior* Woods.	1259	NP	3	n	
Asclepias verticillata L.	OKL			n	
Asclepias viridiflora Raf.	1372	NP	3	n	
Asclepias viridis Walt.	1352	NP	3	n	

Taxon	Co#/Herb[1]	Habitat[2]	Abundance[3]	Origin[4]	Rarity[5]
Cynanchum laeve (Michx.) Pers.	1584*	BF	2	n	
Matelea decipiens (Alexander) Woods.	OCLA			n	
ASTERACEAE					
Achillea millefolium L.	1236	D, NP	4	n/i	
Achillea millefolium L. var. *occidentalis* DC.	OCLA			n	
Ambrosia artemisiifolia L.	1395	NP	4	n	
Ambrosia psilostachya DC.	1522	NP	5	n	
Ambrosia trifida L.	OKL			n	
Ambrosia trifida L. var. *texana* Scheele	1435	D	4	n	
Amphiachyris dracunculoides (DC.) Nutt.	1405*	NP	5	n	
Antennaria plantaginifolia (L.) Richards.	1214*	UF	3	n	
Arnoglossum plantagineum Raf.	OKLA			n	
Artemisia ludoviciana Nutt.	OKL			n	
Artemisia ludoviciana Nutt. ssp. *mexicana* (Willd. ex Spreng.) Keck	1466	NP	4	n	
Berlandiera texana DC.	OCLA			n	
Berlandiera X *betonicifolia* (Hook.) Small (pro sp.)	1163*	NP	3	n	
Bidens bipinnata L.	1411*	BF	3	n	
Bidens frondosa L.	1535*	WA	2	n	
Brickellia eupatorioides (L.) Shinners	OKL			n	
Centaurea americana Nutt.	OKLA			n	
Chrysopsis pilosa Nutt.	1531	NP	4	n	
Cirsium altissimum (L.) Hill	1509*	D	3	n	
Cirsium undulatum (Nutt.) Spreng.	1320	D	3	n	
Conyza canadensis (L.) Cronq.	OKLA			n	
Conyza canadensis (L.) Cronq. var. *canadensis*	1390	D	4	n	
Conyza ramosissima Cronq.	1518*	D, CP	3	n	
Coreopsis grandiflora Hogg ex Sweet	OKLA			n	
Coreopsis lanceolata L.	1461	NP	2	n	
Coreopsis tinctoria Nutt.	OKLA			n	
Dracopis amplexicaulis (Vahl) Cass.	OKLA			n	
Echinacea angustifolia DC.	1265	NP	4	n	
Echinacea pallida (Nutt.) Nutt.	OKL			i	
Eclipta prostrata (L.) L.	1420*	WA	3	n	
Elephantopus carolinianus Raeusch.	1473	BF	3	n	
Erigeron philadelphicus L.	1106	R	3	n	
Erigeron strigosus Muhl. ex Willd.	1238	NP	4	n	
Eupatorium serotinum Michx.	1432*	R	3	n	
Evax verna Raf. var. *verna*	OCLA			n	
Gaillardia aestivalis (Walt.) H. Rock	1294*	NP	4	n	
Gaillardia pulchella Foug.	OCLA			n	
Gaillardia suavis (Gray & Engelm.) Britt. & Rusby	1446*	NP	2	n	
Gamochaeta purpurea (L.) Cabrera	1318	UF	3	n	
Grindelia lanceolata Nutt. var. *texana* (Scheele) Shinners	OKL			n	
Grindelia papposa Nesom & Suh	1475	D	4	n	
Helenium amarum (Raf.) H. Rock	OKL			n	
Helianthus annuus L.	1428	D	4	n	
Helianthus hirsutus Raf.	1543*	NP	3	n	
Helianthus maximiliani Schrad.	1558	NP	2	n	
Helianthus pauciflorus Nutt.	1491*	NP	2	n	
Helianthus petiolaris Nutt.	OKL			n	
Heterotheca subaxillaris (Lam.) Britt. & Rusby	1391*	D, NP	4	n	

Taxon	Co#/Herb[1]	Habitat[2]	Abundance[3]	Origin[4]	Rarity[5]
Hieracium longipilum Torr.	OCLA			n	
Hymenopappus scabiosaeus L'Hér. var. *corymbosus* (Torr. & Gray) B.L. Turner	OKLA			n	
Hymenopappus tenuifolius Pursh	1271	NP (RO)	3	n	
Iva annua L.	OKL			n	
Iva annua L. var. *annua*	OKLA			n	
Lactuca floridana (L.) Gaertn.	1545*	R	3	n	
Lactuca ludoviciana (Nutt.) Riddell	1343	D	3	n	
Lactuca serriola L.	1512*	R	2	i	
Liatris punctata Hook.	1392*	NP	4	n	
Liatris squarrosa (L.) Michx.	1486	NP	3	n	
Liatris squarrosa (L.) Michx. var. *glabrata* (Rydb.) Gaiser	OCLA			n	
Marshallia caespitosa Nutt. ex DC.	1154	S	2	n	
Oligoneuron rigidum (L.) Small var. *rigidum*	1430*	UF	3	n	
Packera plattensis (Nutt.) W.A. Weber & A. Löve	OKLA			n	
Packera tampicana (DC.) C. Jeffrey	OKL			n	
Palafoxia rosea (Bush) Cory var. *macrolepis* (Rydb.) B.L. Turner & Morris	OCLA			n	
Palafoxia rosea (Bush) Cory var. *rosea*	1566	NP	2	n	
Parthenium hysterophorus L.	1521	D	3	i	
Pluchea odorata (L.) Cass.	1482	WA	3	n	
Pseudognaphalium obtusifolium (L.) Hilliard & Burtt	1515*	NP	3	n	
Pyrrhopappus carolinianus (Walt.) DC.	OCLA			n	
Pyrrhopappus grandiflorus (Nutt.) Nutt.	1457	NP, CP	3	n	
Ratibida columnifera (Nutt.) Woot. & Standl.	1267	NP	3	n	
Rudbeckia hirta L.	1160	NP	3	n	
Rudbeckia hirta L. var. *pulcherrima* Farw.	OKLA			n	
Rudbeckia missouriensis Engelm. ex C.L. Boynt. & Beadle	OKL			n	
Silphium laciniatum L.	1481*	NP	2	n	
Solidago canadensis L. var. *scabra* Torr. & Gray	OKLA			n	
Solidago gigantea Ait.	OKLA			n	
Solidago ludoviciana (Gray) Small	1476*	UF	3	n	
Solidago nemoralis Ait.	1417*	UF	3	n	
Solidago ulmifolia Muhl. ex Willd.	1501*	UF	3	n	
Sonchus asper (L.) Hill	OKLA			i	
Symphyotrichum divaricatum (Nutt.) Nesom	OCLA			n	
Symphyotrichum drummondii (Lindl.) Nesom var. *texanum* (Burgess) Nesom	1387*	UF	3	n	
Symphyotrichum ericoides (L.) Nesom var. *ericoides*	1398	NP	4	n	
Symphyotrichum oblongifolium (Nutt.) Nesom	1400*	UF	3	n	
Symphyotrichum oolentangiense (Riddell) Nesom var. *oolentangiense*	1575*	R	3	n	
Symphyotrichum patens (Ait.) Nesom var. *patens*	1503	UF	3	n	
Symphyotrichum subulatum (Michx.) Nesom	1422*	WA	3	n	
Taraxacum officinale G.H. Weber ex Wiggers	OKL			n/i	
Tetraneuris linearifolia (Hook.) Greene var. *linearifolia*	1090	NP	4	n	
Thelesperma filifolium (Hook.) Gray	1171	NP	4	n	
Tragopogon dubius Scop.	1378*	D	2	i	

Taxon	Co#/Herb[1]	Habitat[2]	Abundance[3]	Origin[4]	Rarity[5]
Verbesina encelioides (Cav.) Benth. & Hook. f. ex Gray	1277	R	2	n	
Verbesina virginica L.	1536*	R	2	n	
Vernonia baldwinii Torr.	1162	D, NP	4	n	
Xanthium strumarium L.	1326	D, WA	4	n	
BIGNONIACEAE					
Campsis radicans (L.) Seem. ex Bureau	1167	UF	3	n	
BORAGINACEAE					
Buglossoides arvensis (L.) I.M. Johnston	OKLA			i	
Heliotropium tenellum (Nutt.) Torr.	1280	NP	4	n	
Lithospermum incisum Lehm.	1200	NP	3	n	
Onosmodium molle Michx. ssp. *bejariense* (DC. ex A. DC.) Cochrane	OKLA			n	
BRASSICACEAE					
Brassica juncea (L.) Czern.	OKL			i	
Camelina microcarpa DC.	OKL			i	
Capsella bursa-pastoris (L.) Medik.	1195	CP, D	4	i	
Cardamine hirsuta L.	OKL			i	
Descurainia pinnata (Walt.) Britt.	1217	CP, D	3	n	
Draba brachycarpa Nutt. ex Torr. & Gray	OKL			n	
Draba cuneifolia Nutt. ex Torr. & Gray	1193	NP (RO)	4	n	
Lepidium austrinum Small	OKLA			n	
Lepidium densiflorum Schrad.	OCLA			n	
Lepidium virginicum L.	OKLA			n	
Lesquerella gracilis (Hook.) S. Wats. ssp. *nuttallii* (Torr. & Gray) Rollins & Shaw	OKLA			n	
Lesquerella ovalifolia Rydb. ex Britt.	OCLA			n	
Lesquerella ovalifolia Rydb. ex Britt. ssp. *alba* (Goodman) Rollins & Shaw	OKL			n	
Lesquerella ovalifolia Rydb. ex Britt. ssp. *ovalifolia*	1189	NP (RO)	4	n	
Rorippa nasturtium-aquaticum (L.) Hayek	1204*	WA	2	n/i	
Sibara virginica (L.) Rollins	OKL			n	
CACTACEAE					
Echinocereus reichenbachii (Terscheck ex Walp.) Haage f. var. *reichenbachii*	OKL			n	
Escobaria missouriensis (Sweet) D.R. Hunt	1272*	NP	2	n	
Escobaria missouriensis (Sweet) D.R. Hunt var. *missouriensis*	1149*	NP	2	n	
Opuntia macrorhiza Engelm.	1490	NP	2	n	
CAMPANULACEAE					
Lobelia cardinalis L.	1555*	R	2	n	
Lobelia siphilitica L.	1418*	S	2	n	
Triodanis holzingeri McVaugh	OKLA			n	
CAPRIFOLIACEAE					
Lonicera albiflora Torr. & Gray	OKLA			n	
Lonicera flava Sims	1061	UF	3	n	
Lonicera japonica Thunb.	OKL			i	
Sambucus nigra L. ssp. *canadensis* (L.) R. Bolli	1275	R	3	n	

Taxon	Co#/Herb[1]	Habitat[2]	Abundance[3]	Origin[4]	Rarity[5]
Symphoricarpos orbiculatus Moench	1349	UF	5	n	
Viburnum rufidulum Raf.	1099	UF	3	n	
CARYOPHYLLACEAE					
Arenaria serpyllifolia L.	1210*	CP, D	3	i	
Cerastium glomeratum Thuill.	OCLA			i	
Cerastium nutans Raf.	OKL			n	
Minuartia michauxii (Fenzl) Farw. var. *michauxii*	OKL			n	
Minuartia michauxii (Fenzl) Farw. var. *texana* (B.L. Robins.) Mattf.	1144*	NP (RO)	3	n	
Paronychia jamesii Torr. & Gray	1407	NP	4	n	
Paronychia virginica Spreng.	OCLA			n	
Spergularia salina J.& K. Presl	BRIT			n	
Stellaria media (L.) Vill.	OKLA			i	
CELASTRACEAE					
Celastrus scandens L.	1289	BF	2	n	
CHENOPODIACEAE					
Chenopodium album L.	1464*	D	4	n/i	
Chenopodium pratericola Rydb.	1276*	D	3	n	
Chenopodium simplex (Torr.) Raf.	1465*	D	2	n	
Chenopodium standleyanum Aellen	1520*	D	3	n	
Cycloloma atriplicifolium (Spreng.) Coult.	OKLA			n	
Salsola tragus L.	1541*	D	3	i	
CONVOLVULACEAE					
Convolvulus arvensis L.	OCLA			i	
Evolvulus nuttallianus J.A. Schultes	1231	NP	3	n	
Ipomoea hederacea Jacq.	1548	D	3	i	
Ipomoea pandurata (L.) G.F.W. Mey.	OKLA			n	
Ipomoea purpurea (L.) Roth	1546*	D	3	i	
Ipomoea shumardiana (Torr.) Shinners	OCLA			n	
CORNACEAE					
Cornus drummondii C.A. Mey.	1225	UF	4	n	
CUCURBITACEAE					
Cucurbita foetidissima Kunth	1353	D	3	n	
Melothria pendula L.	1517*	UF	2	n	
CUSCUTACEAE					
Cuscuta pentagona Engelm.	1258*	NP	3	n	
EBENACEAE					
Diospyros virginiana L.	1227	UF, R	3	n	
EUPHORBIACEAE					
Acalypha ostryifolia Riddell	1346*	D	3	n	
Acalypha virginica L.	1556*	R	2	n	
Argythamnia mercurialina (Nutt.) Muell.-Arg. var. *mercurialina*	1358*	NP	2	n	
Chamaesyce maculata (L.) Small	1344	D	3	n	
Chamaesyce missurica (Raf.) Shinners	1463*	D	3	n	

Taxon	Co#/Herb[1]	Habitat[2]	Abundance[3]	Origin[4]	Rarity[5]
Chamaesyce nutans (Lag.) Small	1478*	NP, D	3	n	
Chamaesyce prostrata (Ait.) Small	1519*	D	3	n	
Cnidoscolus texanus (Muell.-Arg.) Small	OKLA			n	
Croton capitatus Michx. var. *capitatus*	1173*	NP	3	n	
Croton glandulosus L.	OCLA			n	
Croton glandulosus L. var. *lindheimeri* Muell.-Arg.	1492	NP	3	n	
Croton glandulosus L. var. *septentrionalis* Muell.-Arg.	OKLA			n	
Croton monanthogynus Michx.	1328	D, NP	4	n	
Euphorbia bicolor Engelm. & Gray	OKL			n	
Euphorbia commutata Engelm.	OCLA			n	G5 S1S2
Euphorbia corollata L.	1427	D	3	n	
Euphorbia dentata Michx.	1345	D	3	n/i	
Euphorbia longicruris Scheele	1207*	NP (RO)	4	n	
Euphorbia marginata Pursh	1469	NP, D	3	n	
Euphorbia pubentissima Michx.	OKLA			n	
Euphorbia spathulata Lam.	OKLA			n	
Phyllanthus polygonoides Nutt. ex Spreng.	OKLA			n	
Stillingia sylvatica Garden ex L.	1229	NP	3	n	
Tragia brevispica Engelm. & Gray	1148*	NP	4	n	
Tragia ramosa Torr.	OKL			n	
FABACEAE					
Acacia angustissima (P. Mill.) Kuntze	OKLA			n	
Acacia angustissima (P. Mill.) Kuntze var. *hirta* (Nutt.) B.L. Robins.	OCLA			n	
Albizia julibrissin Durazz.	1523	D	2	i	
Amorpha canescens Pursh	1528	NP	3	n	
Amorpha fruticosa L.	1357	WA	3	n	
Amphicarpaea bracteata (L.) Fern.	1537*	UF	2	n	
Apios americana Medik.	1576	R	2	n	
Astragalus crassicarpus Nutt. var. *crassicarpus*	OKL			n	
Astragalus nuttallianus DC.	1091*	NP	4	n	
Astragalus racemosus Pursh	OKLA			n	
Baptisia australis (L.) R. Br. ex Ait. f. var. *minor* (Lehm.) Fern.	1445	NP	3	n	
Baptisia bracteata Muhl. ex Ell. var. *leucophaea* (Nutt.) Kartesz & Gandhi	OKLA			n	
Baptisia sphaerocarpa Nutt.	OKL			n	
Cercis canadensis L.	1186	UF	4	n	
Cercis canadensis L. var. *texensis* (S. Wats.) M. Hopkins	OKLA			n	
Chamaecrista fasciculata (Michx.) Greene	1156	D, NP	4	n	
Clitoria mariana L.	OKL			n	
Dalea aurea Nutt. ex Pursh	1264	NP	3	n	
Dalea candida Michx. ex Willd.	OKLA			n	
Dalea candida Michx. ex Willd. var. *oligophylla* (Torr.) Shinners	1170	NP	4	n	
Dalea compacta Spreng. var. *compacta*	OKL			n	G5 S1S2
Dalea enneandra Nutt.	1370	NP	3	n	
Dalea purpurea Vent.	1263	NP	3	n	
Desmanthus illinoensis (Michx.) MacM. ex B.L. Robins. & Fern.	1333*	NP	4	n	
Desmodium sessilifolium (Torr.) Torr. & Gray	1169	NP	3	n	

Taxon	Co#/Herb[1]	Habitat[2]	Abundance[3]	Origin[4]	Rarity[5]
Desmodium tweedyi Britt.	1161*	NP	3	n	
Gleditsia triacanthos L.	1306	UF	4	n	
Glottidium vesicarium (Jacq.) Harper	1573	R, WA	3	n	
Indigofera miniata Ortega	1281	NP	3	n	
Indigofera miniata Ortega var. *leptosepala* (Nutt. ex Torr. & Gray) B.L. Turner	1174	NP	3	n	
Kummerowia stipulacea (Maxim.) Makino	1474*	CP, D	2	i	
Lathyrus hirsutus L.	1138*	CP	3	i	
Lespedeza procumbens Michx.	1530*	UF	3	n	
Lespedeza stuevei Nutt.	1479*	NP	3	n	
Lespedeza virginica (L.) Britt.	1494*	NP	3	n	
Lotus unifoliolatus (Hook.) Benth.	1302	NP	2	n	
Medicago lupulina L.	1298*	NP	3	i	
Medicago minima (L.) L.	1456	CP, D	3	i	
Medicago sativa L.	1542*	D	3	i	
Melilotus alba Medikus	OKL			c	
Melilotus officinalis (L.) Lam.	1330	D	3	i	
Mimosa nuttallii (DC.) B.L. Turner	1239	NP	3	n	
Neptunia lutea (Leavenworth) Benth.	OKLA			n	
Oxytropis lambertii Pursh	1143	NP	2	n	
Oxytropis lambertii Pursh var. *articulata* (Greene) Barneby	OKLA			n	
Pediomelum cuspidatum (Pursh) Rydb.	OKLA			n	
Pediomelum digitatum (Nutt. ex Torr. & Gray) Isely	1359*	NP	2	n	
Pediomelum linearifolium (Torr. & Gray) J. Grimes	OKLA			n	
Pediomelum reverchonii (S. Wats.) Rydb.	OKL			n	G3 S2
Prosopis glandulosa Torr.	OKL			n	
Psoralidium tenuiflorum (Pursh) Rydb.	1175	NP	4	n	
Pueraria montana (Lour.) Merr.	1563	D	n/a	i	
Pueraria montana (Lour.) Merr. var. *lobata* (Willd.) Maesen & S. Almeida	OKLA			i	
Robinia pseudoacacia L.	1103	UF	3	n	
Sophora affinis Torr. & Gray	OKL			n	
Strophostyles helvula (L.) Ell.	1477*	D	4	n	
Strophostyles leiosperma (Torr. & Gray) Piper	OKLA			n	
Trifolium vesiculosum Savi	1321	CP	3	i	
Vicia americana Muhl. ex Willd. ssp. *minor* (Hook.) C.R. Gunn	OKLA			n	
Vicia sativa L.	1196	CP, D	4	i	
FAGACEAE					
Quercus macrocarpa Michx.	1296	BF	3	n	
Quercus margarettiae Ashe ex Small	1270*	UF	2	n	
Quercus marilandica Muenchh.	1202	UF	5	n	
Quercus muehlenbergii Engelm.	1286	UF, BF	4	n	
Quercus prinoides Willd.	OKLA			n	
Quercus rubra L.	OKL			n	
Quercus shumardii Buckl.	OKL			n	
Quercus sinuata Walt.	OKL			n	G5 S1S2
Quercus sinuata Walt. var. *breviloba* (Torr.) C.H. Muller	1269	UF	2	n	G5GT S?
Quercus stellata Wangenh.	1213	UF	5	n	G5 S?

Taxon	Co#/Herb[1]	Habitat[2]	Abundance[3]	Origin[4]	Rarity[5]
Quercus velutina Lam.	1185*	UF	4	n	
FUMARIACEAE					
Corydalis curvisiliqua Engelm.	1182*	D	3	n	
GENTIANACEAE					
Centaurium beyrichii (Torr. & Gray ex Torr.) B.L. Robins.	1180	NP	2	n	
Eustoma exaltatum (L.) Salisb. ex G. Don ssp. *russellianum* (Hook) Kartesz, comb. nov. ined.	OKLA			n	
Sabatia campestris Nutt.	1254	NP	3	n	
GERANIACEAE					
Geranium carolinianum L.	1132*	CP, D	4	n	
Geranium molle L.	OKL			i	
HALORAGACEAE					
Myriophyllum heterophyllum Michx.	OKL			n	
HIPPOCASTANACEAE					
Aesculus glabra Willd. var. *arguta* (Buckl.) B.L. Robins.	OKLA			n	
HYDROPHYLLACEAE					
Ellisia nyctelea (L.) L.	1101*	UF	2	n	
JUGLANDACEAE					
Carya illinoinensis (Wangenh.) K. Koch	1348	BF	4	n	
Juglans nigra L.	1334	BF	3	n	
KRAMERIACEAE					
Krameria lanceolata Torr.	1150	NP	3	n	
LAMIACEAE					
Hedeoma drummondii Benth.	1172	NP	3	n	
Hedeoma hispida Pursh	1242	NP	3	n	
Lamium amplexicaule L.	1085	CP, D	4	i	
Lycopus americanus Muhl. ex W. Bart.	OKL			n	
Monarda citriodora Cerv. ex Lag.	OKLA			n	
Monarda clinopodioides Gray	1248	NP	3	n	
Monarda fistulosa L.	1256	NP	3	n	
Monarda fistulosa L. ssp. *fistulosa* var. *mollis* (L.) Benth.	OKL			n	
Monarda pectinata Nutt.	OKLA			n	G5 S1S3
Physostegia virginiana (L.) Benth.	OKLA			n	
Salvia azurea Michx. ex Lam.	OKL			n	
Salvia azurea Michx. ex Lam. var. *grandiflora* Benth.	1397	NP	4	n	
Salvia reflexa Hornem.	1376*	CP	2	n	
Scutellaria ovata Hill ssp. *bracteata* (Benth.) Epling	OKL			n	
Teucrium canadense L. var. *canadense*	1159	R	3	n	
LAURACEAE					
Sassafras albidum (Nutt.) Nees	OKLA			n	

Taxon	Co#/Herb[1]	Habitat[2]	Abundance[3]	Origin[4]	Rarity[5]
LINACEAE					
Linum alatum (Small) Winkl.	1145*	NP	2	n	
Linum berlandieri Hook. var. *berlandieri*	1240*	NP	4	n	
Linum pratense (J.B.S. Norton) Small	OKLA			n	
Linum rigidum Pursh	OKLA			n	
Linum sulcatum Riddell	OKLA			n	
LOASACEAE					
Mentzelia oligosperma Nutt. ex Sims	OKL			n	
LYTHRACEAE					
Ammannia coccinea Rottb.	1421	WA	3	n	
Lythrum alatum Pursh	OKLA			n	
Lythrum alatum Pursh var. *alatum*	OKL			n	
Lythrum alatum Pursh var. *lanceolatum* (Ell.) Torr. & Gray ex Rothrock	OKLA			n	
Lythrum californicum Torr. & Gray	1369*	S	2	n	
MALVACEAE					
Callirhoe alcaeoides (Michx.) Gray	OKLA			n	
Callirhoe involucrata (Torr. & Gray) Gray	1140	D, CP, NP	4	n	
Sida spinosa L.	OKL			n	
MENISPERMACEAE					
Cocculus carolinus (L.) DC.	1368	UF	4	n	
Menispermum canadense L.	OCLA			n	
MOLLUGINACEAE					
Mollugo verticillata L.	1425*	WA, D	3	n	
MORACEAE					
Maclura pomifera (Raf.) Schneid.	1246	UF	4	n	
Morus alba L.	1544*	UF	2	i	
Morus rubra L.	1307	UF	3	n	
NELUMBONACEAE					
Nelumbo lutea Willd.	1550*	WA	n/a	n	
NYCTAGINACEAE					
Mirabilis albida (Walt.) Heimerl	1385*	D, UF	3	n	
Mirabilis linearis (Pursh) Heimerl	OKLA			n	
OLEACEAE					
Forestiera pubescens Nutt. var. *pubescens*	OCLA			n	
Fraxinus americana L.	1292	BF, R	2	n	
Fraxinus pennsylvanica Marsh.	1221	BF, R	4	n	
Fraxinus texensis (Gray) Sarg.	OKL			n	
ONAGRACEAE					
Calylophus berlandieri Spach	1153*	NP	4	n	
Calylophus berlandieri Spach ssp. *berlandieri*	1241	NP	4	n	
Calylophus serrulatus (Nutt.) Raven	OKLA			n	
Gaura mollis James	1341*	D, NP	3	n	
Ludwigia peploides (Kunth) Raven	OKL			n	

Taxon	Co#/Herb[1]	Habitat[2]	Abundance[3]	Origin[4]	Rarity[5]
Ludwigia peploides (Kunth) Raven ssp. *glabrescens* (Kuntze) Raven	OKLA			n	
Oenothera laciniata Hill	1255	D	3	n	
Oenothera macrocarpa Nutt.	1443*	D, NP	3	n	
Oenothera macrocarpa Nutt. ssp. *oklahomensis* (J.B.S. Norton) Wagner	1224	D, NP (RO)	3	n	
Oenothera speciosa Nutt.	OCLA			n	
Stenosiphon linifolius (Nutt. ex James) Heynh.	1404	D, NP	4	n	
OXALIDACEAE					
Oxalis corniculata L.	1582	CP, D, NP	3	n	
Oxalis stricta L.	OKLA			n	
Oxalis violacea L.	1092	NP	3	n	
PAPAVERACEAE					
Argemone polyanthemos (Fedde) G.B. Ownbey	1223	D	4	n	
PASSIFLORACEAE					
Passiflora incarnata L.	1431*	UF, BF	2	n	
Passiflora lutea L.	1565*	UF, BF	2	n	
PEDALIACEAE					
Proboscidea louisianica (P. Mill.) Thellung	1436*	D	3	n	
PHYTOLACCACEAE					
Phytolacca americana L.	1342	UF, D	3	n	
PLANTAGINACEAE					
Plantago patagonica Jacq.	1233*	NP	3	n	
Plantago rhodosperma Dcne.	OKL			n	
Plantago virginica L.	1208*	NP	3	n	
PLATANACEAE					
Platanus occidentalis L.	OKLA			n	
POLEMONIACEAE					
Ipomopsis rubra (L.) Wherry	OKL			n	
Phlox pilosa L.	1139	NP	2	n	
POLYGALACEAE					
Polygala alba Nutt.	1093	NP (RO)	4	n	
POLYGONACEAE					
Eriogonum alatum Torr.	1406	NP (RO)	3	n	G5 S2S3
Eriogonum alatum Torr. var. *glabriusculum* Torr.	OCLA			n	
Eriogonum annuum Nutt.	1559*	NP, D	3	n	
Eriogonum longifolium Nutt.	1402*	NP	3	n	
Polygonum aviculare L.	1386	D	3	i	
Polygonum hydropiperoides Michx.	1471	WA	3	n	
Polygonum lapathifolium L.	1308	WA	3	n	
Polygonum pensylvanicum L.	1412	WA	3	n	
Polygonum punctatum Ell.	OKLA			n	
Polygonum ramosissimum Michx.	1525*	WA	2	n	

Taxon	Co#/Herb[1]	Habitat[2]	Abundance[3]	Origin[4]	Rarity[5]
Polygonum scandens L. var. *cristatum* (Engelm. & Gray) Gleason	1557*	R	2	n	
Polygonum virginianum L.	OKLA			n	
Rumex altissimus Wood	1327	D, WA	3	n	
Rumex crispus L.	OKLA			i	
Rumex hastatulus Baldw.	OKLA			n	
PORTULACACEAE					
Claytonia virginica L.	OKL			n	
PRIMULACEAE					
Dodecatheon meadia L.	1086	NP	2	n	
Samolus valerandi L. ssp. *parviflorus* (Raf.) Hultén	1506*	WA	3	n	
RANUNCULACEAE					
Anemone berlandieri Pritz.	1188	NP	3	n	
Clematis pitcheri Torr. & Gray	OKLA			n	
Delphinium carolinianum Walt.	1244	NP	3	n	
Ranunculus hispidus Michx.	OKL			n	
Ranunculus sceleratus L.	1569*	WA	2	n	
Thalictrum dasycarpum Fisch. & Avé-Lall.	1578	BF	2	n	
Thalictrum revolutum DC.	OKLA			n	
RHAMNACEAE					
Ceanothus americanus L.	1444	NP (RO)	2	n	
Ceanothus herbaceus Raf.	OKL			n	
ROSACEAE					
Crataegus crus-galli L.	OCLA			n	
Crataegus mollis Scheele	OKL			n	
Crataegus viridis L.	OKLA			n	
Geum canadense Jacq.	1363	BF	3	n	
Geum canadense Jacq. var. *texanum* Fern. & Weatherby	OKLA			n	
Prunus angustifolia Marsh.	OKL			n	
Prunus gracilis Engelm. & Gray	1203	NP	4	n	
Prunus mexicana S. Wats.	1371	UF	3	n	
Rosa foliolosa Nutt. ex Torr. & Gray	OKL			n	
Rosa multiflora Thunb. ex Murr.	1097	UF, NP	3	i	
Rubus oklahomus Bailey	OKLA			n	
RUBIACEAE					
Cephalanthus occidentalis L.	1303	WA	3	n	
Diodia teres Walt.	1493	NP	3	n	
Galium aparine L.	1218	CP, UF	4	n	
Galium pilosum Ait.	1502*	UF	3	n	
Hedyotis nigricans (Lam.) Fosberg	1279	NP	4	n	
Houstonia pusilla Schoepf	1199	NP	4	n	
RUTACEAE					
Ptelea trifoliata L.	OKL			n	
Zanthoxylum americanum P. Mill.	OKL			n	

Taxon	Co#/Herb[1]	Habitat[2]	Abundance[3]	Origin[4]	Rarity[5]
SALICACEAE					
Populus deltoides Bartr. ex Marsh.	1228*	R, S	3	n	
Salix caroliniana Michx.	OKL			n	
Salix exigua Nutt.	1572	R, WA	3	n	
Salix nigra Marsh.	1105	R	3	n	
SAPINDACEAE					
Sapindus saponaria L. var. *drummondii* (Hook. & Arn.) L. Benson	1331	UF	4	n	
SAPOTACEAE					
Sideroxylon lanuginosum Michx. ssp. *oblongifolium* (Nutt.) T.D. Pennington	1257*	BF, UF	3	n	
SCROPHULARIACEAE					
Agalinis heterophylla (Nutt.) Small ex Britt.	1505	NP	3	n	
Bacopa rotundifolia (Michx.) Wettst.	OCLA			n	
Buchnera americana L.	1278	NP	2	n	
Castilleja indivisa Engelm.	1151	NP	4	n	
Castilleja purpurea (Nutt.) G. Don var. *citrina* (Pennell) Shinners	OKL			n	
Castilleja sessiliflora Pursh	OKL			n	
Leucospora multifida (Michx.) Nutt.	1499*	D, WA	3	n	
Nuttallanthus texanus (Scheele) D.A. Sutton	30	D, NP	3	n	
Penstemon cobaea Nutt.	1152	NP	3	n	
Penstemon oklahomensis Pennell	OKLA			n	G3 S3
Scrophularia marilandica L.	OKLA			n	
Verbascum thapsus L.	OKLA			i	
Veronica anagallis-aquatica L.	1570*	WA	2	n	
Veronica peregrina L. ssp. *xalapensis* (Kunth) Pennell	1108*	D	2	n	
SOLANACEAE					
Physalis angulata L.	OKL			n	
Physalis cinerascens (Dunal) A.S. Hitchc.	1311	D	3	n	
Physalis longifolia Nutt. var. *longifolia*	1347*	D	3	n	
Physalis mollis Nutt. var. *mollis*	OKLA			n	
Physalis pubescens L. var. *pubescens*	1434*	D	3	n	
Physalis pumila Nutt.	OKL			n	
Solanum americanum P. Mill.	OKLA			n	
Solanum carolinense L.	OKLA			n	
Solanum dimidiatum Raf.	1319	D	4	n	
Solanum elaeagnifolium Cav.	1268	D, NP	4	n	
Solanum ptychanthum Dunal	OKL			n	
Solanum rostratum Dunal	1350	D	4	n	
TAMARICACEAE					
Tamarix chinensis Lour.	1220*	R	3	i	
Tamarix gallica L.	OKLA			i	
ULMACEAE					
Celtis laevigata Willd.	1197	BF, UF	5	n	
Celtis laevigata Willd. var. *reticulata* (Torr.) L. Benson	1365	UF	4	n	
Celtis laevigata Willd. var. *texana* Sarg.	OKL			n	

Taxon	Co#/Herb[1]	Habitat[2]	Abundance[3]	Origin[4]	Rarity[5]
Celtis tenuifolia Nutt.	OKL			n	
Ulmus americana L.	1184	BF, UF	5	n	
Ulmus rubra Muhl.	1201*	BF	3	n	
URTICACEAE					
Boehmeria cylindrica (L.) Sw.	OKLA			n	
Parietaria pensylvanica Muhl. ex Willd.	OKLA			n	
Urtica dioica L.	OKLA			n	G5 S2
VALERIANACEAE					
Valerianella amarella (Lindheimer ex Engelm.) Krok	1107*	S, R	3	n	
VERBENACEAE					
Glandularia bipinnatifida (Nutt.) Nutt.	1351	NP	3	n	
Glandularia canadensis (L.) Nutt.	OKL			n	
Glandularia pumila (Rydb.) Umber	1190	NP	4	n	
Phyla lanceolata (Michx.) Greene	1510*	WA	2	n	
Phyla nodiflora (L.) Greene	OKLA			n	
Verbena bracteata Lag. & Rodr.	1458*	NP	3	n	
Verbena halei Small	1455*	D	3	n	
Verbena scabra Vahl.	1579*	R	2	n	
Verbena stricta Vent.	1168	NP	3	n	
VIOLACEAE					
Viola affinis Le Conte	1274	BF, UF	4	n	
Viola bicolor Pursh	1198	CP, D	3	n	
Viola sororia Willd.	OKLA			n	
VISCACEAE					
Phoradendron leucarpum (Raf.) Reveal & M.C. Johnston	OKL			n	
Phoradendron tomentosum (DC.) Engelm. ex Gray	1305*	BF, UF	3	n	
VITACEAE					
Cissus incisa auct. non Des Moulins	1562*	NP (RO), R	2	n	
Cissus trifoliata (L.) L.	OKL			n	
Parthenocissus quinquefolia (L.) Planch.	1364	BF, UF	4	n	
Vitis cinerea (Engelm.) Millard	1222*	BF, UF	4	n	
Vitis cinerea (Engelm.) Millard var. *cinerea*	1366*	BF, UF	4	n	
Vitis vulpina L.	1336*	BF, UF	4	n	
ZYGOPHYLLACEAE					
Tribulus terrestris L.	1468	D	3	i	
LILIOPSIDA					
AGAVACEAE					
Yucca arkansana Trel.	1147	NP	3	n	
ALISMATACEAE					
Alisma subcordatum Raf.	OKL			n	
Echinodorus berteroi (Spreng.) Fassett	OCLA			n	
Sagittaria brevirostra Mackenzie & Bush	OKL			n	
Sagittaria calycina Engelm.	OKLA			n	

Taxon	Co#/Herb[1]	Habitat[2]	Abundance[3]	Origin[4]	Rarity[5]
Sagittaria platyphylla (Engelm.) J.G. Sm.	1551	WA	n/a	n	
COMMELINACEAE					
Commelina erecta L.	1332	D	4	n	
Commelina erecta L. var. *deamiana* Fern.	OKLA			n	
Tradescantia occidentalis (Britt.) Smyth	OCLA			n	
Tradescantia ohiensis Raf.	OCLA			n	
CYPERACEAE					
Carex brevior (Dewey) Mackenzie	OKL			n	
Carex bushii Mackenzie	OCLA			n	
Carex crus-corvi Shuttlw. ex Kunze	OKLA			n	
Carex flaccosperma Dewey	OCLA			n	
Carex gravida Bailey var. *lunelliana* (Mackenzie) F.J. Herm.	OKLA			n	
Carex leavenworthii Dewey	OCLA			n	
Carex meadii Dewey	OKLA			n	
Carex microdonta Torr. & Hook.	OKL			n	
Carex muehlenbergii Schkuhr ex Willd.	OKLA			n	
Carex muehlenbergii Schkuhr ex Willd. var. *enervis* Boott	OCLA			n	
Carex retroflexa Muhl. ex Willd.	OCLA			n	
Carex tetrastachya Scheele	OKLA			n	
Cyperus acuminatus Torr. & Hook. ex Torr.	1356	WA	3	n	
Cyperus echinatus (L.) Wood	1529	S	3	n	
Cyperus esculentus L.	1488	D	3	n/i	
Cyperus lupulinus (Spreng.) Marcks	1325	S	3	n	
Cyperus odoratus L.	1526*	D	3	n	
Cyperus reflexus Vahl	1178*	S	3	n	
Cyperus setigerus Torr. & Hook.	1581	WA	1	n	
Cyperus squarrosus L.	OCLA			n	
Cyperus virens Michx.	OKLA			n	
Eleocharis acutisquamata Buckl.	1205*	S	3	n	
Eleocharis compressa Sullivant	OKLA			n	
Eleocharis montevidensis Kunth	OKLA			n	
Eleocharis palustris (L.) Roemer & J.A. Schultes	1514	WA, S	3	n	
Fimbristylis annua (All.) Roemer & J.A. Schultes	OCLA			n	
Fimbristylis puberula (Michx.) Vahl	OKL			n	
Fimbristylis puberula (Michx.) Vahl var. *puberula*	1232	NP	4	n	
Fimbristylis vahlii (Lam.) Link	1571	WA	2	n	
Fuirena simplex Vahl	1419	S	3	n	
Fuirena simplex Vahl var. *aristulata* (Torr.) Kral	1487	S	3	n	
Fuirena simplex Vahl var. *simplex*	1498	S	3	n	
Fuirena squarrosa Michx.	OCLA			n	
Lipocarpha aristulata (Coville) G. Tucker	OCLA			n	
Rhynchospora nivea Boeckl.	1235	S	4	n	G4 S2
Schoenoplectus americanus (Pers.) Volk. ex Schinz & R. Keller	OKLA			n	
Schoenoplectus pungens (Vahl) Palla	1285*	WA, S	3	n	
Schoenoplectus tabernaemontani (K.C. Gmel.) Palla	OKLA			n	
Scirpus lineatus Michx.	OKLA			n	
Scirpus pendulus Muhl.	1322*	WA, S	3	n	

Taxon	Co#/Herb[1]	Habitat[2]	Abundance[3]	Origin[4]	Rarity[5]
IRIDACEAE					
Hypoxis hirsuta (L.) Coville	OKL			n	
Nemastylis geminiflora Nutt.	OKL			n	
Nemastylis nuttallii Pickering ex R.C. Foster	OCLA			n	
Sisyrinchium angustifolium P. Mill.	1243	NP	4	n	
Sisyrinchium campestre Bickn.	OKLA			n	
JUNCACEAE					
Juncus bufonius L.	OCLA			n	
Juncus dudleyi Wieg.	1460*	WA	2	n	
Juncus interior Wieg.	1284*	WA	2	n	
Juncus marginatus Rostk.	1176	S	2	n	
Juncus nodatus Coville	OKLA			n	
Juncus scirpoides Lam.	OKLA			n	
Juncus tenuis Willd.	1374*	BF	3	n	
Juncus torreyi Coville	1472	WA, S	3	n	
LEMNACEAE					
Lemna aequinoctialis Welw.	1549*	WA	3	n	
LILIACEAE					
Allium canadense L.	OCLA			n	
Allium canadense L. var. *fraseri* Ownbey	1095	NP	3	n	
Allium drummondii Regel	1096*	NP	3	n	
Allium stellatum Nutt. ex Ker-Gawl.	OCLA			n	
Androstephium caeruleum (Scheele) Greene	1191	NP	4	n	
Nothoscordum bivalve (L.) Britt.	1192	NP	4	n	
Polygonatum biflorum (Walt.) Ell.	1129*	BF	2	n	
NAJADACEAE					
Najas guadalupensis (Spreng.) Magnus	OCLA			n	
ORCHIDACEAE					
Spiranthes cernua (L.) L.C. Rich.	1564*	NP	2	n	
Spiranthes lacera (Raf.) Raf.	OCLA			n	
Spiranthes magnicamporum Sheviak	1410	NP	3	n	
Spiranthes vernalis Engelm. & Gray	OCLA			n	
POACEAE					
Aegilops cylindrica Host	1135*	D	4	i	
Agrostis hyemalis (Walt.) B.S.P.	OKL			n	
Agrostis perennans (Walt.) Tuckerman	1452*	NP	3	n	
Alopecurus carolinianus Walt.	1459*	WA	3	n	
Andropogon gerardii Vitman	1426	NP	4	n	
Andropogon hallii Hack.	OKL			n	
Andropogon glomeratus (Walt.) B. S. P. var. *hirsutior* (Hack.) C. Mohr	1415*	S, R	3	n	
Aristida oligantha Michx.	1401	NP	4	n	
Aristida purpurea Nutt. var. *purpurea*	1266*	NP	4	n	
Bothriochloa ischaemum (L.) Keng var. *songarica* (Rupr. ex Fisch. & C.A. Mey.) Celarier & Harlan	1394*	NP	3	i	
Bothriochloa laguroides (DC.) Herter ssp. *torreyana* (Steud.) Allred & Gould	1297*	NP	4	n	
Bothriochloa saccharoides (Sw.) Rydb.	OKLA			n	

Taxon	Co#/Herb[1]	Habitat[2]	Abundance[3]	Origin[4]	Rarity[5]
Bouteloua curtipendula (Michx.) Torr.	1317	NP	5	n	
Bouteloua hirsuta Lag.	1316	NP	5	n	
Bouteloua hirsuta Lag. var. *pectinata* (Featherly) Cory	1532*	NP	3	n	
Bouteloua rigidiseta (Steud.) A.S. Hitchc.	OKLA			n	
Bromus catharticus Vahl	1136	CP, D	3	i	
Bromus japonicus Thunb. ex Murr.	1135	CP, D	3	i	
Bromus secalinus L.	OKLA			i	
Bromus tectorum L.	1137	CP, D	4	i	
Buchloe dactyloides (Nutt.) Engelm.	1393	NP	4	n	
Cenchrus spinifex Cav.	1165	CP, D	4	n	
Chasmanthium latifolium (Michx.) Yates	1375	R, BF	4	n	
Chloris verticillata Nutt.	1315	NP	3	n	
Coelorachis cylindrica (Michx.) Nash	1252	NP	3	n	
Cynodon dactylon (L.) Pers.	1377*	CP, D	5	i	
Dichanthelium acuminatum (Sw.) Gould & C.A. Clark var. *fasciculatum* (Torr.) Freckmann	OKLA			n	
Dichanthelium malacophyllum (Nash) Gould	1062	UF	3	n	
Dichanthelium oligosanthes (J.A. Schultes) Gould var. *scribnerianum* (Nash) Gould	1362*	NP	4	n	
Dichanthelium scoparium (Lam.) Gould	OKL			n	
Dichanthelium sphaerocarpon (Ell.) Gould var. *sphaerocarpon*	1295*	UF, NP	3	n	
Dichanthelium villosissimum (Nash) Freckmann var. *praecocius* (A.S. Hitchc. & Chase)	OKLA			n	
Digitaria ciliaris (Retz.) Koel.	1423*	D, CP	3	n	
Digitaria cognata (J.A. Schultes) Pilger var. *cognata*	OKLA			n	
Digitaria sanguinalis (L.) Scop.	1484*	CP, D	4	n	
Echinochloa colona (L.) Link	1574*	R	2	i	
Echinochloa crus-galli (L.) Beauv.	1354*	WA	3	i	
Eleusine indica (L.) Gaertn.	1438*	CP, D	3	i	
Elymus canadensis L.	1157	BF	4	n	
Eragrostis cilianensis (All.) Vign. ex Janchen	1437*	D	3	i	
Eragrostis curtipedicellata Buckl.	1312*	NP	3	n	
Eragrostis pectinacea (Michx.) Nees ex Steud. var. *pectinacea*	1339*	NP	3	n	
Eragrostis secundiflora J. Presl	OKLA			n	
Eragrostis secundiflora J. Presl ssp. *oxylepis* (Torr.) S.D. Koch	1314	NP	4	n	
Eragrostis sessilispica Buckl.	1261	NP	2	n	
Eragrostis spectabilis (Pursh) Steud.	1485	NP	3	n	
Hordeum pusillum Nutt.	1234	NP	4	n	
Leersia oryzoides (L.) Sw.	1534	WA	2	n	
Leersia virginica Willd.	1538*	WA	2	n	
Leptochloa fusca (L.) Kunth ssp. *fascicularis* (Lam.) N. Snow	1355*	WA	2	n	
Lolium perenne L.	OKLA			i	
Lolium perenne L. ssp. *multiflorum* (Lam.) Husnot	1133	CP, D	3	i	
Muhlenbergia bushii Pohl	1539*	R	2	n	G5 S1S2
Muhlenbergia capillaris (Lam.) Trin.	1533*	UF	3	n	
Nassella leucotricha (Trin. & Rupr.) Pohl	1447*	NP	3	n	
Neeragrostis reptans (Michx.) Nicora	OKLA			n	

Taxon	Co#/Herb[1]	Habitat[2]	Abundance[3]	Origin[4]	Rarity[5]
Panicum acuminatum Sw. var. *lindheimeri* (Nash) Lelong	1553*	R	2	n	
Panicum anceps Michx.	1414	S, WA	3	n	
Panicum capillare L.	1483*	NP	4	n	
Panicum dichotomiflorum Michx.	1527	NP	3	n	
Panicum obtusum Kunth	1373	NP	3	n	
Panicum philadelphicum Bernh. ex Trin.	1433*	BF	2	n	
Panicum virgatum L.	1462	S, R	3	n	
Pascopyrum smithii (Rydb.) A. Löve	1164*	NP	4	n	
Paspalum distichum L.	OKL			n	
Paspalum floridanum Michx.	OKLA			n	
Paspalum laeve Michx.	1424*	R, D	3	n	
Paspalum notatum Flueggé	OKLA			n/i	
Paspalum pubiflorum Rupr. ex Fourn.	1313	R, D	3	n	
Paspalum setaceum Michx.	1500	D	3	n	
Poa annua L.	1449*	D	4	i	
Poa arachnifera Torr.	1451	BF	3	n	
Poa bulbosa L.	OKL			i	
Poa pratensis L.	OKL			n/i	
Polypogon monspeliensis (L.) Desf.	OKLA			i	
Schizachyrium scoparium (Michx.) Nash	1403*	NP	5	n	
Sclerochloa dura (L.) Beauv.	1067*	NP	2	i	
Secale cereale L.	1454*	D	2	i	
Setaria parviflora (Poir.) Kerguélen	OKLA			n	
Setaria pumila (Poir.) Roemer & J.A. Schultes	1158*	CP, D	3	i	
Setaria viridis (L.) Beauv.	1337	CP, D	4	i	
Sorghastrum nutans (L.) Nash	1396	NP	5	n	
Sorghum halepense (L.) Pers.	1166	D	4	i	
Sporobolus clandestinus (Biehler) A.S. Hitchc.	1416*	NP	3	n	
Sporobolus compositus (Poir.) Merr.	1409*	NP	3	n	
Sporobolus cryptandrus (Torr.) Gray	1338	NP	3	n	
Tridens flavus (L.) A.S. Hitchc.	1408*	NP	4	n	
Triticum aestivum L.	1453*	D	3	i	
Urochloa texana (Buckl.) R. Webster	1540*	R	2	n	
PONTEDERIACEAE					
Heteranthera limosa (Sw.) Willd.	OCLA			n	
POTAMOGETONACEAE					
Potamogeton nodosus Poir.	1507*	WA	2	n	
SMILACACEAE					
Smilax bona-nox L.	1098	BF, UF	4	n	
Smilax rotundifolia L.	OKL			n	
Smilax tamnoides L.	1554*	BF, UF	3	n	
TYPHACEAE					
Typha angustifolia L.	OKL			n	
ZANNICHELLIACEAE					
Zannichellia palustris L.	OCLA			n	

Oklahoma Native Plant Record
Volume 5, Number 1, December 2005

Editorial

Tribute to John Taylor

It's no wonder that the Taylors have been responsible for the identification and distribution information of more native Oklahoma species than anyone else, worldwide; John loved working in the field more than anything else he did. He and Connie traveled extensively and exhaustively throughout their careers. He was active in the Oklahoma Academy of Science and Oklahoma Native Plant Society and Connie, even in her retirement, continues her active participation in these organizations.

It is an honor to include John's 1967 Master's thesis in this volume of the *Oklahoma Native Plant Record*, as we continue to bring historic and significant scientific work into the hands of today's botanists and ecologists. We thank Connie for updating the format and condensing some of the information for optimal access by current readers. She helped John collect data and prepared the original manuscript for his thesis. She is still a major source of taxonomic expertise for Oklahoma species and the following testimonials are a tribute to her work as well.

"The book 'An annotated list of the ferns, fern allies, gymnosperms and flowering plants of Oklahoma' has been indispensable to me and my students over the past fifteen years. It has been so helpful to be able to consult it when a plant didn't fit the Waterfall keys, and to find that there were species new to Oklahoma that we might have in hand. The lists of synonyms and distribution information have been equally helpful. I am so grateful that John and Connie Taylor undertook this tedious task to help expedite the identification of the Oklahoma plants."

Gloria Caddell, Professor of Biology, CSU Herbarium, University of Central Oklahoma

"I met Dr. Taylor rather late in his life, as he had already retired at the time, but remember very well a field trip he co-led with Connie for the ONPS, along the Talimena Trail in, I think, 1998. It had been very dry, and there weren't many plants in bloom, but the two of them knew every plant we passed, whether blooming or not. Along the way he pulled up a Carex seedling and gave it to me to grow, saying, "This is quite rare in Oklahoma". It was, and still is. It later bloomed for me on a place I built for it in Cleveland County, and by that time I knew enough to know it as *Carex atlantica*. But John's most endearing contribution to Oklahoma plants was that '…Annotated List…' At a time when the USDA database was only an unreliable hatchling, apt to go off-line at irregular intervals, that list was the best reference we had for the organization of the Flora of Oklahoma Project. Using it, we were able to determine workloads and make assignments. It is still the best available source for information about whether a plant is native or not, where to look for it, or why it has three scientific names! Only someone who understood and sympathized with the plight of beginning botanists in Oklahoma could have produced such a valuable book."

Patricia Folley, Bebb Herbarium, University of Oklahoma.

"I use the Annotated List constantly, both for my own personal gratification in

https://doi.org/10.22488/okstate.17.100041

my home landscape and for professional landscape planting projects for clients. It is my bedrock concerning the suitability of planting in the different regions of Oklahoma."

Susan Chambers, Owner
Rose Rock Landscaping, Midwest City, Oklahoma

"I did not have the opportunity to know John Taylor very well; however, I greatly appreciate his contributions to the flora of Oklahoma. In particular, the 'An Annotated List of the Ferns, Fern Allies, Gymnosperms and Flowering Plants of Oklahoma' is an invaluable resource. My students and I use the list several times a week. Student workers (usually work-study students who may not be biology majors) manage our small herbarium and without the list they would be lost. John and Connie's list is the first reference that I use to resolve a nomenclature issue."

Monica Macklin, Instructor of Biology, Joe M. Anderson Herbarium, Northeastern State University

"At 7:30 a.m. on Saturday, March 18, 1989, I left home in Noble to drive to Durant for an ONPS field trip. It was cold and blustery, as March usually is. John Taylor was to be our trip leader with Jim Norman's assistance. I had been on only a few such outings and was excited. However, I had reservations about the weather. It was more like a day to stay inside and read. We were to meet at a restaurant on the outskirts of town.

When I arrived John and Jim were there alone. The three of us were the only ones to show up. I felt badly because John had gone to a lot of trouble to set up a display of things we could expect to see that day, in the school's herbarium at East Central State College. Then we proceeded on an extensive driving and walking trip to several locations and John was just as instructive and patient with only one student as he would have been with a dozen or more. Sixteen years later I don't remember many details except that somewhere we saw seaside alder growing in a bar ditch and I realized that my miniature pinecone earrings that had been dipped in gold were actually seaside alder cones. I had never even heard of them before.

In spite of my earlier misgivings and disappointment that we hadn't had more people, it turned out to be one of the best experiences of my life. I will always remember that trip and all the special attention I received as an only student with two excellent teachers."

Ruth Boyd, Charter member of the Central Chapter of ONPS

"John and Connie Taylor's, *An Annotated List of the Ferns, Fern Allies, Gymnosperms and Flowering Plants of Oklahoma"* is one of the most valuable publications about Oklahoma plants I own. It is certainly the *first* one I reach for when I want to know a plant's range, use, and common name. I wish I could have taken field trips with the Taylors. What an adventure that would have been!"

Marilyn Stewart, Owner, Wild Things Nursery, Seminole, Oklahoma

His work has benefitted many more Oklahoma botanists than he knew or could ever have met. That number will surely increase in the coming decades. SS

ONPS

Editorial Policies and Practices

Oklahoma Native Plant Record is published annually by Oklahoma Native Plant Society. Submission for publication in the journal is open to all. Manuscripts will be accepted on topics related to Oklahoma's regional botany, including historical research reports, current research articles, site record species lists, and descriptions of new or important species sightings in Oklahoma. Oklahoma's environmental gradients of human impact, climate, and elevation make us a prime target for research on habitat edges, species ranges, and edge species, but articles of other themes may be included as well. Research overlooked by journals of broader geographic regions will be considered for publication in the Record.

Papers must not have been published previously or accepted for submission elsewhere and should represent research conducted in accordance with accepted procedures and scientific ethics. All articles are copyrighted by their authors. Submission of the article implies the granting to Oklahoma Native Plant Society of permission to publish it. We ask only for the right to publish articles. We do not seek to own them. In return, we require our authors to allow that work to be used freely for non-commercial purposes, allowing each individual to make, gratis, a single copy of the published manuscript whether from its print or its Internet version, instructors to make gratis, multiple copies available for non-commercial teaching purposes, and libraries to make copies available, gratis for interlibrary loan. Authors are responsible for supplying reprints upon request.

Manuscripts will be reviewed for content and appropriateness by at least two reviewers. The title page should state the affiliation and complete addresses of all authors and telephone numbers for the corresponding author. Research and technical papers should include a one-paragraph abstract of not more than 250 words. It should concisely state the goals, principal results, and major conclusions of the paper. All references, figures, and tables should be cited in the text. Site descriptions should include latitude, longitude, total area and elevation. Common names should be referenced to a scientific name. Abbreviations of authorities for scientific names should follow Authors of Plant Names (Brummitt and Powell 1992). Titles of periodicals should be abbreviated following Botanico-Peridoicum-Huntianum and its supplement - except in historic publications when original format will be used.

Authors with access to PC-compatible microcomputers are encouraged to send a copy of the manuscript on CD or diskette in rtf (rich text format). If the manuscript is typed, manuscripts should be double-spaced on 8 1/2 X 11 inch paper with minimum one-inch margins and should be submitted in duplicate. Use no headers, footers, nor auto page numbering. A limited number of color photos may be submitted on CD or diskette. CDs, Diskettes, or hardcopy manuscripts should be sent to the managing editor at the address below by June 1.

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