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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 is open to any person who supports the aims of the Society. ONPS offers individual, student, family, and life memberships.

Cover photo: Skipper on *Asclepias tuberosa* (butterfly milkweed) by Gloria Caddell

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Oklahoma Native Plant Record

Volume 14

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Foreword

We are very excited that such a wide range of contributors, from gardeners and students to professional botanists and ecologists, submitted articles for Volume 14. This demonstrates the strength of our membership and helps us, as a society, bring all our interests together in a way that best promotes our goal of encouraging the study, protection, propagation, appreciation, and use of the native plants of Oklahoma.

Our "historic" article this year is about the flora of Kiowa County. There is very little historic plant distribution information from that far southwestern part of the state, but we hope that Lottie O. Baldock's 1938 master's thesis will spark interest there. This article will be of special value to today's botanists and ecologists studying historic species distributions and environmental changes.

Stan Rice and Sonya Ross have done a small scale study of the different effects our warmer winter temperatures might have on the timing of spring budburst in three native tree species: sycamore (*Platanus occidentalis*), pecan (*Carya illinoensis*), and sweetgum (*Liquidambar styraciflua*). Katie Keil raises awareness of three invasive species by updating and proposing revisions in the formats of distribution maps for purple loosestrife (*Lythrum salicaria)*, Japanese honeysuckle (*Lonicera japonica*), and multiflora rose (*Rosa multiflora*). Sadie Gordon reports on research that she has done regarding the use of native species in historic, domestic gardens in the NE Oklahoma, SE Kansas, SW Missouri, and NW Arkansas region. All three of these articles will pique the interests of both professional and amateur botanists and gardeners.

Angela McDonnell's article will be valuable to both professional and amateur field biologists. She describes the characteristic features and distributions of two milkweed vines, *Matelea biflora* and *M. cynanchoides*, and provides a valuable key for the species in that genus that, until now, have been difficult to discern.

Educators will be inspired by Gloria Caddell's Critic's Choice Essay. As Professor of Botany at the University of Central Oklahoma, she describes pollination studies done by undergraduate students at UCO's field site at Lake Arcadia east of Edmond as well as the Arcadia Conservation Education Area.

As we continue to develop the quality of the journal and its usefulness for botanists, researchers, enthusiasts, and gardeners, the global footprint of the Society grows. Statistics show that, in addition to the hundreds of printed volumes sold, valuable information from the *Oklahoma Native Plant Record* has been accessed thousands of times from Oklahoma State University's eJournals Digital Collections. The *Oklahoma Native Plant Record* is listed in the "Directory of Open Access Journals", and our abstracts are indexed in the "Centre for Agricultural Bioscience International", which is based in the U.K.

Our editorial board has included many Society members over the years, and *The Record* could not have reached those milestones without their help. We are especially grateful to Paula Shryock, who has been our valuable, multi-talented Production Editor in this process since 2008. Sandy Graue has updated our previous electronic versions, produced between 2001 and 2010, and reformatted them for upload into the OSU Digital Collections website. She has been our Electronic Production Editor since she joined us in 2010, and she now uploads each new volume of *The Record*. We thank both of them for the time and work they put into getting our journal out each year. We also appreciate the many members and colleagues who have authored and reviewed articles, as well as the members who have served on our editorial board as technical assistants and proof-readers. We thank them all for their support.

Sheila Strawn, Managing Editor

FLORA OF KIOWA COUNTY, OKLAHOMA

Master's Thesis
Oklahoma Agricultural and Mechanical College
[Oklahoma State University]
1938

Lottie Opal Baldock

Keywords: distribution, ecology, historic, vascular

[ABSTRACT]

This paper presents the results of taxonomic and ecological studies of the plants of Kiowa County, Oklahoma. The collections were begun in 1933 and continued until the summer of 1938; however, little intensive collecting was done until the spring and summer of 1938. The Flora of Kiowa County, Oklahoma includes six species of pteridophytes, one species of gymnosperms, and 489 species of angiosperms. More than one third of these are in Compositae, Gramineae, and Leguminosae. There are 81 families represented. The 11 largest families, with the number of species are Compositae, 86; Gramineae, 58; Leguminosae, 41; Onagraceae, 17; Euphorbiaceae, 16; Cruciferae, 16; Polygonaceae, and Solanaceae, 12 each; Asclepiadaceae, Cyperaceae, and Labiatae, 11 each. The three largest families comprise 37.4 per cent of the total number of species.

[Species names used in the original thesis which appear in brackets have been updated using the USDA Plants Database.]

PREFACE

The main value of studies such as this is to establish the distribution of species and to observe the varying ecological conditions in which the plants under consideration are growing.

Plants considered in this study and included in the list are native wild species and mainly indigenous to the county; however, a few species of cultivated plants are listed in cases where they have escaped cultivation and seem to have established themselves in the new habitat.

The author does not aim to give a complete list of the vascular plants of the county as the time was limited, and such a survey is a fit subject for more advanced graduate work.

INTRODUCTION

This paper presents the results of taxonomic and ecological studies of the plants of Kiowa County, Oklahoma (Figure). The collections were begun in 1933 and continued until the summer of 1938; however, little intensive collecting was done until the spring and summer of 1938. More systematic work has been done with the spring and summer flowering plants than with those flowering in the fall. In most cases the nomenclature is that of *Gray's Manual* (Robinson and Fernald 1908); however, the *Oklahoma Flora* by Stemen and Meyers (1937) was used as a check, and in some cases plants were listed in the latter publication only. For the grasses, Hitchcock (1935) was the final authority.

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LOCATION AND SIZE

Kiowa County is in southwestern Oklahoma. It comprises an area of 1,025 square miles, or 656,000 acres [2,655 km^2]. The county is bounded by Washita on the north, Greer and Jackson on the west, Tillman on the south, and Comanche and Caddo counties on the east. Hobart, the county seat and largest town, is located in the northwestern part, about 136 miles [219 km] southwest of Oklahoma City. The elevation at Hobart is 1,536 feet [468 m] (Wahlgren).

HISTORY

In 1834, a large military expedition was sent out from Forts Gibson and Towson to stop the warfare among the Indians and to pay a visit to the wild bands of Kiowas, Wichitas, and Comanches who lived among the Wichita Mountains. This was probably the first official expedition to reach any part of Kiowa County. They explored the region about the Wichita Mountains going as far west as North Fork Red River. George Catlin, the famous painter of Indian pictures, was with this expedition and left many pictures of things he observed.

The county was opened to settlement by a proclamation of President McKinley on July 4, 1901. The land was allotted by drawing for a choice. This county was formerly a part of the Kiowa, Comanche, and Apache Indian Reservation. In 1910, a part of the county was taken with a part of Comanche County to form Swanson County (Goke and Holopeter 1931), but the creation of Swanson County was declared illegal by a decision of the Supreme Court of Oklahoma, August 9, 1911, and the territory was restored to the former counties. A part was annexed to Tillman County.

The main industry is farming, with cotton and wheat as the leading crops. Quarrying of granite is carried on to a small extent.

Original dominant vegetation in the county consisted of grasses, a scattered growth of mesquite (*Prosopis glandulosa* Torr. var. *glandulosa* [=*Prosopis juliflora glandulosa*]), and cactus (*Opuntia humifusa* (Raf.) Raf.). Along the streams, cottonwood *(Populus deltoids* W. Bartram ex Marshall), elm *(Ulmus americana* L.), and pecan (*Carya illinoiensis* (Wagenh.) K. Koch) were in predominance. During the winter, the grasses in the valley provide the chief source of feed for livestock. Before the land was open for settlement, these valleys were highly prized among the Indians for grazing purposes.

TOPOGRAPHY

The Wichita Mountains in the south central and eastern portion rise abruptly above the gently rolling plains which are characteristic of the prairies. The mountains are composed of igneous rocks surrounded by sedimentary formations. The igneous rocks are pre-cambrian, but younger than the Proterozoic rocks which they have intruded. Most of the rock is medium to fine grained pink granite, except those of the northern range in the eastern part of the county which are made up of limestone. The granite mountains are covered with a scrubby growth of oaks, but the limestone hills are comparatively barren. The southward facing escarpment which crosses the northern part of the county shows a distinctly different physical feature. This escarpment is composed of calcareous ledges of the Blaine formation (Sawyer 1929).

STREAMS AND DRAINAGE

North Fork Red River, bounding the county on the west, and Washita River, along the northeastern edge, are the two largest streams. Most of the drainage waters flow through them from their several

tributaries. East Fork of Deep Red Creek and its tributaries with East, West, and Middle Otter Creeks drain the lower southern section. North Fork Red River with Elk Creek and their tributaries drain the western section. The northeastern section of the county is drained by Washita River and Rainy Mountain, Saddle Mountain, and Stinking Creeks.

SOIL

The soils of 95 per cent of the area of Kiowa County are heavy in texture either in the surface soil or subsoil, with clay loam mainly in both; the rest, which occur in irregularly shaped areas in different parts of the county, are sandy. The sandy soils are found along the two rivers mentioned, at the western boundary and the northeastern corner. The outstanding difference between the sandy soils and the clay loam soils is that the material of the sandy areas is much more friable throughout the surface soil and subsoil, continuing to a depth of several inches.

Foard silt loam comprises about 128,896 acres [522 km^2] (Goke and Holopeter 1931) or 19.6 per cent of the total. This type has a dark-brown surface soil that extends to a depth of six inches, where it gradually passes downward to a dark-brown or brown heavy plastic subsoil. The color in this layer gradually changes to a yellowish-brown. At a depth of 18 inches [46 cm], lime is present in sufficient quantitites to effervesce in acid.

Tillman clay loam is next in importance with 112,064 acres [454 km^2] or 17.1 per cent. It has a chocolate-brown friable surface soil that passes at a depth of six inches [15 cm] into a dark-brown friable subsurface soil. At about 12 inches [30 cm], this changes to a chocolate-brown or reddish-brown clay subsoil which is tough and plastic when wet and very hard and dense when dry. At a depth of about 24 inches [60 cm], lime is first reached in the form of hard concretions or in a finely disseminated form.

The third important type of soil is Vernon clay loam which covers 65,536 acres [265 km^2] or 10.0 per cent of the land. The surface soil of Vernon clay loam consists of reddish-brown, brown, or chocolate-brown friable material to a depth of four inches. The subsoil is reddish-brown granular clay loam which continues to a depth of about 12 inches [30 cm] where it changes into a reddish-brown clay which is plastic when wet but very hard when dry. This soil is found chiefly on slopes along the valleys and in areas that are cut by many drainage channels. Both Tillman and Vernon clay loams are best suited for pasture (Goke and Holopeter 1931), as shown by the severely eroded areas over the county where these soils have not been cultivated carefully. In many places, erosion is quite severe although the land has been cultivated little more than 30 years. Foard silt loam belongs to the better productive group of soils and is more suited to cultivation.

CLIMATE

The average yearly rainfall for Hobart from 1903 to 1930 was 28.13 inches [71 cm]. The months April, May, and June received the most rainfall while December, January, and February proved to be the driest months for those years. The lowest average rainfall came in the year 1910, which was 12.72 inches [32 cm]. The other extreme was 43.33 inches [110 cm] for 1908 (Wahlgren); however, the year 1938 proved a record one for moisture. From January to May, the average precipitation was from an inch to an inch and one-half [2.5-3.75 cm] above the average for each month.

Prevailing winds are from the south in all months except December when they are from the north. The lowest temperature recorded over a period of 28 years is -11ºF [-23.9ºC]; the highest is 114ºF [45.6ºC], with an average minimum temperature of 48ºF

[8.9ºC] and an average maximum of 74.6ºF [23.7ºC] for the period. The average date of the last killing frost comes on November 2. There is an average growing season of 213 days.

PREVIOUS COLLECTORS

Dr. G. G. Shumard (Bull 1932; Eskew 1937) was perhaps the first person to make a collection of plants in this vicinity. He was with Captain R. B. Marcy on his expedition of 1852 to the source of the North Fork of the Red River. The expedition entered the state near the center of the southern border and passed through the Wichita Mountains and into the panhandle of Texas. About 100 plants were collected within the present boundaries of Oklahoma.

Probably the largest single collection was made by the late Dr. G. W. Stevens in 1913 while he was preparing his *Flora of Oklahoma*. This complete collection is now in the Gray Herbarium at Harvard. Oklahoma Agricultural and Mechanical College has more specimens from the Stevens collection than any other herbarium within the state.

Professor Robert Stratton of Oklahoma Agricultural and Mechanical College has collected in the vicinity to add to his personal herbarium of Leguminosae and for the college herbarium. In 1932, Miss Rotha Bull made a collection of the plants of Greer County which is separated from Kiowa County on the west by North Fork Red River. Mr. C. T. Eskew made a collection of plants in 1937 of the Wichita National Forest within the boundaries of Comanche County which adjoins Kiowa County on the east.

ECOLOGY

The most common pre-vernal plants are *Claytonia virginica* L., *Glandularia canadensis* (L.) Nutt. [=*Verbena canadensis*], *Viola bicolor* Pursh [=*Viola rafinesquii*], *V. sororia* Willd. [=*V. papilionacea*], *Erysimum asperum* (Nutt.) DC., *Anemone caroliniana* Walter, *A. berlandieri* Pritz. [=*A. decapetala*], *Lithospermum incisum* Lehm. [=*Lithospermum angustifolium*], *Cercis canadensis* L., *Glandularia bipinnatifida* (Nutt.) Nutt. [=*Verbena bipinnatifida*], *Allium canadense* L. var. *mobilense* (Regel) Ownbey [=*Allium mutabile*], *A. drummondii* Regel [=*A. nuttallii*], *Nothascordum bivalve* (L.) Britton, and *Quincula lobata* (Torr.) Raf. [=*Physalis lobata*]. All of these were to be found on the streams and ravines. The prairie communities have fewer flowering plants; the outstanding ones are *Glandularia bipinnatifida*, *Allium drummondii*, *Northascordum bivalve*, *Quincula lobata*, *Anemone*, and *Lepidium* [=*Lepidium apetalum*]. Liliaceae and Violaceae have more representatives at this time than other families.

Among the spring plants are *Tradescantia ohiensis* Raf. [=*Tradescantia reflexa*], *T. occidentalis* (Britton) Smyth, *Baptisia bracteata* Muhl. ex Elliott, *B. australis* (L.) R. Br., *Corydalis*, *Oxalis*, and a great percent of *Cruciferae*, all of which appear on mountains and streams with the budding trees and other woody plants. *Cruciferae* are in more abundance on the prairies along with *Sphaeralcea coccinea* (Nutt.) Rydb. [=*Malvastrum coccineum*], *Opuntia humifusa*, *Oenothera laciniata* Hill, *Hordeum pusillium* Nutt., *Bromus catharticus* Vahl. [=*Bromus unioloides*], *Vulpia octoflora* (Walter) Rydb. [=*Festuca octoflora*], *Aristida purpurea* Nutt., *Yucca glauca* Nutt., and *Oxalis*. Grasses begin flowering in late spring and early summer when they become predominant.

Leguminosae is another family which flowers mainly in the summer. Other plants which become predominant at this time are *Argemone albiflora* Hornem. [=*Argemone alba*], *A. polyanthemos* (Fedde) G.B. Ownbey [=*A. intermedia*], *Cirsium* [=*Cirsium discolor*], *Centaurea americana* Nutt., *Gaillardia*, *Tribulus terrestris* L., *Plantago patagonica* Jacq. [=*Plantago purshii*], *Krameria lanceolata* Torr. [=*Krameria secundiflora*], *Erigeron strigosus* Muhl. ex Willd.

[=*Erigeron ramosus*], *Chloris verticillata* Nutt., *Solanum elaeagnifolium* Cav., *S. rostratum* Dunal, *Polygonum*, *Salsola tragus* L. [=*Salsola kali*], and the greatest percent of Euphorbiaceae.

During the latter part of the summer the composites begin to gain predominance as for number of species in flower, but the grass family is still the most important as to the amount of space it covers. During the autumn the outstanding plants are *Helianthus*, *Rhus*, *Vernonia*, *Euphorbia marginata* Pursh, *Liatris punctata* Hook., *Solidago*, *Aster*, *Ambrosia*, *Xanthium*, *Sorghastrum nutans* (L.) Nash, and others of the tall grass group.

Annual and biennial plants on the mountains and streams are not so different from those of the prairies in the summer and fall as they are in the spring. The fall grasses are more adapted to the former habitat. Many woody plants are seeding in the autumn, and in the latter part of the year the mountainsides are colorful with the brilliant foliage of the trees and shrubs.

Along the streams, trees and woody plants are dominant. *Carya illinoinensis*, *Juglans nigra* L., *Rhus glabra* L., *Ulmus americana*, *Vitis*, *Fraxinus*, *Toxicodendron*, *Sapindus saponaria* L. var *drummondii* (Hook. & Arn.) L.D. Benson [=*Sapindus drummondii*], and *Salix nigra* Marshall are the outstanding plants in this type of vegetation. These same genera are found on the mountains, but species of *Quercus* become dominant in the eastern section of the county. Other mountain plants are *Rhus aromatica* Aiton [=*Rhus trilobata*], *Ptelea trifoliata* L., *Ribes aureum* Pursh, *Baptisia*, *Sedum*, *Ceanothus americanus* L., *Rubus*, *Galium aparine* L., and *Poa arachnifera* Torr.

Plants in dry sand and along the rivers form another distinctly different type. *Artemisia*, *Mentzelia*, *Sporobolus*, and species of *Prunus* form the dominant covering on the sand hills, and *Tamarix* [=*Tamarix gallica*] is found in abundance in damp sandy soil. Other outstanding plants here are *Glandularia canadensis*, *Comandra umbellata* (L.) Nutt. ssp. *pallida* (A. DC.) Piehl [=*Comandra pallida*], *Lithaspermum incisum*, *Cenchrus*, and a species of *Gaura*.

The types of vegetation mentioned above are all connected by the prairie type which covers the greatest percent of the area of the county. Here is found one main association in the undisturbed pastures. *Prosopis glandulosa* var. *glandulosa* forms an orchard type of growth, and under the trees the dominant vegetation is *Bouteloua dactyloides* (Nutt.) J.T. Columbus [=*Buchloe dactyloides*] interspersed with *Opuntia humifusa*.

SUMMARY

The Flora of Kiowa County, Oklahoma includes six species of pteridophytes, one species of gymnosperms, and 489 species of angiosperms. More than one third of these are in Compositae, Gramineae, and Leguminosae. There are 81 families represented. The 11 largest families, with the number of species, are Compositae, 86; Gramineae, 58; Leguminosae, 41; Onagraceae, 17; Euphorbiaceae, 16; Cruciferae, 16; Polygonaceae and Solanaceae, 12 each; and Asclepiadaceae, Cyperaceae, and Labiatae, 11 each. The three largest families comprise 37.4 per cent of the total number of species.

The county lies in the plains region. The prairies are broken by the Wichita Mountains and a few streams, of these the North Fork Red River is the largest. The vegetation is mainly that adapted to the prairies. Tall grass is found near mountains or streams; it is predominately a short-grass area. Trees are to be seen along streams or on mountainsides. The only native trees on the prairies are mesquite (*Prosopis glandulosa* var. *glandulosa*) which grow in association with cactus (*Opuntia humifusa)* and buffalo grass (*Bouteloua dactyloides).*

ACKNOWLEDGEMENTS

The writer wishes to express her appreciation to the following people for their services in preparing this paper: Dr. H. I. Featherly of the Oklahoma Agricultural and Mechnical College, under whose direction this study was made, for constant advice and criticism; Dr. K. Starr Chester, head of the Department of Botany, and Professor R. H. Stratton, of the same department, for their aid in securing materials; and Dr. Elbert L. Little, Jr., in the United States Forest Service at Flagstaff, Arizona, for suggestions. The writer also wishes to express her appreciation to her family for assistance in collecting and preparing specimens.

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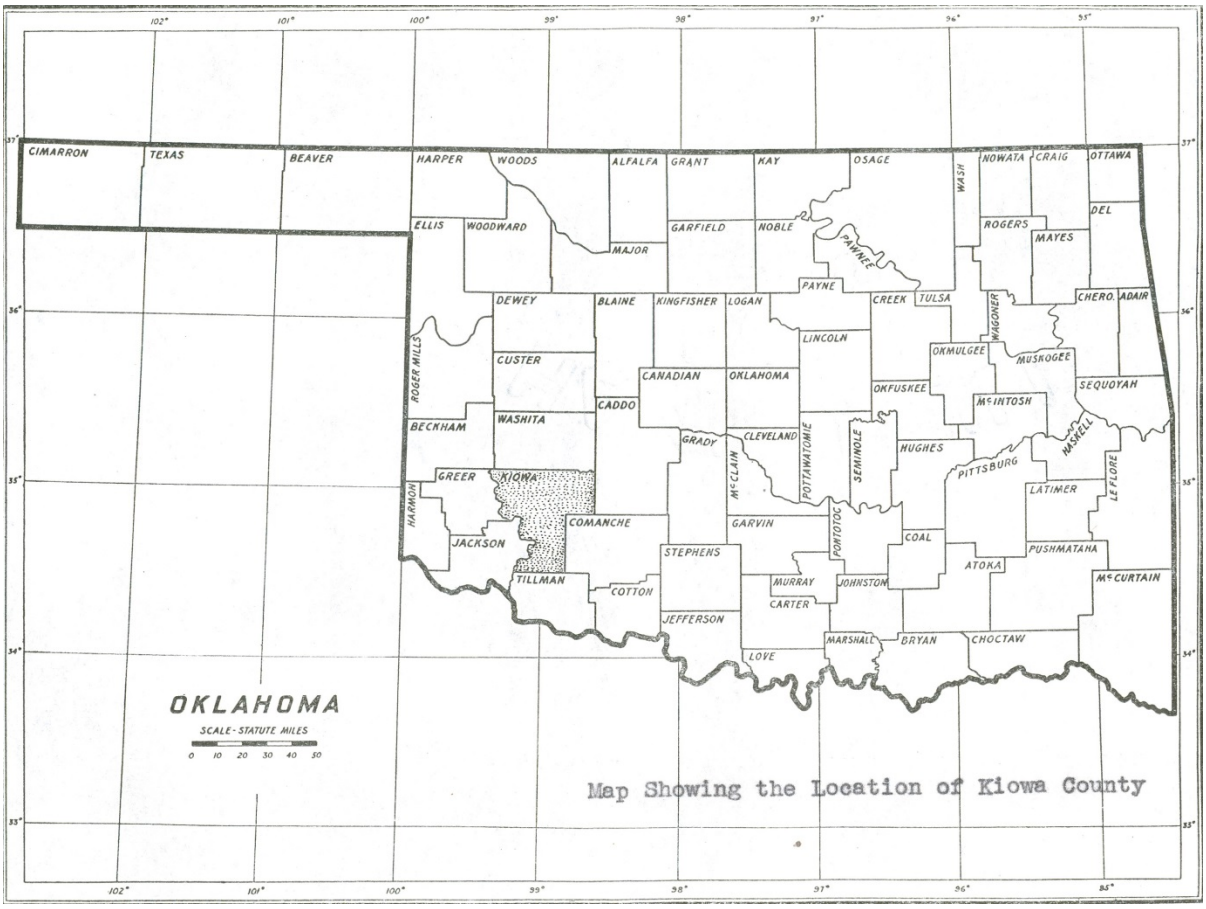

Figure Map of Kiowa County, Oklahoma

APPENDIX A

List of Species, Kiowa County, OK

[Nomenclature has been updated using the PLANTS Database (http://plants.usda.gov/plants).]

PTERIDOPHYTA

Dryopteridaceae [Polypodiaceae]		
Woodsia obtusa (Spreng.) Torr.	blunt-lobed woodsia	mountainsides
Marsileaceae		
Marsilea vestita Hook. & Grev.	water fern, hairy pepperwort	low places, pastures
Pteridaceae [Polypodiaceae]		
Cheilanthes eatonii Baker	Eaton's lip fern	mountainsides
Cheilanthes lanosa (Michx.) D.C. Eaton [=*Cheilanthes lanulosa* (Michx.) Watt]	hairy lip fern	mountainsides
Notholaena standleyi Maxon	Standley's notholaena	mountainsides
Pellaea atropurpurea (L.) Link	purple cliff brake	mountainsides

SPERMATOPHYTA

Gymnosperms

Cupressaceae [Pinaceae]		
Juniperus virginiana L.	red cedar	hillsides

Angiosperms

Acanthaceae		
Ruellia pedunculata Torr. ex A. Gray	stalked ruellia	mountainsides; summer, fall
Ruellia sp. [=*Ruellia ciliosa* Pursh, misapplied]	hairy ruelllia	rivers; summer, fall
Agavaceae [Liliaceae]		
Yucca glauca Nutt.	yucca, bear-grass, soap weed	pastures, roadsides; spring
Aizoaceae		
Mollugo verticillata L.	carpet-weed	pastures, common; summer
Amaranthaceae		
Amaranthus blitoides S. Watson	prostrate amaranth	fields, pastures, common; summer

Amaranthus hybridus L.	dark green pig-weed	pastures; spring to fall
Amaranthus retroflexus L.	red root	roadsides; spring, summer
Amaranthus tuberculatus (Moq.) Sauer	western water-hemp	pastures; summer
Anacardiaceae		
Rhus aromatica Aiton [=*Rhus canadense* Mill., *Rhus trilobata* Nutt.]	fragrant sumac, sumac	mountains, streams; spring, summer
Rhus glabra L.	smooth upland sumac	creeks, hillsides; common; summer
Toxicodendron radicans (L.) Kuntze	poison ivy	mountainsides, streams; summer
Apocynaceae		
Amsonia tabernaemontana Walter	broad-leaved amsonia	mountain ravines; spring
Apocynum cannabinum L.	dogbane, Indian hemp	roadsides; common; summer
Asclepiadaceae		
Asclepias amplexicaulis Sm.	milkweed, silkweed	near rivers; spring, summer
Asclepias asperula (Decne.) Woodson ssp. *capricornu* (Woodson) Woodson [=*Asclepiodora decumbens* (Nutt.) A. Gray]	milkweed	mountainsides; spring
Asclepias engelmanniana Woodson [=*Acerates auriculata* Engelm. ex Torr.]	green milkweed	roadsides; summer
Asclepias latifolia (Torr.) Raf.	broad-leaved milkweed	dry sandy soils; summer
Asclepias stenophylla A. Gray [incl. *Acerates angustifolia* (Nutt.) Decne.]	narrow-leaved milkweed	prairies; summer
Asclepias tuberosa L.	butterfly weed	sand, near rivers; spring, summer
Asclepias verticillata L.	whorled milkweed	mountainsides; spring, summer
Asclepias viridiflora Raf. [=*Acerates viridiflora* (Raf.) Pursh ex Eaton]	green milkweed	prairies; summer
Asclepias viridis Walter [=*Asclepiodora viridis* (Walter) A. Gray]	oblong-leaved milkweed	prairies; summer
Gonolobus suberosus (L.) R. Br. [=*Vincetoxicum gonocarpos* Walter]	large-leaved angle-pod	rivers; early summer
Boraginaceae		
Heliotropium convolvulaceum (Nutt.) A. Gray	sand heliotrope	rivers; late summer
Heliotropium indicum L.	Indian heliotrope	pastures, creeks; spring to fall

Lappula occidentalis (S. Watson) Greene [=*Lappula redowskii* (Hornem.) Greene var. *occidentalis* (S. Watson) Rydb.]	western stick-weed	mountainsides; spring
Lithospermum incisum Lehm. [=*Lithospermum angustifolium* Michx.]	puccoon	dry sandy soils; spring
Myosotis verna Nutt. [=*Myosotis virginica* (L.) Britton, Sterns & Poggenb., misapplied]	spring or early scorpion-grass	sand near rivers; spring
Onosmodium bejariense DC. ex A. DC. [=*Onosmodium occidentale* Mack.]	western false gromwell	prairies; summer
Cactaceae		
Echinocereus reichenbachii (Terscheck ex Walp.) J.N. Haage [=*Echinocereus caespitosus* (Englem.) Engelm.	lace cactus	mountainsides
Opuntia humifusa (Raf.) Raf.	western prickly-pear	pastures; common; spring
Campanulaceae [incl. Lobeliaceae]		
Lobelia cardinalis L.	cardinal flower, red lobelia	mountain ravines; summer
Lobelia spicata Lam. var. *leptostachys* (A. DC.) Mack. & Bush [=*Lobelia leptostachys* A. DC.]	spiked lobelia	mountainsides; summer
Triodanis leptocarpa (Nutt.) Nieuwl. [=*Specularia leptocarpa* (Nutt.) A. Gray]	western Venus's looking-glass	pastures; spring, summer
Triodanis perfoliata (L.) Nieuwl. [=*Specularia perfoliata* (L.) A. DC.]	Venus's looking-glass	prairies, streams; spring, summer
Capparaceae		
Cleome serrulata Pursh *Cleomella angustifolia* Torr.	pink cleome, stinking clover	prairies; summer
Caprifoliaceae		
Symphoricarpos orbiculatus Moench	coral-berry, Indian currant	streams; summer
Viburnum rufidulum Raf.	southern black-haw	mountainsides; spring
Caryophyllaceae [incl. Illecebraceae]		
Cerastium brachypodum (Engelm. ex A. Gray) B.L. Rob.	short-stalked chickweed	prairies; spring
Cerastium nutans Raf.	long-stalked chickweed	mountainsides; spring
Paronychia jamesii Torr. & A. Gray	James's whitlow-wort	prairies; summer
Silene antirrhina L.	sleepy catchfly	roadsides; spring
Stellaria media (L.) Vill.	common chickweed, starwort	low damp places; early spring

Chenopodiaceae		
Chenopodium album L.	lamb's quarters	roadsides, common; summer
Cycloloma atriplicifolium (Spreng.) J.M. Coult.	sand tumbleweed	rivers; summer
Monolepis nuttalliana (Schult.) Greene	monolepis	common near dwellings; spring
Salsola tragus L. [=*Salsola kali* L., misapplied]	Russian thistle	roadsides, cultivated soil; summer
Commelinaceae		
Commelina erecta L. [incl. *Commelina crispa* Woot.]	slender day-flower, crinkle-leaved day-flower	mountainsides, creeks; spring, summer, fall
Commelina virginica L. [incl. *Commelina hirtella* Vahl]	Virginia day-flower, bearded day-flower	mountain ravines, streams; summer
Tradescantia occidentalis (Britton) Smyth	western spiderwort, trinity	mountainsides; spring
Compositae		
Achillea millefolium L. [incl. *Achillea lanulosa* Nutt.]	common yarrow, wooly common yarrow	roadsides, prairies, creeks; summer
Ambrosia artemisiifolia L.	ragweed	ravines; summer, fall
Ambrosia psilostachya DC.	western ragweed	roadsides, pastures; fall
Ambrosia trifida L.	great ragsweed	creeks; summer, fall
Amphiachyris dracunculoides (DC.) Nutt.	August flower kindling-weed	roadsides; fall
Aphanostephus ramosissimus DC. [=*Aphanostephus humilis* (Benth.) A. Gray, misapplied]	sand-daisy	hillsides; summer
Aphanostephus skirrhobasis (DC.) Trel.	white-flowered sand-daisy	rivers; summer
Artemisia ludoviciana Nutt.	dark-leaved mugwort	dry hillsides near rivers; late summer
Baccharis salicina Torr. & A. Gray	willow baccharis	rivers; early summer
Berlandiera betonicifolia (Hook.) Small [=*Berlandiera texana* DC.]	Texas berlandiera	streams; summer
Brickellia eupatorioides (L.) Shinners	false boneset	prairies; summer, fall
Centaurea americana Nutt.	centaurea	roadsides; summer
Chaetopappa asteroides Nutt. ex DC.	chaetopappa	rivers; spring
Chaetopappa ericoides (Torr.) G.L. Nesom [=*Aster ericaefolius* Rothr.]	aster	hillsides; summer
Chrysopsis pilosa Nutt.	Nuttall's golden aster	mountainsides; summer, fall
Chrysopsis sp. [=*Chrysopsis villosa* (Pursh) Nutt. ex DC. var. *hispida* (Hook.) A. Gray, misapplied]	hispid golden aster	rivers; summer

Cirsium ochrocentrum A. Gray	yellow-spined thistle	prairie pastures; summer
Cirsium sp. [=*Cirsium discolor* (Muhl. ex Willd.) Spreng., misapplied]	field thistle	roadsides; common; summer
Conyza canadensis (L.) Cronquist [=*Erigeron canadensis* L.]	horsetail, horse-weed	pastures; summer, fall
Coreopsis grandiflora Hogg ex Sweet	large-flowered coreopsis	rivers; summer
Coreopsis tinctoria Nutt.	golden coreopsis, garden tickseed	streams; spring, summer
Coreopsis sp. [=*Coreopsis verticillata* L., misapplied]	whorled tickseed	rivers; late summer
Dracopis amplexicaulis (Vahl) Cass. [=*Rudbeckia amplexicaulis* Vahl]	cone flower	streams; late spring
Echinacea angustifolia DC. [=*Brauneria angustifolia* (DC.) A. Heller]	narrow-leaved purple cone-flower	hillsides; spring to fall
Engelmannia peristenia (Raf.) Goodman & C.A. Lawson [=*Engelmannia pinnatifida* A. Gray ex. Nutt.]	engelmannia	hillsides; summer
Erigeron strigosus Muhl. ex Willd. [=*Erigeron ramosus* (Walter) Britton, Sterns & Poggenb.]	daisy fleabane	pastures; spring
Euthamia gymnospermoides Greene	viscid bushy goldenrod	prairies; late summer
Evax prolifera Nutt. ex DC.	rabbit tobacco	roadsides, pastures; spring, summer
Evax verna Raf. [=*Evax multicaulis* DC.]	rabbit tobacco	roadsides, pastures; common; spring, early summer
Flaveria campestris J.R. Johnst.	plains flaveria	dry plains; late summer
Gaillardia pulchella Foug.	showy gaillardia	hillsides; summer, fall
Gaillardia suavis (A. Gray & Engelm.) Britton & Rusby	cut-leaved rayless three-nerved gaillardia	prairie roadsides; spring
Gaillardia sp. [=*Gaillardia aristata* Pursh, misapplied]	gaillardia	roadsides; common; summer
Grindelia papposa G.L. Nesom & Suh [=*Haplopappus ciliatus* (Nutt.) DC.]	rosin-weed	prairie roadsides; spring to fall
Grindelia squarrosa (Pursh) Dunal	broad-leaved gum plant, rosin-weed	rivers; summer, fall
Helenium amarum (Raf.) H. Rock var. *amarum* [=*Helenium tenuifolium* Nutt.]	fine-leaved sneezeweed	creeks; summer
Helenium amarum (Raf.) H. Rock var. *badium* (A. Gray ex S. Watson) Waterf. [=*Helenium tenuifolium* Nutt. var. *badium* A. Gray ex S. Watson]	fine-leaved sneezeweed	streams; summer

Helenium autumnale L.	false or swamp sunflower	creeks; late summer
Helianthus annuus L.	common sunflower	prairies; common; summer
Helianthus hirsutus Raf.	stiff-haired sunflower	mountainsides; summer
Helianthus maximiliani Schrad.	Maximilian's sunflower	prairies; late summer
Helianthus petiolaris Nutt.	sunflower	roadsides; common; summer
Heterotheca subaxillaris (Lam.) Britton & Rusby	heterotheca	hillsides; summer
Hymenopappus scabiosaeus L'Hér. var. *corymbosus* (Torr. & A. Gray) B.L. Turner [=*Hymenopappus corymbosus* Torr. & A. Gray]	corymbed, smooth hymenopappus	roadside ditches; summer
Hymenopappus scabiosaeus L'Hér. var. *scabiosaeus* [=*Hymenopappus carolinensis* (Lam.) Porter]	Carolina hymenopappus	roadsides; spring
Hymenopappus tenuifolius Pursh	wooly white hymenopappus	prairies; spring to fall
Iva annua L. [=*Iva ciliata* Willd.]	rough marsh elder	creeks; late summer
Lactuca ludoviciana (Nutt.) Riddell	western lettuce	prairies; common; summer to fall
Lactuca sp. [=*Lactuca virosa* L., misapplied]	prickly lettuce	fields, pastures; late summer
Liatris punctata Hook.	dotted button snakeroot, small blazing star	prairies; late summer
Liatris squarrosa (L.) Michx.	scaly blazing star	roadsides; summer
Packera plattensis (Nutt.) W.A. Weber & Á. Löve [=*Senecio plattensis* Nutt.]	prairie ragwort	pastures, prairies; spring
Pyrrhopappus carolilnianus (Walter) DC.	leaf-stemmed false dandelion	fields; infrequent; spring
Pyrrhopappus grandiflorus (Nutt.) Nutt. [=*Pyrrhopappus scaposus* DC.]	rough false dandelion	roadsides; prairies; spring
Ratibida columnifera (Nutt.) Woot. & Standl. [=*Lepachys columnaris* (Pursh) Torr. A. Gray]	lepachys, cone-flower	common; late spring, summer
Senecio riddellii Torr. & A. Gray	Riddell's ragwort	prairies; late summer
Silphium integrifolium Michx.	entire-leaved rosin-weed	prairies; late summer
Silphiium laciniatum L.	compass-plant	prairies; common; summer
Solidago altissima L.	tall goldenrod	hillsides; late summer
Solidago arguta Aiton var. *boottii* (Hook.) Palmer & Steyerm. [=*Solidago boottii* Hook.]	Boott's goldenrod, wreath goldenrod	mountains; summer, fall

Solidago gigantea Aiton [=*Solidago serotina* Aiton]	late goldenrod	creeks; late summer
Solidago missouriensis Nutt.	Missouri goldenrod	mountainsides; summer
Solidago petiolaris Aiton	downy ragged goldenrod	fields; fall
Solidago radula Nutt.	western rough goldenrod	prairies; summer
Sonchus asper (L.) Hill	spiny sow-thistle	roadsides; spring to fall
Symphyotrichum divaricatum (Nutt.) G.L. Nesom [*Aster exilis* Elliott]	slim aster	creeks; summer
Symphyotrichum ericoides (L.) G.L. Nesom [=*Aster multiflorus* Aiton]	many-flowered aster	prairies; summer, fall
Symphyotrichum falcatum (Lindl.) G.L. Nesom var. *commutatum* (Torr. & A. Gray) G.L. Nesom [=*Aster commutatus* (Torr. & A. Gray) A. Gray]	aster	prairies; spring
Symphyotrichum fendleri (A. Gray) G.L. Nesom [=*Aster fendleri* A. Gray]	Fendler's aster	pastures; summer
Taraxacum officinale F.H. Wigg. [=*Taraxacum vulgare* Lam.]	common dandelion	fields, pastures; spring to fall
Tetraneuris linearifolia (Hook.) Greene [=*Actinea linearifolia* (Hook.) Kuntze]	fine-leaved actinea	hillsides; summer
Tetraneuris scaposa (DC.) Greene [=*Actinea scaposa* (DC.) Kuntze var. *linearis* (Nutt.) B.L. Rob.]	narrow-leaved actinea	rivers; summer
Thelesperma filifolium (Hook.) A. Gray [=*Thelesperma trifidum* (Poir.) Britton]	thelesperma, tickseed	prairies, mountains; common; summer to fall
Thelesperma megapotamicum (Spreng.) Kuntze [=*Thelesperma gracile* (Torr.) A. Gray]	rayless thelesperma	prairies; summer
Vernonia baldwinii Torr.	Baldwin's ironweed	rivers; summer
Vernonia gigantea (Walter) Trel. [=*Vernonia altissima* Nutt.]	tall ironweed	streams; summer
Vernonia missurica Raf.	Missouri ironweed	prairies; fall
Xanthisma texanum DC.	Texas xanthisma, sleepy daisy	prairies; summer
Xanthium strumarium L. [=*Xanthium pensylvanicum* Wallr., *Xanthium speciosum* Kearney]	cocklebur, great cocklebur	roadsides, ravines; common; summer, fall

Convolvulaceae

Cuscuta cephalanthi Engelm.	button-bush dodder	parasite; summer
Cuscuta cuspidata Engelm.	cuspidate dodder	pastures; ragweeds; summer
Cuscuta indecora Choisy	pretty dodder	on composites; summer
Evolvulus nuttallianus Schult. [*Evolvulus argenteus* Pursh]	dwarf morning-glory	prairies; summer

Ipomoea leptophylla Torr.	bush morning-glory	roadsides; early summer
Ipomoea pandurata (L.) G. Mey.	wild potato vine	roadside ditches; summer
Cornaceae		
Cornus drummondii C.A. Mey. [=*Cornus asperifolia* Michx., misapplied]	rough-leaved dogwood	streams; spring
Cornus florida L.	flowering dogwood	mountainsides; spring
Crassulaceae		
Sedum nuttallianum Raf.	Nuttall's stonecrop	rocks on mountainsides; spring
Cruciferae		
Capsella bursa-pastoris (L.) Medik.	shepherd's purse	fields, meadows; spring
Descurainia pinnata (Walter) Britton [=*Sisymbrium canescens* Nutt.]	tansy-mustard	hillsides; spring
Descurainia sp. [=*Sisymbrium incisum* Englem. ex A. Gray, misapplied]	western tansy-mustard	prairie roadsides; spring, summer
Dimorphocarpa candicans (Raf.) Rollins [=*Dithyrea wislizeni* Engelm.]	spectacle pod	dry, sandy soils, near rivers; summer
Draba brachycarpa Nutt. ex Torr. & A. Gray	short-fruited whitlow-grass	fields, pastures; early spring
Draba cuneifolia Nutt. ex Torr. & A. Gray	wedge-leaved whitlow-grass	fields; common; early spring
Erysimum asperum (Nutt.) DC.	yellow phlox	mountainsides; spring
Lepidium virginicum L.	wild pepper grass	abundant; spring
Lepidium sp. [=*Lepidium apetalum* Willd., misapplied]	wild pepper grass	roadsides; common; spring
Lesquerella auriculata (Engelm. & A. Gray) S. Watson	hairy bladder-pod	prairies; early spring
Lesquerella densiflora (A. Gray) S. Watson	bladder-pod	near rivers; spring
Lesquerella ovalifolia Rydb. ex Britton	slender bladder-pod	rocky hillsides; spring
Nasturtium officinale W.T. Aiton [=*Radicula nasturtium-aquaticum* (L.) Britten & Rendle]	water cress	streams; spring
Rorippa sessiliflora (Nutt.) Hitchc. [=*Radicula sessiflora* (Nutt.) Greene]	sessile-flowered cress	mountain ravines; spring
Sibara virginica (L.) Rollins [=*Arabis virginica* (L.) Poir.]	cut-leaved rock-cress	mountainsides; early spring

Cucurbitaceae		
Cucurbita foetidissima Kunth [=*Pepo foetidissima* (Kunth) Britton]	Missouri gourd	fields, streams; summer
Cyperaceae		
Carex vulpinoidea Michx.	fox sedge	mountain ravines; summer
Cyperus echinatus (L.) Alph. Wood [=*Cyperus ovularis* (Michx.) Torr.]	globose cyperus	rivers
Cyperus esculentus L.	yellow nut-grass	rivers
Cyperus odoratus L. [=*Cyperus ferax* Rich.]	coarse cyperus	damp soils, pastures
Cyperus strigosus L.	straw colored cyperus	mountain ravines
Eleocharis compressa Sull.	flat-stemmed spike-rush	ponds; summer
Fuirena simplex Vahl	western-umbrella-grass	rivers; late summer
Lipocarpha micrantha (Vahl) G. Tucker [=*Hemicarpha micrantha* (Vahl) Pax]	dwarf sedge	riversides; summer
Schoenoplectus americanus (Pers.) Volkart ex Schinz & R. Keller [=*Scirpus americanus* Pers.]	three-cornered bulrush, sand-bar bulrush	damp ravines; summer
Scirpus pendulus Muhl. [=*Scirpus lineatus*, misapplied]	reddish bulrush	damp ravines; summer
Ebenaceae		
Diospyros virginiana L.	persimmon	mountain ravines; spring
Euphorbiaceae		
Cnidoscolus texanus (Müll. Arg.) Small [=*Jatropha stimulosa* Michx.]	spurge nettle	rivers; spring, summer
Croton capitatus Michx.	goat-weed, hogwort	roadsides; spring to fall
Croton glandulosus L. var. *septentrionalis* Müll. Arg.		creeks; summer
Croton lindheimerianus Scheele	Lindheimer's croton-weed	pastures; summer
Croton texensis (Klotzsch) Müll. Arg.	Texas croton	roadsides; mid-summer
Euphorbia dentata Michx.	toothed spurge	streams; summer
Euphorbia spathulata Lam. [=*Euphorbia dictyosperma* Fisch. & C.A. Mey.]	reticulate-seeded spurge	plains; summer
Euphorbia geyeri Engelm. & A. Gray	Geyer's spurge	rivers; summer
Euphorbia maculata L.	spurge	prairies; spring to fall
Euphorbia marginata Pursh	snow-on-the-mountain	hillsides, rivers; summer, fall
Euphorbia missurica Raf. [=*Euphorbia petaloidea* Engelm.]	white-flowered spurge	prairies; summer

Euphorbia nutans Lag. [=*Euphoribia preslii* Guss.]	large spotted spurge, upright spotted spurge	mountains, spring to fall
Euphorbia serpens Kunth	round-leaved spreading spurge	prairies; spring to fall
Stillingia sylvatica L.	queen's delight	prairies; spring to fall
Tragia ramosa Torr.	branching tragia	mountainsides; summer
Tragia sp. [=*Tragia nepetifolia* Cav., misapplied]	catnip-leaved tragia	rivers; summer
Fagaceae		
Quercus fusiformis Small [=*Quercus virginiana* Mill., misapplied]	live oak	mountains; pre-vernal
Quercus macrocarpa Michx.	bur oak, mossy-cup oak	mountainsides; pre-vernal
Quercus marilandica Münchh.	black jack oak	mountains; pre-vernal
Quercus muehlenbergii Engelm.? [=*Quercus prinus* L.]	cow oak, swamp oak	mountains; spring
Quercus shumardii Buckley var. *schneckii* (Britton) Sarg.	Schneck's red oak, spotted oak	mountains; spring
Quercus stellata Wangenh.	post oak	mountains; pre-vernal
Fumariaceae		
Corydalis aurea Willd.	golden corydalis	prairies; spring
Corydalis micrantha (Engelm. ex A. Gray) A. Gray [=*Corydalis campestris* (Britton) J. Bucholz & Palmer]	plains corydalis	creeks, pastures, near moisture; spring
Gentianaceae		
Eustoma exaltatum (L.) Salisb. ex G. Don [=*Eustoma russellianum* (Hook.) G. Don]	Russell's eustoma	creeks; summer
Sabatia angularis (L.) Pursh	rose pink, bitter bloom	creeks; summer
Sabatia campestris Nutt.	prairie sabatia	prairies; summer
Geraniaceae		
Geranium carolinianum L.	wild geranium	mountains, streams; spring
Gramineae		
Agrostis hyemalis (Watt) Britton, Sterns & Poggenb.	ticklegrass	mountainsides
Alopecurus geniculatus L.	foxtail	streams
Andropogon gerardii Vitman [=*Andropogon furcatus* Muhl. ex Willd.]	forked beard-grass, big blue-stem	mountainsides

Aristida dichotoma Michx.	aristida	prairies; summer
Aristida oligantha Michx.	few-flowered aristida	pastures; summer
Aristida purpurascens Poir.	purplish aristida	pastures, roadsides
Aristida purpurea Nutt.	purple three-awn	prairies; spring
Bothriochloa laguroides (DC.) Herter ssp. *torreyana* (Steud.) Allred & Gould	andropogon	creeks; summer
Bouteloua curtipendula (Michx.) Torr.	fall grama-grass	prairies; summer
Bouteloua dactyloides (Nutt.) J.T. Columbus [=*Buchlöe dactyloides* (Nutt.) Engelm.]	buffalo grass	pastures; summer
Bouteloua gracilis (Willd. ex Kunth) Lag. ex. Griffiths	blue grama-grass	pastures; summer, fall
Bouteloua hirsuta Lag.	hairy mesquite-grass	pastures; summer
Bouteloua sp. [=*Bouteloua breviseta* Vasey, not in OK]	bouteloua	creeks; spring, summer
Bromus arvensis L.	field chess	roadsides; summer
Bromus catharticus Vahl [=*Bromus unioloides* Kunth]	brome grass	pastures, roadsides; spring
Bromus racemosus L. [=*Bromus commutatus* Schrad.]	brome grass	roadsides; common; summer
Cenchrus spinifex Cav. [=*Cenchrus pauciflorus* Benth.]	field sandbur	rivers; summer
Chasmanthium latifolium (Michx.) Yates [=*Uniola latifolia* Michx.]	broadleaf uniola	mountains; autumn
Chloris verticillata Nutt.	windmill grass	prairies; common; spring
Cynodon dactylon (L.) Pers.	Bermuda grass	roadsides; common
Dichanthelium acuminatum (Sw.) Gould & C.A. Clark [=*Panicum tennesseense* Ashe]	panicum	mountain ravines
Digitaria cognata (Schult.) Pilg. [=*Leptoloma cognata* (Schult.) Chase]	diffuse crag-grass	fields; fall
Digitaria sanguinalis (L.) Scop.	large crab-grass	fields
Echinochloa crus-galli (L.) P. Beauv.	barnyard grass	streams
Eleusine indica (L.) Gaertn.	goosegrass	pastures
Elymus canadensis L.	Canada wild-rye	streams, ravines
Elymus glabriflorus (Vasey ex L.H. Dewey) Scribn. & C.R. Ball [=*E. virginicus* L. var. *glabriflorus* (Vasey) Bush]	Virginia wild-rye	streams
Elymus repens (L.) Gould [=*Agropyron repens* (L.) P. Beauv.]	couch grass	fields; summer
Eragrostis capillaris (L.) Nees	lace-grass	prairies; summer
Eragrostis cilianensis (All.) Vign. ex Janchen	stinkgrass	fields, roadsides; summer
Eragrostis curtipedicellata Buckley	short-stalked love-grass	roadsides, pastures; summer
Eragrostis secundiflora J. Presl	love-grass	near river; summer
Eragrostis trichodes (Nutt.) Alph. Wood	eragrostis	near river; summer

Erioneuron pilosum (Buckley) Nash [=*Triodia pilosa* (Buckley) Merr.]	hairy triodia	mountainsides; spring
Hordeum pusillum Nutt.	little barley	prairies; spring
Melica nitens (Scribn.) Nutt. ex Piper	three-flower melic	mountainsides; spring
Panicum anceps Michx.	panicum	rivers
Panicum capillare L.	witch-grass, tumbleweed	fields; summer
Panicum dichotomiflorum Michx.	fall panicum	streams; fall
Panicum obtusum Kunth	blunt panic-grass, range-grass	rivers
Panicum rigidulum Bosc ex Nees [=*Panicum agrostoides* Spreng.]	panicum	streams
Panicum virgatum L.	switch-grass, wild red-top	creeks; fall
Pascopyrum smithii (Rydb.) Á. Löve [=*Agropyron smithii* Rydb.]	western wheat-grass	prairies; spring, summer
Paspalum setaceum Michx. [=*Paspalum pubescens* Muhl. ex Willd.]	paspalum	along rivers
Phalaris caroliniana Walter	Carolina canary-grass	moist places, roadsides; spring
Poa arachnifera Torr.	Texas blue grass	highways, hillsides; spring
Schedonnardus paniculatus (Nutt.) Trel.	Texas crab-grass, wire-grass	prairies; common; summer
Schizachyrium scoparium (Michx.) Nash	prairie beard-grass	roadsides
Setaria parviflora (Poir.) Kerguélen [=*Setaria geniculata* (Willd.) P. Beauv.]	knot-root bristle-grass	creeks, roadsides; spring
Setaria pumila (Poir.) Roem. & Schult. [=*Setaria lutescens* (Weigel) F.T. Hubbard]	yellow fox-tail	roadsides; common; late spring
Setaria viridis (L.) P. Beauv.	green foxtail-grass	fields; summer
Sorghastrum nutans (L.) Nash	Indian-grass	mountains; fall
Sorghum halepense (L.) Pers.	Johnson grass	roadside ditches; summer
Sphenopholis obtusata (Michx.) Scribn.	prairie wedge grass	streams
Sporobolus cryptandrus (Torr.) A. Gray	sand dropseed	rivers; summer, fall
Tridens flavus (L.) Hitchc. [=*Triodia flava* (L.) Smyth]	purpletop	mountains, ravines
Vulpia octoflora (Walter) Rydb. [=*Festuca octoflora*]	six-weeks fescue	fields, pastures; spring
Grossulariaceae [Saxifragaceae]		
Ribes aureum Pursh	Missouri or buffalo currant	hillsides, streams; spring
Hydrophyllaceae		
Phacelia hirsuta Nutt.	hairy phacelia	prairies; spirng
Phacelia sp. [=*Phacelia dubia* (L.) Trel., misapplied]	small-flowered phacelia	prairies; spring

Iridaceae		
Sisyrinchium angustifolium Mill. [incl. *Sisyrinchium gramineum* Curtis]	blue-eyed grass , stout blue-eyed grass	creeks, prairies; spring
Sisyrinchium langloisii Greene [=*Sisyrinchium varians* E.P. Bicknell]	variable blue-eyed grass	prairies; spring
Juglandaceae		
Carya illinoinensis (Wagenh.) K. Koch	pecan	streams; spring
Juglans microcarpa Berl. [=*Juglans rupestris* Engelm. ex Torr.]	little walnut	creeks; spring
Juglans nigra L.	black walnut	creeks; spring
Juncaceae		
Juncus biflorus Elliott [=*Juncus aristulatus* Michx.]	large grass-leaved rush	riversides
Juncus brachycarpus Engelm.	rush	roadside ditches; summer
Juncus interior Wiegand	Indian rush	roadside ditches; summer
Juncus marginatus Rostk.	awn-petaled rush	rivers; summer
Juncus torreyi Coville	Torrey's rush	rivers; summer
Krameriaceae [Leguminosae]		
Krameria lanceolata Torr. [=*Krameria secundiflora* DC., misapplied]	bank-bur	prairie roadsides; common; summer
Labiatae		
Hedeoma hispida Pursh	rough or little pennyroyal	plains; summer
Lamium amplexicaule L.	henbit, dead nettle	fields, roadsides; early spring
Monarda citriodora Cerv. ex Lag. [=*Monarda dispersa* Small]	purple lemon mint	praries; summer
Monarda fistulosa L.	horse mint, wild bergamot	ravines; early summer
Monarda punctata L.	horse mint	dry sandy soils; summer
Salvia azurea Michx. ex Lam. var. *grandiflora* Benth.	tall blue sage	plains; spring, summer
Salvia reflexa Hornem. [=*Salvia lancaefolia* Poir.]	lance-leaved sage	creeks; spring, summer
Scutellaria drummondii Benth.	Drummond's skullcap	roadside ditches; common; spring
Scutellaria wrightii A. Gray	Wright's skullcap	hillsides; spring
Teucrium canadense L.	germander, wood sage	ravines; summer

Leguminosae

Acacia angustissima (Mill.) Kuntze	acacia	sandy soils, near rivers; summer
Amopha canescens Pursh	lead-plant, devil's shoe-string	creeks; summer
Amorpha fruticosa L.	river-locust, false indigo	streams; summer
Astragalus canadensis L.	tall astragalus	creeks; summer
Astragalus crassicarpus Nutt. [=*Astragalus caryocarpus* Ker Gawl.]	ground plum	creeks, pastures; spring
Astragalus lotiflorus Hook.	low astragalus	prairies; spring
Astragalus nuttallianus DC.	Annual astragalus	prairies; spring
Baptisia australis (L.) R. Br.	blue false indigo	mountainsides; spring
Baptisia bracteata Muhl. ex Elliott	false indigo	mountainsides; spring
Cercis canadensis L.	redbud, Judas tree	creeks, mountain ravines; pre-vernal
Chamaecrista fasciculata (Michx.) Greene [=*Cassia chamaecrista* L.]	partridge pea	fields, pastures; summer
Dalea aurea Nutt. ex Pursh [=*Parosela aurea* (Nutt. ex Pursh) Britton]	golden parosela	hillsides; summer
Dalea candida Michx. ex Willd. [=*Petalostemon candidus* Michx.]	white prairie clover	near rivers, sandy soils; summer
Dalea enneandra Nutt. [=*Parosela enneandra* (Nutt.) Britton]	slender parosela	rivers; summer
Dalea multiflora (Nutt.) Shinners [=*Petalostemon multiflorus* Nutt.]	round-headed prairie clover	prairies; summer
Dalea purpurea Vent. [=*Petalostemon purpureus* (Vent.) Rydb.]	purple prairie-clover	prairies; summer
Dalea sp. [=*Petalostemon gracilis* Nutt., misapplied]	slender white prairie clover	prairies; summer
Desmanthus illinoensis (Michx.) MacMill. ex B.L. Rob. & Fernald	Illinois desmanthus	rivers; summer
Desmodium cuspidatum (Muhl. ex Willd.) DC. [=*Desmodium grandiflorum* DC.]	pointed-leaved tick trefoil, sticktight	prairies; summer
Desmodium sessilifolium (Torr.) Torr. & A. Gray	sessile-leaved tick-trefoil	mountains; summer
Glycyrrhiza lepidota Pursh	wild liquorice	dry sands, roadsides; summer
Gymnoclados dioicus (L.) K. Koch	Kentucky coffee-tree	ravines; spring
Hoffmannseggia glauca (Ortega) Eifert [=*Hoffmannseggia falcaria* Cav.]	blue-weed	prairies; spring
Indigofera miniata Ortega [=*Indigofera leptosepala* Nutt. ex Torr. & A. Gray]	western indigo plant	prairies; summer to fall
Lathyrus pusillus Elliott	low wild pea	rivers; spring
Lotus unifoliolatus (Hook.) Benth. [=*Hosackia americana* (Nutt.) Piper]	prairie bird's foot, trefoil	prairies; summer

Medicago sativa L.	alfalfa	escaped cultivation, fields, roadsides; spring, summer
Melilotus officinalis (L.) Lam.	yellow meliot, sweet clover	roadsides; abundant; summer
Mimosa microphylla Dryand. [=*Schrankia angustata* Torr. & A. Gray, *Schrankia uncinata* Willd.]	sensitive brier	roadside ditches; common; summer
Neptunia lutea (Leavenworth) Benth.	neptunia	mountain ravines; summer
Pediomelum cuspidatum (Pursh) Rydb. [=*Psoralea cuspidata* Pursh]	large-bracted psoralea	prairies; spring
Pomaria jamesii (Torr. & A. Gray) Walp. [=*Hoffmannseggia jamesii* Torr. & A. Gray]	James's hoffmannseggia	prairies; early summer
Prosopis glandulosa Torr. var. *glandulosa* [=*Prosopis juliflora* (Sw.) DC. var. *glandulosa* (Torr.) Cockerell]	prairie mesquite	prairies; common; late spring
Psoralidium tenuiflorum (Pursh) Rydb. [=*Psoralea tenuiflora* Pursh]	few-flowered psoralea	prairies; spring to fall
Robinia pseudoacacia L.	black or yellow locust	low waste places, cultivated; summer
Vicia caroliniana Walter	pale vetch	prairies; spring
Liliaceae [incl. Amaryllidaceae]		
Allium canadense L. var. *mobilense* (Regel) Ownbey [=*Allium mutabile* Michx.]	wild onion	damp soils, roadsides; spring
Allium drummondii Regel [=*Allium nuttallii* S. Watson]	Nuttall's wild onion	roadsides; spring
Allium textile A. Nelson & J.F. Macbr. [=*Allium reticulatum* G. Don]	wild onion	mountain ravines; late spring
Androstephium coeruleum (Scheele) Greene	androstephium	prairies, rare; early spring
Camassia scilloides (Raf.) Cory [=*Camassia esculenta* (Raf.) Cory]	hyacinth, eastern camas	mountain ravines
Cooperia drummondii Herb.	prairie lily	mountain ravines; spring
Nothoscordum bivalve (L.) Britton	yellow false garlic	pastures, fields; spring, fall
Polygonatum biflorum (Walter) Elliott	great Solomon's seal	damp shady places; summer
Linaceae		
Linum lewisii Pursh	Lewis's wild flax	roadsides; spring
Linum rigidum Pursh	large-flowered yellow flax	prairies; spring
Linum sulcatum Riddell		prairies; summer

Loasaceae		
Mentzelia decapetala (Pursh ex Sims) Urb. & Gilg ex Gilg	stick-leaf	sand, near rivers; summer
Mentzelia oligosperma Nutt. ex Sims	stick-leaf, few seeded mentzelia	rivers; summer
Lythraceae		
Ammannia coccinea Rottb.	long-leaved ammannia	mountain ravines; summer
Malvaceae		
Callirhoe involucrata (Torr. & A. Gray) A. Gray	purple poppy mallow	roadside ditches; common; spring
Callirhoe papaver (Cav.) A. Gray	larger purple poppy mallow	creeks; spring, summer
Sphaeralcea coccinea (Nutt.) Rydb. [=*Malvastrum coccineum* (Nutt.) A. Gray]	red false-mallow	roadsides; common; spring
Martyniaceae		
Proboscidea louisianica (Mill.) Thell. [=*Martynia louisiana* Mill.]	unicorn plant	cultivated soils; summer
Menispermaceae		
Cocculus carolinus (L.) DC.	Carolina moonseed	streams; summer
Moraceae [Urticaceae]		
Morus rubra L.	red mulberry; wild mulberry	creeks; spring
Nyctaginaceae		
Mirabilis albida (Walter) Heimerl [=*Oxybaphus albidus* (Walter) Sweet]	white oxybaphus	roadsides, dry sand; summer
Mirabilis hirsuta (Pursh) MacMill. [=*Oxybaphus hirsutus* (Pursh) Sweet]	hairy oxybaphus	dry soils, roadsides; summer
Mirabilis linearis (Pursh) Heimerl [=*Oxybaphus linearis* (Pursh) B.L. Rob.]	oxybaphus	prairies; summer
Mirabilis nyctaginea (Michx.) MacMill. [=*Oxybaphus nyctagineus* (Michx.) Sweet]	petioled wild four-o'clock	creeks; spring
Oleaceae		
Fraxinus americana L.	white ash	creeks; spring, summer
Fraxinus pennsylvanica Marshall	red ash	mountain ravines; spring
Onagraceae		
Ludwigia peploides (Kunth) P.H. Raven [=*Jussiaea repens* L.]	creeping primrose-willow	ponds; summer

Oenothera cinerea (Wooton & Standl.) W.L. Wagner & Hoch [=*Gaura villosa* Torr.]	wooly gaura	creeks; summer
Oenothera curtiflora W.L. Wagner & Hoch [=*Gaura parviflora* Douglas ex Lehm.]	gaura	dry sandy soils; summer
Oenothera glaucifolia W.L. Wagner & Hoch [=*Stenosiphon linifolius* (Nutt. ex E. James) Heynh.]	flax-leaved stenosiphon	sandy soils near rivers; summer
Oenothera grandis (Britton) Smyth [=*Oenothera laciniata* Hill var. *grandiflora* (S. Watson) B.L. Rob.]	evening-primrose	hillsides; spring
Oenothera hartwegii Benth.	evening-primrose	plains; summer
Oenothera laciniata Hill	evening-primrose	sand, near rivers; summer
Oenothera macrocarpa Nutt. [=*Oenothera missouriensis* Sims]	Missouri evening-primrose	hillsides; summer
Oenothera rhombipetala Nutt. ex Torr. & A. Gray	evening-primrose	near rivers; summer
Oenothera serrulata Nutt.	tooth-leaved primrose	pastures, roadsides; summer
Oenothera sinuosa W.L. Wagner & Hoch [=*Gaura sinuata* Nutt. ex Ser.]	wavy-leaved gaura	hillsides; summer
Oenothera speciosa Nutt.	showy evening-primrose	prairies; spring
Oenothera suffrutescens (Ser.) W.L. Wagner & Hoch [=*Gaura coccinea* Nutt. ex Pursh]	scarlet gaura	roadside ditches, mountainsides; spring
Oenothera triloba Nutt.	three-lobed evening-primrose	rivers; summer
Oenothera sp. [=*Gaura biennis* L., misapplied]	biennial gaura	rivers; summer
Oenothera sp. [=*Oenothera humifusa* Nutt., misapplied]	evening-primrose	near rivers; summer
Oenothera sp. [=*Oenothera oakesiana* (A. Gray) J.W. Robbins ex S. Watson & J.M. Coult., misapplied]	evening-primrose	sandy soils, near rivers; summer

Oxalidaceae

Oxalis corniculata L.	yellow or procumbent wood-sorrel	damp soils, mountainsides; spring
Oxalis stricta L.	upright yellow wood-sorrel	damp soils, mountainsides; spring
Oxalis violacea L.	violet wood-sorrel	damp soils, creeks, mountainsides; spring

Papaveraceae		
Argemone albiflora Hornem. [=*Argemone alba* Lestib. f.]	white prickly poppy	roadsides; spring, summer
Argemone polyanthemos (Fedde) G.B. Ownbey [=*Argemone intermedia* Sweet]	prickly poppy	roadsides; summer
Phrymaceae		
Phryma leptostachya L.	lop-seed	mountains; summer
Phytolaccaceae		
Phytolacca americana L.	pokeweed	creek banks; summer
Plantaginaceae		
Plantago aristata Michx.	ribwort	prairies; common; spring
Plantago patagonica Jacq. [=*Plantago purshii* Roem. & Schult.]	Pursh's plantain	pastures, roadsides; spring
Plantago rhodosperma Decne.	red-seeded plantain	rivers; early spring
Plantago virginica L.	dwarf plantain	creeks; spring
Polemoniaceae		
Ipomopsis rubra (L.) Wherry [=*Gilia rubra* (L.) A. Heller]	red gilia	mountainsides; summer
Phlox pilosa L.	phlox	prairie roadsides; spring, summer
Polygalaceae		
Polygala alba Nutt.	white milkwort	prairies; summer
Polygonaceae		
Eriogonum annuum Nutt.	annual gray-weed	prairies; summer
Eriogonum longifolium Nutt.	long-leaved gray-weed	rivers; summer, fall
Polygonum aviculare L.	joint-weed, pink-weed	near dwellings; summer
Polygonum hydropiper L.	common smart-weed	lakes; late summer
Polygonum lapathifolium L.	dock-leaved joint-weed	ravines; summer
Polygonum pensylvanicum L.	showy joint-weed	streams; summer
Polygonum punctatum Elliott [=*Polygonum acre* Kunth]	water smart-weed, dotted water pepper	mountain ravines; summer, fall
Polygonum ramosissimum Michx.	bushy joint-weed	rivers; summer
Polygonum tenue Michx.	slender joint-weed	mountains; summer
Rumex altissimus Alph. Wood	tall dock	roadsides; summer
Rumex crispus L. [incl. *Rumex elongatus* Guss.]	dock, curly dock	damp soils, mountains; spring, summer

Portulacaceae [incl. Caryophyllaceae, in part]		
Claytonia virginica L.	spring beauty	creeks, pastures; common; early spring
Primulaceae		
Androsace occidentalis Pursh	androsace	pastures, fields; early spring
Samolus valerandi L. [=*Samolus floribundus* Kunth]	water pimpernel, brookweed	streams; summer
Ranunculaceae		
Anemone berlandieri Pritz. [=*Anemone decapetala* Ard.]	ten-petaled anemone	pastures; spring
Anemone caroliniana Walter	Carolina anemone	pastures; common; March, April
Clematis pitcheri Torr. & A. Gray	virgin's bower, leather-flower	creeks, mountain ravines; spring
Delphinium carolinianum Walter ssp. *virescens* (Nutt.) R.E. Brooks [=*Delphinium penardii* Huth]	larkspur	mountains, roadsides; spring
Myosurus minimus L.	mouse tail	streams, fields; early spring
Rhamnaceae		
Ceanothus americanus L.	New Jersey tea	mountains, streams; spring
Rosaceae		
Crataegus crus-galli L.	cock-spur haw, red raw	rivers; spring
Crataegus viridis L.	southern thorn	streams; early spring
Geum canadense Jacq.	white avena	mountain ravines; summer
Prunus americana Marshall	wild yellow or red plum	rivers; spring
Prunus angustifolia Marshall	Chickasaw plum	roadside ditches, near rivers; spring
Rubus argutus Link	bramble	rivers; spring
Rubus sp. [=*Rubus baileyanus* Britton, misapplied]	Bailey's blackberry	mountainsides; spring
Rubiaceae		
Cephalanthus occidentalis L.	button-bush	streams, mountains; late spring
Diodia teres Walter	rough button-weed	rivers; summer
Galium aparine L.	cleavers	mountains, streams; spring

Galium pilosum Aiton	hairy bedstraw	mountains, streams; summer
Houstonia pusilla Schoepf [=*Houstonia minima* Beck]	bluets	creeks, pastures; early spring
Stenaria nigricans (Lam.) Terrell [=*Houstonia angustifolia* Michx.]	narrow-leaved houstonia	mountains; spring
Rutaceae		
Ptelea trifoliata L.	tree-leaved hop-tree	mountainsides; spring
Salicaceae		
Populus deltoides W. Bartram ex Marshall	cottonwood, necklace poplar	creeks; pre-vernal
Salix nigra Marshall	black willow	damp soils, streams; spring
Sapotaceae		
Sideroxylon lanuginosum Michx. [=*Bumelia lanuginosa* (Michx.) Pers.]	chittim-wood, wooly buckthorn	mountainsides; summer
Smilacaceae [Liliaceae]		
Smilax bona-nox L.	spiny-leaved greenbrier	creeks; spring
Smilax herbacea L.	carrion flower	mountain ravines; summer
Smilax rotundifolia L.	common greenbrier, horse-brier	creeks; spring
Santalaceae		
Comandra umbellata (L.) Nutt. ssp. *pallida* (A. DC.) Piehl [=*Comandra pallida* A. DC.]	bastard toad-flax	dry sandy soils, near rivers; spring
Sapindaceae		
Sapindus saponaria L. var *drummondii* (Hook. & Arn.) L.D. Benson [=*Sapindus drummondii* Hook. & Arn.]	wild China-tree, Drummond's soapberry	creeks; spring
Scrophulariaceae		
Castilleja purpurea (Nutt.) G. Don var. *lindheimeri* (A. Gray) Shinners [=*Castilleja lindheimeri* A. Gray]	Indian paint brush	mountains, pastures; spring
Castilleja sessiliflora Pursh	downy painted-cup	mountainsides; summer
Collinsia violacea Nutt.	violet or narrow-leaved collinsia	mountainsides; spring
Nuttallanthus canadensis (L.) D.A. Sutton [=*Linaria canadensis* (L.) Chaz.]	linaria	mountains; spring

Penstemon cobaea Nutt.	beard-tongue	prairies; late spring
Penstemon tubaeflorus Nutt.	funnel-shaped beard-tongue	creeks; summer
Penstemon sp. [=*Penstemon acuminatus* Douglas ex Lindl., misapplied]	sharp-leaved beard-tongue	hillsides; summer
Veronica agrestis L.	field speedwell	fields, pastures; spring
Veronica peregrina L.	neckweed purslane, l speedwell	creeks; early spring
Solanaceae		
Chamaesaracha sp. [=*Chamaesaracha sordida* (Dunal) A. Gray, misapplied]	hairy chamaesaracha	roadsides; summer
Datura stramonium L.	jimson weed	roadsides; summer
Physalis cinerascens (Dunal) Hitchc. [=*Physalis viscosa* L., misapplied]	ground-cherry	creeks; spring
Physalis longifolia Nutt.var. *longifolia*	smooth ground-cherry	creeks; spring
Physalis longifolia Nutt. var. *subglabrata* {Mack. & Bush) Cronq. [=*Physalis subglabrata* Mack. & Bush]	smooth ground-cherry	sandy soils, near rivers; summer
Physalis mollis Nutt.	velvety ground-cherry	roadsides; summer
Quincula lobata (Torr.) Raf. [=*Physalis lobata* Torr.]	purple-flowered ground-cherry	roadsides, prairies; spring, early summer
Solanum carolinense L.	horse nettle	prairies; common; spring, summer
Solanum elaeagnifolium Cav.	horse nettle	pastures, roadsides; common; spring, summer
Solanum rostratum Dunal	buffalo bur	abundant; summer, fall
Solanum sp. [=*Solanum nigrum* L., misapplied]	nightshade	dry sandy soils; summer
Tamaricaceae		
Tamarix sp. [=*Tamarix gallica* L., misapplied]	tamarish	damp sandy soils; summer
Typhaceae		
Typha latifolia L.	broad-leaved cat-tail	ponds; summer
Ulmaceae [Urticaceae]		
Celtis laevigata Willd.	southern hackberry	creeks; spring
Celtis occidentalis L.	rough-leaved hackberry	mountains, streams; early spring
Ulmus americana L.	white, American, or water elm	creeks; early spring

Ulmus rubra Muhl. [=*Ulmus fulva* Michx.]	slippery or red elm	mountain ravines; spring
Umbelliferae		
Chaerophyllum tatinturieri Hook.	Teinturier's chervil	roadsides; common; spring
Daucus pusillus Michx.	American carrot	fields, pastures; spring
Lomatium foeniculaceum (Nutt.) J.M. Coult. & Rose ssp. *daucifolium* (Torr. & A. Gray) W.L. Theobald [=*Lomatium daucifolium* (Torr. & A. Gray) J.M. Coult. & Rose]	carrot-leaved parsley	rivers; summer
Ptilimnium nuttallii (DC.) Britton	Nuttall's mock bishop-weed	low places near mountains; summer
Sanicula canadensis L.	short-styled snake-root	mountainsides; summer
Spermolepis echinata (Nutt. ex DC.) A. Heller	bristly-fruited spermolepis	mountainsides; spring
Spermolepis inermis (Nutt. ex DC.) Mathias & Constance [=*Spermolepis patens* (Nutt. ex DC.) B.L. Rob.]	spreading spermolepis	rivers; spring
Valerianaceae		
Valerianella radiata (L.) Dufr.	beaked corn salad	creeks; spring
Verbenaceae		
Glandularia bipinnatifida (Nutt.) Nutt. [=*Verbena bipinnatifida* Nutt.]	small-flowered verbena	creeks, pastures; early spring, summer
Glandularia canadensis (L.) Nutt. [=*Verbena canadensis* (L.) Britton]	large-flowered verbena	sandy soils, near rivers; spring
Glandularia pumila (Rydb.) Umber [=*Verbena pumila* Rydb.]	dwarf verbena	roadsides; summer
Phyla cuneifolia (Torr.) Greene [=*Lippia cuneifolia* (Torr.) Steud.]	wedge-leaved fog-fruit	hillsides; summer
Phyla lanceolata (Michx.) Greene [=*Lippia lanceolata* Michx.]	fog-fruit	creeks; summer
Phyla nodiflora (L.) Greene [=*Lippia nodiflora* (L.) Michx.]	spatulate-leaved fog-fruit	streams; summer
Verbena bracteata Cav. ex Lag. & Rodr. [=*Verbena bracteosa* Michx.]	large-bracted verbena	prairies; summer
Verbena stricta Vent.	hoary vervain	mountainsides; summer
Violaceae		
Viola bicolor Pursh [=*Viola rafinesquei* Greene]	pansy or heart's ease	streams, pastures; early spring

Viola sororia Willd. [=*Viola papilionacea* Pursh]	violet	damp sandy soils; early spring
Vitaceae		
Ampelopsis cordata Michx. [=*Cissus ampelopsis* Pers.]	simple-leaved cissus	rivers; spring
Cissus trifoliata (L.) L. [=*Cissus incisa* Des Moulins, misapplied]	rock-grape	mountains; summer
Parthenocissus quinquefolia (L.) Planch.	Virginia creeper, five-leaved ivy	creeks; summer
Vitis cinerea (Engelm.) Engelm. ex Millard	ashy or downy grape	streams; spring
Vitis vulpina L. [incl. *Vitis cordifolia* Michx.]	frost-grape, sweet scented grape	creeks, rivers; spring
Zygophyllaceae		
Kallstroemia parviflora J.B.S. Norton [=*Kallstroemia maxima* (L.) Hook. & Arn., misapplied]	greater caltrop	rivers; summer
Tribulus terrestris L.	caltrop	roadsides; common; summer

APPENDIX B

Tabular List of the Families, Kiowa County, OK

[This table includes taxa as they were in the original thesis.]

Divisions, Orders, Families, Etc.	Genera	Species	Varieties
PTERIDOPHYTA			
Filicales			
Polypodiaceae	4	5	
Marsileaceae	1	1	
SPERMATOPHYTA			
Gymnospermae			
Coniferales			
Pinaceae	1	1	
Angiospermae			
MONOCOTOLEDONEAE			
Pandales			
Typhaceae	1	1	
Graminales			
Gramineae	31	58	2
Cyperaceae	6	11	
Xyridales			
Commelinaceae	2	6	
Liliales			
Juncaceae	1	6	
Liliaceae	7	11	
Amaryllidaceae	1	1	
Iridaceae	1	3	
DICOTYLEDONEAE			
Salicales			
Salicaceae	2	2	
Juglandales			
Juglandaceae	2	3	
Fagales			
Fagaceae	1	6	
Urticales			
Urticaceae	4	5	1
Santalales			
Santalaceae	1	1	
Polygonales			
Polygonaceae	3	12	
Chenopodiales			

Chenopodiaceae	4	5	1
Amaranthaceae	3	5	
Phytolaccaceae	1	1	
Nyctaginaceae	1	4	
Illecebraceae	1	1	
Aizoaceae	1	1	
Caryophyllales			
Caryophyllaceae	3	4	
Portulacaceae	1	1	
Ranunculales			
Ranunculaceae	4	5	
Menispermaceae	1	1	
Papavervales			
Papaveraceae	1	2	
Fumariaceae	2	2	
Cruciferae	8	16	
Capparidaceae	2	2	
Rosales			
Crassulaceae	1	1	
Saxifragaceae	1	1	
Rosaceae	4	7	
Leguminosae	25	42	20
Geraniales			
Linaceae	1	3	
Oxalidaceae	1	3	
Geraniaceae	1	1	
Zygophyllaceae	1	2	
Rutaceae	1	1	
Polygalaceae	1	1	
Euphorbiaceae	5	16	1
Sapindales			
Anacardiaceae	2	4	
Sapindaceae	1	1	
Rhamnales			
Rhamnaceae	1	1	
Vitaceae	3	6	
Malvales			
Malvaceae	2	3	
Tamaricales			
Tamaricaceae	1	1	
Violales			
Violaceae	1	2	
Loasaceae	1	2	

Opuntiales			

Cactaceae	2	2	
Myrtales			
Lythraceae	1	1	
Onagraceae	4	17	1
Umbellales			
Umbelliferae	6	7	
Cornaceae	1	2	
Primulales			
Primulaceae	2	2	
Ebenales			
Sapotaceae	1	1	
Ebenaceae	1	1	
Gentianales			
Oleaceae	1	2	
Gentianaceae	2	3	
Apocynaceae	2	2	
Asclepiadaceae	4	11	
Polemoniales			
Convolvulaceae	3	6	
Polemoniaceae	2	2	
Hydrophyllaceae	1	2	
Boraginaceae	5	6	1
Verbenaceae	2	8	
Labiatae	6	11	1
Solanaceae	4	12	
Scrophulariaceae	5	9	
Martyniaceae	1	1	
Acanthaceae	1	2	
Phrymaceae	1	1	
Plantaginales			
Plantaginaceae	1	4	
Rubiales			
Rubiaceae	4	6	
Caprifoliaceae	4	2	
Valerianaceae	1	1	
Campanulales			
Curcurbitaceae	1	1	
Campanulaceae	1	2	
Lobeliaceae	1	2	
Compositae	42	86	2

ADDENDA

[Nomenclature has been updated according to the PLANTS database (http://plants.usda.gov/plants).]

The following plants were counted in the tabular list but are not given in the list of species:

Artemisia filifolia
Desmodium obtusum
Draba reptans [*Draba caroliniana*]
Eleocharis obtusa
Gaillarida suavis [*Gaillardia trinervata*]
Juncus tenuis
Physalis virginiana
Rudbeckia hirta
Scutellaria parvula
Symphyotrichum oblongifolium [*Aster oblongifollius*]
Vicia minutiflora [*Vicia micrantha*]
Xanthisma texanum

The following plants listed in the Stevens' collection were not found by the author:

Artemisia ludoviciana spp. *mexicana* [*Artemisia mexicana*]
Beta vulgaris
Bouteloua rigidiseta [*Bouteloua texana*]
Carex gravida
Distichlis spicata
Dyssodiopsis tagetoides [*Dyssodia tagetoides*]
Eleocharis rostellata
Muhlenbergia arenicola
Palafoxia sphacelata
Samolus ebracteatus

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GARDENS OF YESTERYEAR

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Keywords: cultivated, heritage, historic, Oklahoma

ABSTRACT

Begun as a response to a request to develop a historically accurate museum garden representing home gardens before and after Oklahoma's statehood in 1907, research reported in this article describes both native and non-native plants cultivated in gardens in Northeast Oklahoma, Southwest Missouri, Southeast Kansas, and Northwest Arkansas between 1841 and 1930. Much of the evidence of the diversity of plants grown in home gardens by Native Americans who were moved here and homesteaders who settled here is found in historic records that have only recently been digitized for global accessibility.

INTRODUCTION

The initial goal of this project was to investigate the history of home gardens in Northeastern Oklahoma during the time period of 1860-1930 so that a historically accurate museum garden could be developed. This historical investigation focused on identifying both native and non-native plants that were available for cultivation by homesteaders before and after Oklahoma statehood.

Many difficulties exist for those who are interested in researching garden history. This is especially true concerning early home gardens in Northeast Oklahoma. Therefore, the decision was made to enlarge the geographical area of study to include Southwest Missouri, Northwest Arkansas, and Southeast Kansas, since the growing conditions of these three regions are similar to Northeast Oklahoma. Furthermore, these three neighboring areas established statehood many years before Oklahoma, and it seemed likely that by researching all these areas, more historical evidence could be found that might be helpful in this project. Research yielded unexpected records of plants cultivated in Native American gardens as early as 1841, which has also been included here. Historical archives and agricultural bulletins from all of these areas were useful for the identification of native plants used by Native Americans before settlement and by homesteaders during that time period. Species nomenclature has been updated following the PLANTS Database compiled by the United States Department of Agriculture, Natural Resources Conservation Service (USDA, NRCS 2014).

NATIVE AMERICAN GARDENS

Ethan Allen Hitchcock, an army officer, had been sent by the United States Government to investigate conditions among Native American tribes and nations from November 1841 through March 1842 in a region that included the Grand Saline River near what is now Salina, Oklahoma (Foreman 1996). He had described the Cherokees of this area as having well cultivated fields, gardens, and orchards. In 1873, a review was made of agricultural conditions among 24 Native American tribes who were living in Indian Territory and was presented to the General Council

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of the Indian Territory meeting at Okmulgee. The report described the gardens as being well cultivated. The plants were not identified as to whether they were native; however, the information provides documentation about the home gardens at that time. The Cherokees were growing corn, wheat, and tobacco for home use. The Muskogee Nation reported growing fruit. In Tahlequah, there was an establishment called the Cherokee Nursery where a large number of fruit trees could be purchased. The Cherokee delegation also reported that honeysuckle was growing near windows of their homes (Wright 1956).

Norman Graebner described similar agricultural conditions in his article, "Provincial Indian Society in Eastern Oklahoma". He observed vegetables such as beans, potatoes, squash, turnips, and pumpkins, as well as new varieties from other states, growing in gardens. He went on to explain that there was a great variety of fruit trees. In the spring and summer, food such as edible wild vegetables and fruit supplemented garden foods (Graebner 1906).

M. A. Carleton, a botanist from the Kansas Agricultural Experimental Studies, visited Eastern Oklahoma in the summer of 1891. He described the eastern part of the Territory as having soil of a clayey consistency that was desirable for growing fruits such as plums. He observed native fruits in both the Cherokee and Creek Nations areas. They included *Prunus angustifolia* Marsh. (Chickasaw plum), *Prunus americana* Marsh. (ordinary wild plum), and *Prunus serotina* Ehrh. var. *serotina* (wild cherry). He also reported that he saw many *Rubus flagellaris* Willd. (common blackberry) and *Rubus occidentalis* L. (raspberry) growing in the town of Vinita. He identified another species of blackberry, *Rubus trivialis* Michx. (southern blackberry), as well (Carleton 1892).

GARDENS OF EARLY SETTLERS

Very few historic landscape plans are available for documenting home gardens in the United States (Griffith 2008). The first home gardens in the four state region were devoted to growing food for survival and were planted nearby. It is likely that early settlers depended on both native and non-native plants. The development of the railroad system, as well as the nearby Fort Smith, Arkansas port, offered the home gardener many possibilities to purchase plants if income was sufficient (Slossen 1951). Later, as small crops of corn, wheat, and barley were successful and the railroad was expanded, communities developed so that foods could be purchased or bartered. In later years, the gardens were enlarged to include flowers and ornamental shrubs as well as fruits such as raspberries and strawberries.

An issue important to the establishment of early gardens was weeds. Oklahoma Agricultural Station Bulletin No. 41 from May 1899 by E. E. Bogue, a botanist and entomologist, explored the topic of "Weeds of Oklahoma". He asserted that one of his objectives was to call attention to weeds that interfere with agriculture. He identified *Solanum carolinense* L. var. *carolinense* (horse nettle), *Acacia angustissima* (Mill.) Kuntze (prairie acacia), *Amaranthus cruentus* L. (red amaranthus), *Convolvulus arvensis* L. (field binderweed), *Erigeron annuus* (L.) Pers. (eastern daisy fleabane), and *Passiflora incarnata* L. (passion vine). He also identified 10 native sunflowers and compared the differences between them and the ones he saw in Kansas in 1898. The most common one in Oklahoma was *Helianthus annuus* L. (common sunflower). He stated that in favorable conditions they grow to be 12–14 feet (4 m) tall (Bogue 1899). It is highly likely that these weeds were transplanted to the home garden for their ornamental flowers.

The following year, Bogue authored another bulletin, "Annotated Catalog of Ferns and Flowering Plants of Oklahoma", which provides identification of native plants growing without cultivation in the territory. The author asserted that the results recorded in the bulletin were "those obtained by four years of more or less constant study and observation on the flora of the territory". He went on to affirm that this is the first attempt made to permanently record the plants of Oklahoma (Bogue 1900a).

Bogue admitted that he did not travel to every part of the territory, but he claimed that he made visits to the southern and eastern section as well as Payne County. Among his findings he observed that:

> …in the eastern part, the climate is more moist and surface of the country is more broken than in other parts of the territory. In the western part are extensive level plains of more or less sandy soil which do not support a great variety of plants… In the eastern part of the territory, limestone crops out more or less, and here plants differ a little from those found in other parts of the territory. Sandstone frequently crops out or comes very near the surface. In such places are plants which occur nowhere else. In some places sandstone exposes walls more or less extensive, even to the height of twenty feet or more. In the crevices of these rocks some ferns of small growth can be found. (Bogue 1900b)

He identified 750 plants growing throughout the territory, including two ferns growing in Pawhuska: *Asplenium trichomanes* L. ssp. *trichomanes* (maidenhair spleenwort) and *Polystichum acrostichoides* (Michx.) Schott var. *acrostichoides* (Christmas fern). Plants he identified that were suitable for cultivation include *Clitoria mariana* L. (butterfly pea [Atlantic pigeon wings]), *Oxalis violacea* L. (violet wood sorrel), *Callirhoe involucrata* (Torr. & A. Gray.) A. Gray (purple poppy mallow), *Oenothera speciosa* Torr. (showy primrose), *Conoclinium coelestinum* (L.) DC. (blue mistflower), and *Solidago speciosa* Nutt. (showy golden rod) (Bogue 1900a).

Use of native plants and trees in early home gardens occurred more frequently in the Central and Great Plains regions than other parts of the United States. Extreme weather changes, wind, soil conditions, and pests were some of the challenges of gardening in this region. Inability to secure commercially cultivated plants could also have contributed to the transplantation of native plants into the home gardens of Northeast Oklahoma (Adams 2004).

It is obvious that those who dared to travel far away from their birthplaces during 1860–1930 to settle in Oklahoma experienced many physical hardships. They depended on native plants and trees for survival. The first plants grown were those that could provide food, while herbs were grown for medicinal use rather than ornamentation. Brides were often given seeds and plants as their dowries. These gifts included native plants as well as cultivated ones (Ise 1996). Many garden historians also believe that the early gardens served as powerful sources of identity or a link to their pasts which helped them cope with the psychological hardships (Haavisto and O'Sullivan 1995).

Like early American colonists, the first gardens developed in this four-state region were planted very close to the residence of the settler, using landscape plans that offered security. Likewise, many of the homesteaders who settled in Oregon used this same plan which is commonly referred to as a "dooryard garden" (Calkins 1996). Furthermore, water often had to be transported from a distance; therefore, any

used household water could be reused. Often the water was tossed from a bucket into the garden. The term "dooryard garden" describes this landscaping arrangement. Fencing was a priority due to the potential damage that might occur from wildlife and livestock. Theft of food from the garden was also a concern. Thus, a garden placed in close proximity to the home was a way of enforcing security (Calkins 1996; Haavisto and O'Sullivan 1995).

By 1886, University of Arkansas was offering classes on the subject of home gardens (Reynolds and Thomas 1910). As early as 1886 there is evidence that dooryard gardens were indeed important in the region. In an article authored by Lou Pancost of Iola, Kansas in the Kansas Horticultural Report Meeting for the year 1886 entitled "The Home Garden", emphasis is made that a home garden should be located near the house and be surrounded by a fence (Pancost 1887). Another article reported to this same group is "Flowering Plants and Shrubs: Their Management in Dooryard Gardens" (Milliken 1887).

During this same time, cultivated apple trees from Northwest Arkansas were being sold commercially (Fruit-full Arkansas 2013). Likewise, cultivated fruit trees could be obtained from Stark Brothers Nursery in Louisiana, Missouri (Booth and Mooring 1911). An assortment of garden plants such as peonies, daylilies, and iris could be purchased from Gilbert Wild Nursery in Sarcoxie, Missouri (Slosson 1951).

Examination of notes from the Missouri Horticultural Society Meetings during 1893 confirms that native plants were recommended for use in the home gardens. C. W. Elliot (1894), in "Some Desirable Native Perennials", points out that many plants advertised for sale at that time are native to Missouri. Perennials that he identifies for their beauty in the garden include *Asclepias incarnata* L. ssp. *incarnata* (flesh colored asclepias or swamp milkweed), *Baptisia australis* (L.) R. Br. (deep blue baptisia or blue wild indigo), *Aruncus dioicus* (Walter) Fernald var. *vulgaris* (Maxim.) H. Hara (goat's beard [bride's feathers]), and *Coreopsis lanceolata* L. (coreopsis or lanceleaf tickseed).

The goal of this article is to provide information about native plants in historical gardens and to spark interest in native plant advocacy. It is hoped that bringing this historic data to the attention of professional botanists, amateur gardeners, and those who love nature will promote and insure the preservation and propagation of native plants.

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OKLAHOMA DECIDUOUS TREES DIFFER IN CHILLING ENHANCEMENT OF BUDBURST

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ABSTRACT

In many tree species, winter chilling accelerates budburst in response to spring warmth. Global climate change has already accelerated budburst in deciduous tree species around the world. But as global climate change leads to milder winters, trees species also experience less chilling, which may actually delay spring budburst in some species. We hypothesized that reduced duration of winter chilling would delay spring budburst in sycamore (*Platanus occidentalis*) and pecan (*Carya illinoinensis*), but would not delay it in sweetgum (*Liquidambar styraciflua*). We tested this hypothesis experimentally by manipulating the number of weeks of chilling from 0 to 6 weeks. Lack of winter chilling did not delay budburst in sweetgum but did delay it in sycamore and pecan, in agreement with the hypothesis. Mild winters in Oklahoma may eventually favor the growth of sweetgums at the expense of sycamores and pecans.

INTRODUCTION

Earlier spring budburst in deciduous trees is widely recognized as one of the consequences of global climate change. It has been occurring for the last century and a half and has continued in recent decades (Schwartz et al. 2006; Ibañez et al. 2010; Polgar and Primack 2011). This conclusion is based upon several sources of information: comparison of recent with historical budburst dates, including the records of Henry David Thoreau at Walden Pond, and comparisons of recent with historical herbarium specimens and photographs (Primack et al. 2004; Miller-Rushing et al. 2006; Primack 2014); satellite imagery during recent decades (Liang et al. 2011); yearly records of individual woody plants during recent decades (Schwartz 1994; Rice and Schwartz, in prep.); and functional models (e.g. Morin et al. 2009).

The first author of this paper has maintained an ongoing record of budburst times for about 400 individuals of 22 deciduous tree species in Durant, Oklahoma, starting in 2006. By observing each tree at least weekly, and usually more often, the first author determined budburst date for each individual using a protocol similar to that of the Globe program (Globe.gov 2014). The data clearly indicate earlier budburst during the nine-year period, particularly from 2008-2012, during which time several tree species advanced their budburst time about two days per year. This did not occur in all species, however. In particular, budburst did not change in American elm *(Ulmus americana* L.*)* and became later each year in silver maple *(Acer saccharinum* L.*),* probably in association with summer drought and heat damage that either directly, or indirectly through pathogens, killed many of these trees (Rice and Schwartz, in prep).

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It is, however, invalid to extrapolate the trend toward earlier budburst for most tree species, because many woody species benefit from chilling for timely budburst (Schwartz and Hanes 2010). Chilling induces the development of structures within buds and/or alters the concentration of plant growth substances such as cytokinins (Hewett and Wareing 1973), a process sometimes called vernalization. If winters in some areas (such as southern Oklahoma) become brief and warm, the buds of some species may experience insufficient chilling and therefore reduced fitness (Luedeling et al. 2011). Some tree species also require a minimum daylength for budburst (e.g., Heide 1993a).

In general, we would expect tree species that open their buds early in the spring to have floral and vegetative structures already well-formed within the buds prior to winter, while these structures may have to develop during the winter in tree species that open their buds later in the spring. The tree species in the latter group may require chilling to initiate and complete the process of bud development. We therefore hypothesized that tree species that open their buds early in the spring do not have as much chilling enhancement of budburst as tree species that open their buds later in the spring. Specifically, we expected a negative association between time of budburst and chilling enhancement. We used three species to test this hypothesis in Oklahoma: sweetgum (*Liquidambar styraciflua* L., Altiginaceae), which opens its buds earliest of these three species, often in February; sycamore (*Platanus occidentalis* L., Platanaceae), which opens its buds later, often in March; and pecan (*Carya illinoinensis* (Wangenh.) K. Koch, Juglandaceae), which opens its buds last of these three species, often in April.

Numerous studies have examined the effect of chilling on budburst, but most of these studies have been conducted at higher latitudes (e.g., Hunter and Lechowicz 1992; Heide 1993b; Chuine 2000). We wanted to test the hypothesis using Oklahoma trees, which may differ genetically from trees of the same species that live in other locations. For example, research in other parts of the world show that trees such as pecans (Kuden et al. 2013) have a chilling enhancement of budburst, but we cannot conclude from this that Oklahoma trees of these species have a similar chilling enhancement.

METHODS

We selected five individual trees at least 10 meters in height that are in the long-term data set from each of the three species. All were in parks or along streets in Durant, Oklahoma (Fig. 1). We originally also included post oak (*Quercus stellata* Wangenh.), but mortality of twigs during the experiment reduced the sample size to only one twig in two of the treatments.

From each tree, we obtained six twigs with intact terminal and axillary buds, two for each of the three chilling treatments described below, resulting in 30 twigs for each species (total of 90 twigs). We gathered twigs on 18 November 2013, after leaf senescence was well advanced but before the first frost. We labeled all twigs with masking tape. For each tree, we placed two twigs in a plastic food storage container with wet paper towels and stored them in a refrigerator at about 10º C for three weeks, and we stored two other twigs for six weeks. Six weeks is considerably less than the average of approximately 18 weeks between first (about November 9) and last (about March 28) frost during the previous four decades in Durant, Oklahoma (Fig. 2). At the end of chilling, we removed the twigs and placed them in warm conditions to allow budburst to begin. We also placed two twigs from each tree immediately into warm conditions (0 weeks). These unchilled twigs were the control. The warm conditions were in a temperature-controlled laboratory

(about 25º C) under continuous fluorescent illumination.

Once we exposed the buds to warm conditions, we kept the cut ends of the twigs continuously submerged in water. We checked each twig at least twice a week for signs of budburst, defined as green tissue showing through separated bud scales (Fig. 3). We also changed the water and cleansed the cut ends of the twigs with a brush to prevent decomposers, living off of sap, from blocking the xylem. Eighteen of the original 90 twigs failed to burst their buds during this experiment and were presumed dead.

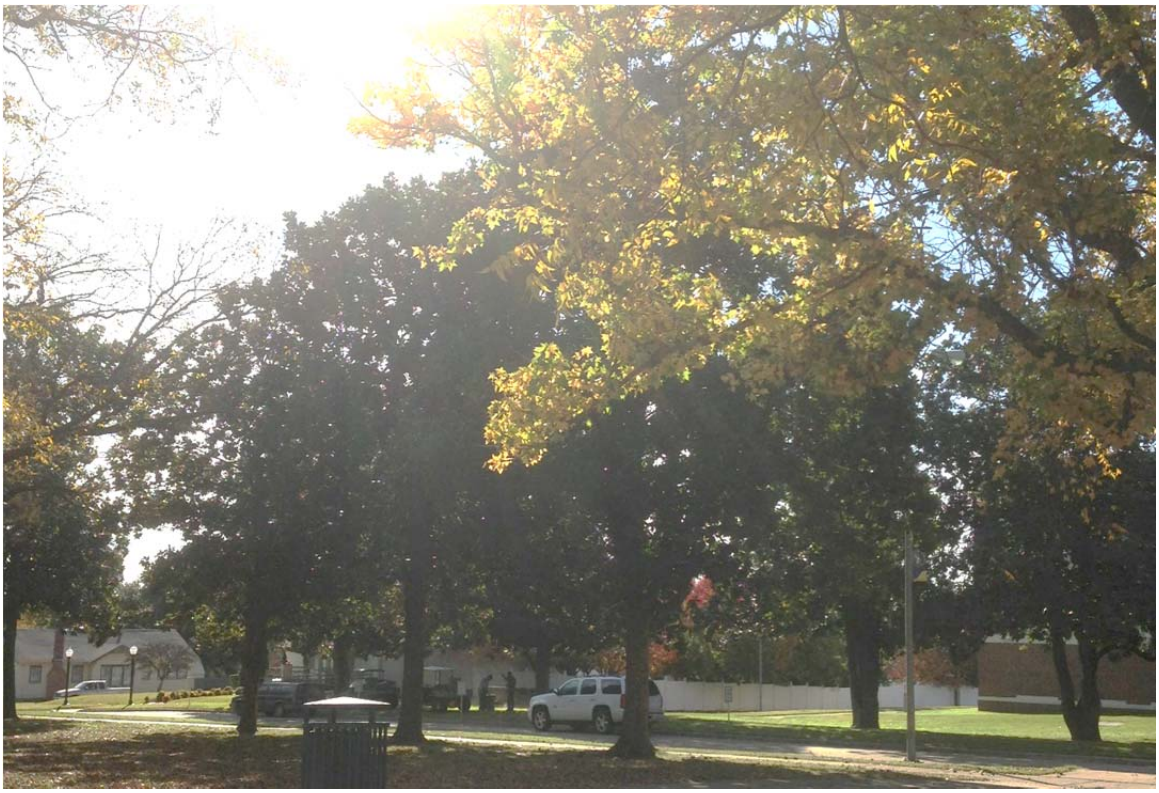

Figure 1 The general habitat of the trees used in this study in November 2013

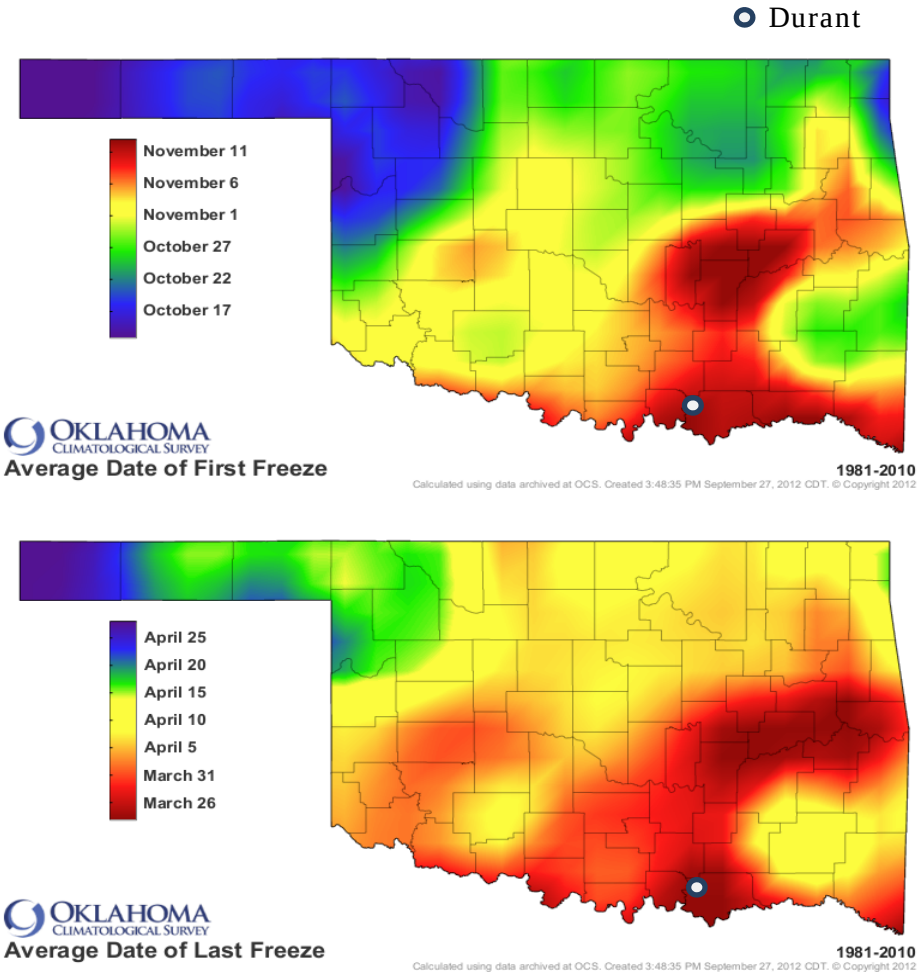

Figure 2 Average first and last freeze dates in Oklahoma, 1961-2010 average. Maps modified and used with permission from Oklahoma Climatological Survey (http://climate.ok.gov/index.php/climate).

Figure 3 Buds of sweetgum (*Liquidambar styraciflua*) at various stages of budburst. The top bud has not yet opened, and the bud at the lower right is just beginning to open.

RESULTS AND DISCUSSION

Results shown in the following table indicate that chilling greatly reduced the budburst time in sycamore ($p < 0.001$) and pecan ($p = 0.012$) but not in sweetgum ($p = 0.089$). Because the data distribution was skewed toward early budburst dates, we used separate Kruskal-Wallis analyses for each species to obtain these values (IBM SPSS 2011). All three species burst their buds quickly following six weeks of chilling. Budburst of unchilled sycamore and pecan buds were significantly delayed while unchilled sweetgum buds burst quickly after exposure to warm temperatures.

Table Mean number of days of exposure to warmth that induced budburst in three species of trees in southeast Oklahoma. Values in parentheses indicate the number of twigs that were exposed to different levels of the treatment (= chilling). Asterisk (*) indicates significant difference using Kruskal-Wallis test at $p < 0.05$.

Weeks of chilling				
Species	Zero	Three	Six	*p*-value
Liquidambar styraciflua	26.3 (7)	29.8 (9)	24.7 (6)	0.089
Platanus occidentalis	63.0 (6)	38.0 (10)	21.3 (9)	0.001*
Carya illinoinensis	53.3 (6)	32.6 (10)	23.4 (9)	0.012*

DISCUSSION

The data confirmed the association between time of budburst and chilling enhancement, based on Oklahoma specimens of three tree species. We would expect sweetgum to respond the most to warmer winters. Gunderson et al. (2012) reported that experimentally-imposed warmer temperatures caused earlier budburst in sweetgum than in three other tree species, consistent with our results.

Global climate change has been associated not only with earlier spring budburst in deciduous trees but also earlier flowering in spring wildflowers and earlier spring activity in many kinds of animals (Miller-Rushing et al. 2008; Willis et al. 2008; Primack 2014). The extent to which different species respond to global climate change may alter the species makeup of an ecological community (Miller-Rushing and Primack 2008). If future global climate change should cause forests in the southern United States, such as those in southern Oklahoma, to have very mild winters, not all deciduous tree species will continue their trend toward earlier budburst. Instead, some tree species—such as the sycamores and pecans in this study—may reverse their trend toward earlier budburst and instead have later budburst. Flexibility of phenological response appears to be an important contributor to survival in a world of global climate change. The eventual loss of chilling temperatures may alter the relative growth patterns of deciduous tree species in Oklahoma.

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MAPPING DISTRIBUTION IN OKLAHOMA AND RAISING AWARENESS: PURPLE LOOSESTRIFE (*LYTHRUM SALICARIA),* MULTIFLORA ROSE (*ROSA MULTIFLORA),* AND JAPANESE HONEYSUCKLE (*LONICERA JAPONICA)*

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ABSTRACT

This paper includes updated Oklahoma distribution maps and informational fact sheets for purple loosestrife, multiflora rose, and Japanese honeysuckle to promote awareness of invasive plant issues. The current information on the Internet contains discrepancies concerning the county-level distribution data of these three invasive plants in Oklahoma. To gain a more accurate dataset, the authors created a survey and sent it to Oklahoma State University Extension Educators, Master Gardeners, Oklahoma Association of Conservation Districts, and other knowledgeable, credible parties across Oklahoma. Once survey data were compiled, 3 distribution maps were created and 6 unique fact sheets were produced with the updated information. From the 22 survey responses, 7 new county records were documented and mapped. Two new sightings were documented for purple loosestrife in Canadian County and Rogers County; 4 new sightings were documented for multiflora rose in the counties of Atoka, Johnston, Payne, and Pushmataha; and 1 new sighting was documented for Japanese honeysuckle in Garfield County. The findings in this research detail the need for updated distribution maps and increased education to prevent the spread of problem species and provide the public with methods of eradication.

INTRODUCTION

According to the United States National Arboretum, an invasive plant is a species that "has the ability to thrive and spread aggressively outside its natural range" (The United States National Arboretum 2008). These invasive plants have a competitive edge on their native counterparts because the insects, diseases, and animals that naturally keep their numbers in check do not typically exist in the new environment. This situation is known as an "enemy release", which allows the populations of an invasive species to increase to high levels, suppressing growth of native vegetation and altering their composition and structure (Keane and Crawley 2002). Invasive plant species adversely affect the habitats they invade economically, environmentally, and/or ecologically by disrupting natural ecosystem processes (The United States National Arboretum 2008).

Purple loosestrife (*Lythrum salicaria*), multiflora rose (*Rosa multiflora*), and Japanese honeysuckle (*Lonicera japonica*) are 3 problematic invasive species in Oklahoma. They were chosen for this study because each represents a difference in abundance and growth form. According to the Oklahoma Vascular Plants Database (OVPD), purple loosestrife is the least abundant of the three and is known to occur in only 4 Oklahoma counties.

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Japanese honeysuckle, however, has spread extensively across Oklahoma and is listed in 45 counties. Finally, multiflora rose is documented in 39 counties (Oklahoma Vascular Plants Database 2014). The three plants also differ in growth form: purple loosestrife is an herb, multiflora rose is a shrub, and Japanese honeysuckle is a vine. Our objective was to accumulate information about invasive species that demonstrate the wide variation in abundance, growth form, and distribution of invasive plant species in Oklahoma.

Figure 1 Purple loosestrife flower. Courtesy of Samuel Roberts Noble Foundation, Ardmore, Oklahoma.

Purple loosestrife is an erect, perennial, wetland herb that is popular among gardeners because of its magenta-colored spikes of flowers (Fig. 1) that bloom from June to September. Purple loosestrife was brought to America from Europe for ornamental and medicinal purposes in the 19th century but was also unintentionally imported in ship ballast water (Bravo 2009a). In addition to anthropogenic vectors, the high reproductive ability of purple loosestrife has contributed to its success as an invasive species in the United States. A single flowering individual can produce approximately 2.5 million seeds a year. These seeds are dispersed by animals, humans, and other vectors that carry the propagules significant distances. For example, waterfowl can carry the seeds along waterways, or seeds can attach to boat bottoms and be transported downstream. Purple loosestrife also spreads asexually by stem and root fragments that resprout when they settle in a new location (New Hampshire Department of Environmental Services 2010). Purple loosestrife has spread extensively throughout the United States and is now documented in every contiguous state, excluding Florida (Blossey 2002).

As the Pennsylvania Department of Conservation and Natural Resources states, the rapid growth rate and resulting dense stands of purple loosestrife allow it to out-compete native vegetation, some of which may be rare or endangered species (e.g., federally endangered orchids). This causes significant ecological harm by reducing the biodiversity of an area and creating monocultures. These dense stands of purple loosestrife can reduce the native species' habitats and available food sources. Purple loosestrife can also inhibit stream flow, changing the hydrology of wetlands (Pennsylvania Department of Conservation and Natural Resources, n.d.).

Economic impacts of purple loosestrife include reduced land values for properties infested by the plant and impediment of boating and other recreational activities. In addition, purple loosestrife invades irrigation systems and adversely impacts agricultural productivity (Washington State Department of Ecology, n.d.).

However, because it is valued as a garden plant, purple loosestrife typically stirs little concern. For example, this project unveiled that purple loosestrife has been planted in demonstration and teaching gardens in Oklahoma, whose purpose is to educate the public about plants that grow well in the area (Penn State Extension 2014). Promoting invasive species growth in gardens is potentially harmful because these plants can become garden escapees, alter valuable ecosystem functions, and threaten local vegetation (The United States National Arboretum 2008).

Figure 2 Multiflora rose flower. Courtesy of Samuel Roberts Noble Foundation, Ardmore, Oklahoma.

Multiflora rose is a multi-stemmed, sprawling shrub that can grow more than 4.5 m tall with long, arching stems that produce recurved thorns. In June and July, multiflora rose begins to bloom, displaying large clusters of fragrant white flowers (Fig. 2) (The University of Maine 2001). Multiflora rose was first introduced to the United States from Japan in 1866 as a rootstock for ornamental roses and was distributed approximately 70 years later by the U. S. Soil Conservation Service to control soil erosion. Since then, it has been intentionally spread to serve as wildlife habitat improvement, fences for livestock, vehicle crash barriers along roadways, and protection from the glare of oncoming vehicle headlights (Swearingen et al. 2010).

Even without human aid, multiflora rose is prolific and can successfully spread by its own means. Each adult plant can produce approximately 1 million seeds annually that are distributed by birds and other wildlife that eat the fruits, known as hips. Multiflora rose can also spread asexually. As stems grow taller they begin to arch, and when they come into contact with the ground they form roots (Forest Invasive Plants Resource Center 2005).

Although it is a practical shrub, multiflora rose remains highly invasive and its spread should be avoided if possible. It grows aggressively, creating dense, impenetrable thickets. These blankets of multiflora rose suppress native vegetation and lead to a loss in biological diversity by prohibiting nest construction by birds, altering habitat structure, and inhibiting forest tree regeneration (The University of Maine 2001).

Figure 3 Japanese honeysuckle flower. Courtesy of Samuel Roberts Noble Foundation, Ardmore, Oklahoma.

Japanese honeysuckle is a woody vine with fragrant white flowers that yellow with age. The flowers consist of 5 fused petals, occur in pairs on axillary peduncles (Fig. 3), and bloom from April to July. In autumn, mature Japanese honeysuckle plants bear small black fruits containing two to three seeds each (Forest Invasive Plants Resource Center 2005).

Japanese honeysuckle was introduced to the US from Asia in the 1800s and first became naturalized in the northeast. Since its arrival, it has been intentionally spread throughout the country because it is valued as a fragrant ornamental. Japanese honeysuckle has also been anthropogenically distributed to offset erosion and serve as wildlife forage and cover (Schierenbeck 2004). Wildlife is of further assistance to distribution by consuming Japanese honeysuckle fruits and dispersing seeds long distances (Forest Invasive Plants Resource Center 2005).

Similar to the aforementioned plants, Japanese honeysuckle is a successful invader

without external assistance. Japanese honeysuckle's lack of natural competitors, ability to grow rapidly, adaptability to varying habitats, and prolonged growth period allow it to spread successfully. It also has vegetative runners that root when they make contact with the soil (Forest Invasive Plants Resource Center 2005).

Japanese honeysuckle impacts both individual plants and plant communities. Due to its climbing nature, Japanese honeysuckle winds around the stems and trunks of native woody plants, restricting the water flow to the plant and ultimately killing them. Japanese honeysuckle also affects the herbaceous and understory plant communities by forming a dense blanket of growth that blocks sunlight and suppresses native plants growth, altering forest structure (Bravo 2009b).

Distribution information for purple loosestrife, multiflora rose, and Japanese honeysuckle was compiled from three sources: The Oklahoma Vascular Plants Database (OVPD), The Oklahoma Invasive Plant Council (OkIPC), and The United States Department of Agriculture PLANTS Database (USDA). The OVPD is an online data source consisting of label data from specimens stored in Oklahoma herbaria. These data are queryable and are used to produce county-level distribution maps for Oklahoma plants. Since an accessioned voucher is necessary for inclusion in their database (Oklahoma Vascular Plants Database 2014), the OVPD does not accept any public observation data in the form of online submissions, photos, or other reports. The USDA PLANTS Database is a clearinghouse derived from scientific literature, herbarium specimen, and confirmed observations. The public is able to contribute by providing verifiable plant distribution information including locality, date collected, collector's name, and at least one form of documentation of the invasive plant (USDA, NRCS 2014). The OkIPC compiles data from the OVPD and observations provided by the Oklahoma Biological Survey to generate their county distribution maps. OkIPC records of invasive plants are not of exact physical locations but consist of occurrences within Oklahoma counties. Their ultimate goal is "facilitating education and management for protection of our economic and natural resources" (Oklahoma Invasive Plant Council 2014).

The county distribution maps for each plant species, however, differ between organizations, revealing discrepancies among the data sources. These differences can create confusion for Oklahomans concerned about the spread of invasive plants throughout the state. As a contribution to remedying this discrepancy, this study's objective is to update distribution data for purple loosestrife, multiflora rose, and Japanese honeysuckle and promote awareness of invasive plant impacts in 6 new fact sheets.

METHODS

We created a survey in order to more accurately reflect the distribution and density of purple loosestrife, multiflora rose, and Japanese honeysuckle in the 77 counties of Oklahoma. The survey included 11 questions about the presence, specific location, and density of these three species and was distributed to Oklahoma State University Extension Educators, Master Gardeners, Oklahoma Association of Conservation Districts, and other experienced parties across Oklahoma. Those who received the survey were encouraged to forward it to their colleagues and include it in LISTSERVs, so we estimate 250-350 surveys were distributed in total. Survey responses were recorded in an Excel® workbookfor summary and analysis. Although data were collected on the density of specific invasive plant occurrences, the resources to accurately map abundance were lacking, and thus any further conclusions on

abundance in Oklahoma counties are excluded from this report.

These new distribution data were then compared with data from OVPD, OkIPC, and USDA. Three new maps were created to integrate the survey data with the pre-existing data to enhance the accuracy of distribution maps for purple loosestrife, multiflora rose, and Japanese honeysuckle.

These maps were used in the production of two different formats of new fact sheets for each species of invasive plant. The first fact sheet follows the Oklahoma State University Extension Services format and provides a general description of the species' characteristics and life histories, invasive traits and impacts, and recommended management options (Appendix A). The second fact sheet is unique, specific to Oklahoma, and formatted to the style of an old western wanted poster. The authors designed this second fact sheet in a reader-friendly manner to attract attention and be memorable. This fact sheet includes a description of the plant and its habitat, its "crime", "hometown", classification in Oklahoma, and the number of counties in which it is found (Appendix B).

RESULTS AND DISCUSSION

The results of the data collection were limited to the 22 responses the survey respondents provided, and thus some location data on the invasive plants are less detailed than desired. A comparison of the pre-existing data from the OVPD, OkIPC, and USDA to survey data illuminates several discrepancies. Comparisons among these data sources and analysis of newly acquired data are discussed for each plant below.

Purple Loosestrife

Of the 22 surveys returned, three respondents provided data for purple loosestrife, noting that it exists in Canadian, Cleveland, and Rogers counties. In Canadian County, purple loosestrife was sighted in the city of Edmond on Morgan Road, 0.25 miles north of Edmond Road. In Cleveland County, purple loosestrife was located in a demonstration and teaching garden in the Cleveland County Fairgrounds. In Rogers County, purple loosestrife was sighted around the edges of a homeowner's pond on the western border of the county.

The distribution maps of purple loosestrife (Fig. 4) include the OVPD occurrences in four counties and the OkIPC in 3 counties. The USDA Plants Database shows purple loosestrife as occurring in Oklahoma, but does not provide county level occurrence data. This project's data resulted in a six county distribution map with new occurrence records for Rogers and Canadian counties.

Multiflora rose

A total of 8 surveys were returned for multiflora rose, noting invasive occurrences in Atoka, Bryan, Choctaw, Comanche, Johnston, McCurtain, Oklahoma, Okmulgee, Osage, Payne, Pittsburg, and Pushmataha counties. A single respondent provided the county sightings in Atoka, Bryan, Choctaw, McCurtain, Pittsburg, and Pushmataha, describing all 6 counties as having scattered occurrences. In Comanche County, multiflora rose was sighted in the Wichita Mountains Wildlife Refuge, with the occurrence being approximately 53 m^2 in size. In Johnston County, multiflora rose was sighted in the south-central part of the county, but no other information was provided. In Oklahoma County, multiflora rose was sighted on Tinker Air Force Base with the invasion being described as light to moderate in density. There were several sightings in pastures and fence lines throughout Okmulgee County. In Osage County, multiflora rose was sighted in both the southeast and far northeast portions of the county with a sparse occurrence on the ground and in fence lines. In Payne County,

multiflora rose was sighted in a forested area outside of the Stillwater city limits and was noted as a light occurrence.

The OVPD contains records for multiflora rose for 39 counties, the OkIPC for 35 counties, and the USDA Plants Database for seven counties. Combined with this project's data, multiflora rose has a 43 county distribution with new occurrence records for Atoka, Johnston, Payne, and Pushmataha counties (Fig. 5). It is evident from the number of records of multiflora rose that this invasive plant is widespread in Oklahoma, and eradication efforts will be significantly more difficult than for purple loosestrife. Thus, efforts should be focused primarily on limiting the spread of populations to the western tier counties of Oklahoma or other uninhabited regions of the state.

Japanese honeysuckle

Nine surveys were returned on Japanese honeysuckle, providing information for Atoka, Bryan, Carter, Choctaw, Comanche, Garfield, McCurtain, Oklahoma, Okmulgee, Payne, Pushmataha, and Tulsa counties. The sightings of Atoka, Bryan, Choctaw, McCurtain, and Pushmataha counties were all recorded by one respondent, who described occurrences at "numerous locations" including the Antlers Industrial Park property, which was described as a very dense infestation. In Carter County, Japanese honeysuckle was reported as a dense occurrence on a homeowner's property east of Ardmore. In Comanche County, Japanese honeysuckle was sighted in the Wichita Mountains Wildlife Refuge, encompassing approximately 4 m^2. No details were provided regarding the Japanese honeysuckle occurrences in Garfield County. In Oklahoma County, Japanese honeysuckle was sighted on Tinker Air Force Base and was described as moderately to highly dense. In Okmulgee County, Japanese honeysuckle was sighted across the county, with no specific location or density information mentioned by the respondent. In Payne County, Japanese honeysuckle was sighted in a forested area outside of Stillwater city limits and was moderately dense. In Tulsa County, Japanese honeysuckle was sighted in Mohawk Park surrounding the Tulsa Zoo.

For Japanese honeysuckle, the OVPD records this species in 45 counties, the OkIPC in 43 counties, and the USDA in 7 counties. In combination with this project's data, Japanese honeysuckle has a 46 county distribution with a new occurrence record for Garfield County (Fig. 6). Japanese honeysuckle is not present in the northwestern portion of Oklahoma, which is likely due to colder temperatures and lower precipitation that limits Japanese honeysuckle growth (Forest Invasive Plants Resource Center 2005). However, the rest of the state is widely inhabited by this species and thus efforts should be focused on preventing further spread of this highly invasive plant in these areas.

Distribution maps

The differences in county distributions among the OVPD, OkIPC, and USDA, (see Figs. 4-6) can be attributed mostly to each organization's differing data sources. The USDA Plants Database distribution maps had the lowest documented occurrences of these species, while the OVPD had the most occurrences recorded.

It is important to note that not all invasive occurrences are equally significant. For example, the record of purple loosestrife in the Cleveland County demonstration gardens may hold less threat of spreading beyond the residential site; whereas, the invasion on the pond's edge in Rogers County is more problematic due to its increased likelihood of spreading through the watershed. Purple loosestrife is readily transported through waterways, establishing communities downstream or in this example, potentially spreading around the

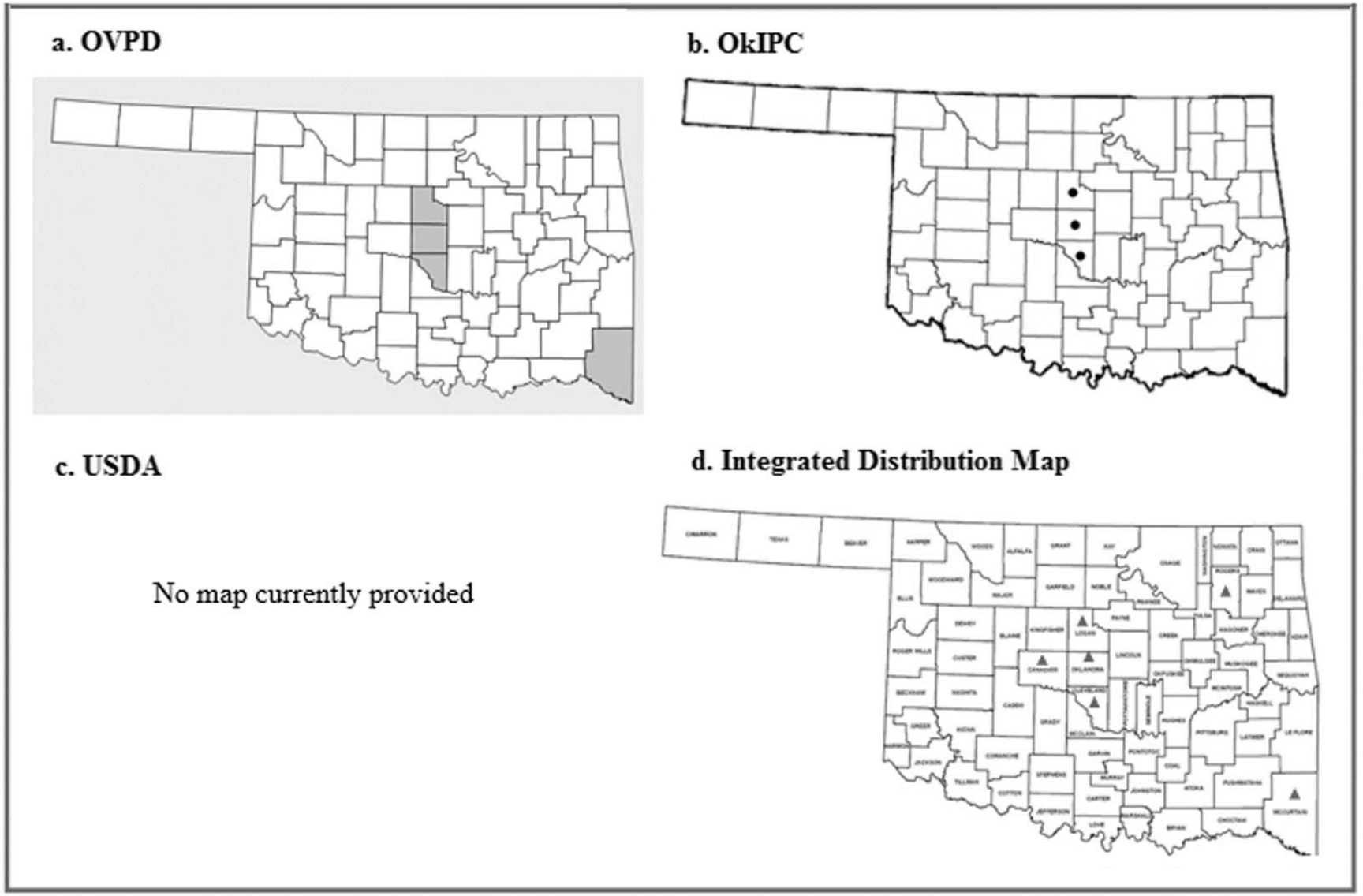

Figure 4 The distribution of purple loosestrife in Oklahoma between sources

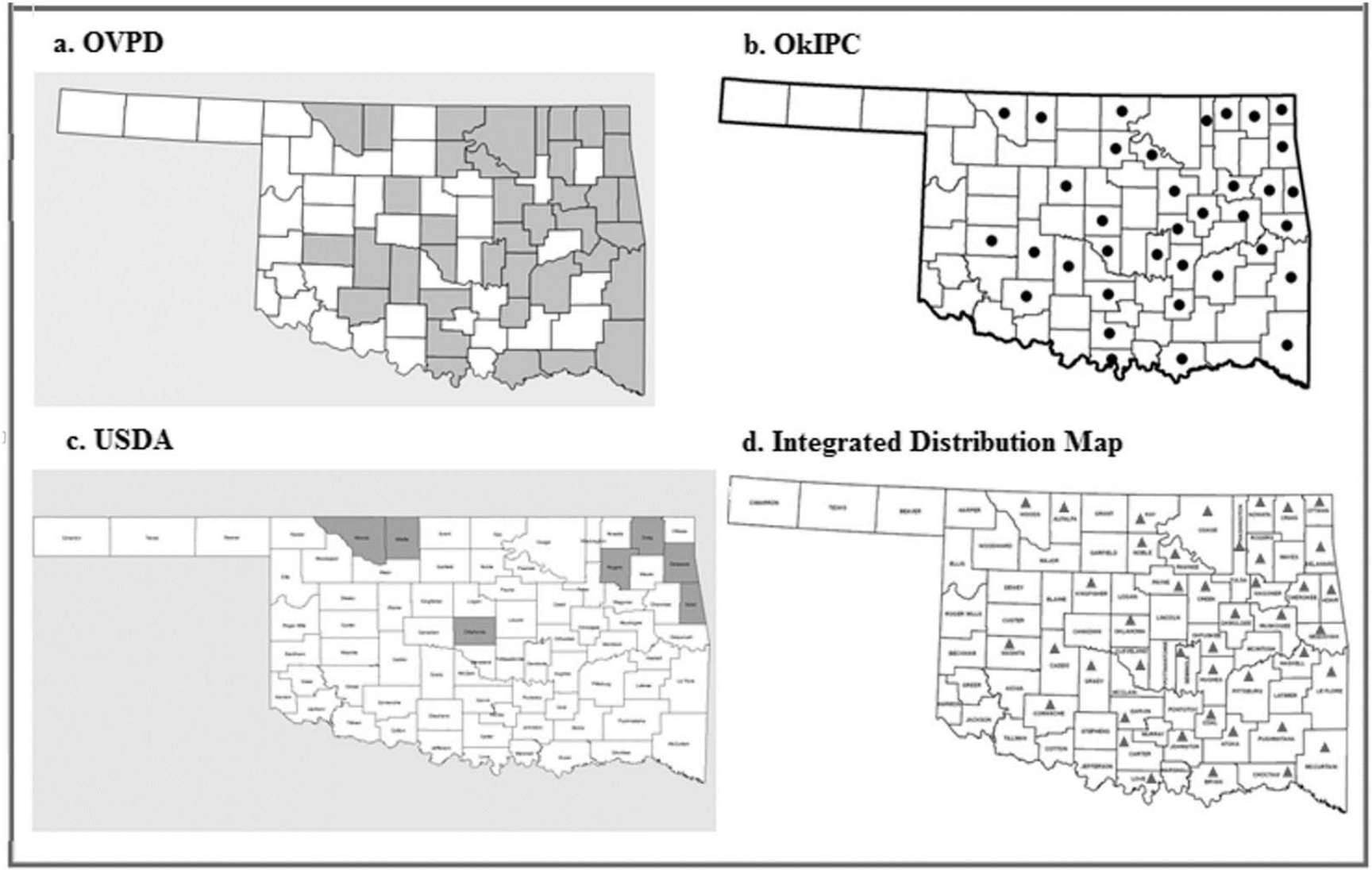

Figure 5 The distribution of multiflora rose in Oklahoma between sources

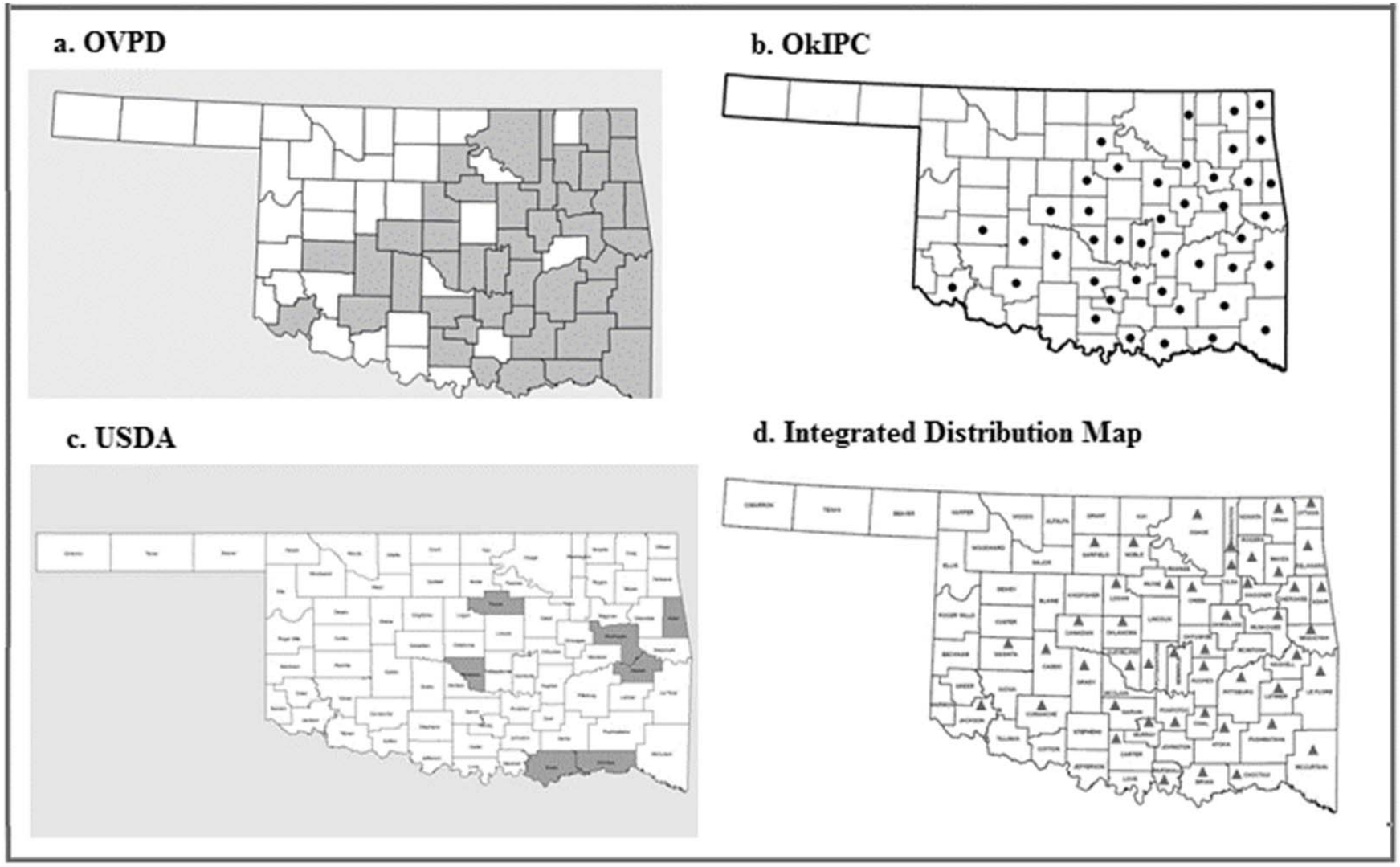

Figure 6 The distribution of Japanese honeysuckle in Oklahoma between sources

Rogers County pond. Once established, these purple loosestrife stands may outcompete the native vegetation and alter the pond's wetland structure and function (New Hampshire Department of Environmental Services 2010). In addition, these larger communities of purple loosestrife have increased odds of spreading to other sites due to the greater number of offspring they produce. In the Cleveland County gardens, however, the extent of the purple loosestrife population may be maintained, and there is reduced opportunity to spread through the waterways. The difference in each organization's criteria for adding an invasive into their distribution maps may explain why the ornamental planting in the Cleveland County gardens is not listed by any of the organizations. The authors, however, have included the Cleveland County record in this report to show that residential ornamental plantings, albeit less pervasive than others, can still spread outside the garden's borders and cause ecological impact. Although it may not qualify as a record by the organizations listed in this report, it can be argued that no invasive plant should be viewed as acceptable and remain undocumented.

Overall, accurate distribution maps must be produced to inform the public and land managers where invasive populations exist in order to limit the spread of invasive populations to uninhabited areas of Oklahoma. Accurate fact sheets must also be available to guide conservationists to the best method(s) for their eradication.

CONCLUSION

The objective of this study was to emphasize the need for more research in invasive plant distributions while increasing the number of known occurrences for purple loosestrife, multiflora rose, and Japanese honeysuckle using survey responses. Based on survey results, 7 new county-level occurrences were documented for these 3 invasive plants. The differences among existing data sources in this report currently provide conflicting impressions of invasive plant distributions. These discrepancies can potentially impede management and eradication efforts and become increasingly problematic without the availability of accurate data.

It is evident that one person or research project alone cannot efficiently take on the burden of mapping invasive plants. Invasive plant species play a role in many aspects of life — from the environment to the economy — and must be considered as a group. Programs such as Early Detection and Distribution Mapping System (EDDmapS®), a phone application and website, enable the citizen scientist aspect of research. This program allows a user to upload photographs, GPS coordinates, and population data of a plant that they believe is invasive. These data are then submitted to an expert to confirm species identification. Once the identification is verified, the occurrence is added to a statewide distribution map that is viewable online (EDDMapS 2014). Maps that contain more detailed occurrence records enhance our ability to provide information to the public about the threats these invasive species have on our natural resources.

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APPENDIX A

Fact Sheet: Purple Loosestrife

Common Name: Purple Loosestrife

Scientific Name: *Lythrum salicaria*

Country of Origin: Europe and Asia

History of Introduction: It was brought to North America and Canada in the early 1800s from Eurasia for ornamental and medicinal purposes. It was also imported accidentally as a contaminant on ship ballasts or as seeds on raw wool and sheep aboard. When the US expanded their road and canal systems, purple loosestrife expanded with these developments and now inhabits every contiguous state in the nation except Florida.

How It Invades: Purple loosestrife spreads by seeds, which an adult plant produces about 2.5 million a year. Purple loosestrife is also able to spread by re-sprouting from roots and fragments. It is easily transported by animals, waterways, boats, cars, and many other vectors.

Species Description: Purple loosestrife is an erect perennial herb that stands typically 3-10 feet tall. It has showy magenta colored flower spikes consisting of 5-7 petals that bloom from July to September. The flower has a yellow-white center that contains nectar and is useful for bee-forage. Purple loosestrife has tough stems, which can number as many as 50. Its leaves are lance-shaped and heart-shaped or rounded at the base with pubescent surfaces.

Population Level Traits Promoting Invasion: Purple loosestrife is able to invade native communities successfully because it is able to adapt quickly, produces a large amount of offspring, thrives in a wide variety of wet habitats and conditions, has no natural predators, and spreads rapidly.

Community and Ecosystem Level Effects of Invasion: Purple loosestrife is problematic because it outcompetes native vegetation creating monocultures, changes water flow that can cause sediment buildups, alters the nitrogen cycle and the water's chemistry, grows in irrigation systems which blocks the flow of water, alters wetland structure and thus function, and forms dense stands which reduces native animals habitat and food sources.

Management: Purple loosestrife can be managed through mechanical, chemical, and biological methods. If a small community exists, physically remove the plants and (if possible) burn them. For larger communities, spray with a glyphosate herbicide and/or use the beetle *Galerucella spp*. that feeds on the purple loosestrife. Ideal time for removal is in June-September due to plant's noticeability and lack of seeds.

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Fact Sheet: Multiflora Rose

Common Name: Multiflora rose

Scientific Name: *Rosa multiflora*

Country of Origin: Japan, Korea, and Eastern China

History of Introduction: Multiflora rose was introduced to the United States from Japan in 1866 as a rootstock for grafted ornamental cultivars. In the 1930s, it was further distributed by the U.S. Soil Conservation Service to control erosion. It also has been promoted as effective habitat for animals, crash barriers and headlight reduction for roadways, and fencing for livestock. Multiflora rose has since spread significantly and now encompasses 30 states, including the D.C. area.

How It Invades: Multiflora rose most commonly establishes from fruits that fall close to the original plant, which lead to dense thickets. However, animals that eat the plant can disperse seeds longer distances. A single adult plant can produce 1 million seeds annually. Plants can also establish roots where their canes touch the ground.

Species Description: Multiflora rose is a perennial thorny shrub that can grow to upwards of 15 feet tall. It has clusters of white or tinted pink flowers consisting of 5 petals that appear in May or June. It is multi-stemmed with long, flexible stems containing re-curved thorns and large, alternate leaves. Multiflora rose can sometimes be a climbing vine.

Population Level Traits Promoting Invasion: Multiflora rose is able to invade native communities successfully because it has a tolerance for diverse soil conditions, grows aggressively, and produces a lot of offspring. It also has a long-lived seed bank that remains viable for 10-20 years that allows it to invade communities even after it is believed to be eradicated.

Community and Ecosystem Level Effects of Invasion: It forms dense, impenetrable thickets that outcompetes native vegetation for resources, including light.

Management: Mechanical, chemical, and biological methods can be implemented to manage multiflora rose. Cutting and hand-pulling can remove plants, but one must ensure that all roots are removed in order to be successful. Frequent cuttings of 3-6 times a growing season may be necessary. Glyphosate herbicides can be sprayed on the foliage or applied to stumps and is ideally used during the dormant season to minimize effect on native plants. Rose-rosette disease, a virus, is transported by mites and has fatal effects on multiflora rose. It can kill plants in two years, but must be used with caution so that it does not also wipe out native plants. Goats and other grazers can also aid in the control of multiflora rose. Fire regimes can prevent plant establishment as well.

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Fact Sheet: Japanese Honeysuckle

Common Name: Japanese Honeysuckle

Scientific Name: *Lonicera japonica*

Country of Origin: Japan and Korea

History of Introduction: Japanese honeysuckle was introduced to Long Island, New York from Japan in 1806 for ornamental and ground cover purposes. It was slow to spread, but once it escaped New York it took over the majority of the United States by the early 1900s. It has since been used for erosion control and wildlife forage and cover.

How It Invades: Japanese honeysuckle invades ecosystems through a series of long runners that develop roots and underground rhizomes. Their seeds can also be transported by birds and other wildlife that consume the berries.

Species Description: Japanese honeysuckle is a perennial woody vine that often remains evergreen. Its white flowers contain 5 petals and bloom from April to October, turning yellow with age. These flowers occur in pairs at leaf junctures and are highly fragrant. Japanese honeysuckle is notorious for twisting around objects, specifically stems and trunks. Small, black fruits form in August.

Population Level Traits Promoting Invasion: Japanese honeysuckle is able to invade native communities successfully because it has few natural enemies in North America, is tolerant to a wide range of environmental conditions, spreads by sending out vegetative runners that can root in a plethora of environments, forms dense thickets, and has a high growth rate. It also has a large seed bank, which can remain viable in the soil for long periods of time.

Community and Ecosystem Level Effects of Invasion: Japanese honeysuckle inflicts damage on forest communities because it twines around stems and trunks, establishing dense blankets that block out light, inhibit water flow in native plants, and ultimately smother them. It can prevent growth of native vegetation and decreases the biological diversity of the area. Because Japanese honeysuckle largely remains evergreen, it remains physiologically active while other vegetation is dormant, allowing it to outcompete native plants.

Management: Prevention is ideal, but both mechanical and chemical management options exist if Japanese honeysuckle becomes established. For small communities, hand-pulling at the base of the plant to uproot it and cutting the vines can be successful if monitored regularly to ensure no new seedlings have established. Mowing in both July and September can be beneficial for larger patches. Glyphosate herbicides can be applied in autumn when the plant has healthy, green leaves, but should be carefully applied according to labels. Burning can eliminate the ground cover, but since Japanese honeysuckle contains underground rhizomes, prescribed burns remain a temporary solution. Finally, animals such as goats have been successful in eating this invasive plant and preventing further spread of it. A combination of the practices listed above will be most effective.

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APPENDIX B

Wanted Poster Fact Sheet: Purple Loosestrife

WANTED

***Lythrum salicaria* –** Alias: Purple Loosestrife

Description: 3-10 feet tall perennial herb Magenta colored flower spikes consisting of 5-7 petals from July to September, often has multiple tough stems, leaves are lance-shaped and heart-shaped or rounded at the base

Hometown: Europe

Oklahoma Classification: Declared aquatic nuisance species

Habitat: Wetland conditions (i.e., marshes, river banks, ditches, pond edges, roadsides, reservoirs, and wet meadows)

Crime: Suppression of native vegetation leading to loss of biological diversity, alteration of N cycle and flow of water, disruption of natural wetland function, elimination of food sources for animals

Instructions for "Capture": If small community, manually remove plant and (if possible) burn it. For larger communities, spray with a glyphosate herbicide or use the beetle *Galerucella spp*.
Ideal time for removal is in June-August due to plant's noticeability

Sightings: Approximately 6 counties in Oklahoma

Victims: Unsuspecting wetlands or waterways

How you can help: Prevent it, Recognize it, Report it, and Remove it

Citations: http://www.nps.gov/plants/alien/fact/pdf/lysa1.pdf
http://www.dnr.state.mn.us/invasives/aquaticplants/purpleloosestrife/control.html
http://www.sleloinvasives.org/about-invasives/target-species/purple-loosestrife/

Wanted Poster Fact Sheet: Multiflora Rose

WANTED

Rosa Multiflora – Alias: Multiflora Rose


Mugshot
2014

Description: Up to 15 feet tall thorny shrub, Clusters of white or tinted pink flowers with 5 petals in May and June, Multi-stemmed with long flexible stems, leaves are alternate with large oval leaflets

Hometown: Japan, E. China, Korea

Oklahoma Classification: No current legal status

Habitat: Sunny areas with well drained soil but can survive a range of conditions (i.e., stream banks, forests, prairies, woodlands, and wetlands)

Crime: Suppression of native vegetation leading to loss of biological diversity, alteration habitat structure which prohibits nesting of birds, creates impenetrable thickets

Instructions for "Capture": If a small community, manually mow or cut plants. For larger communities, spray with a herbicide, promote grazing by sheep and goats, or use the mite *Phyllocoptes fructiphilus*
Monitoring and control required for several years

Sightings: Approximately 43 counties in Oklahoma

Victims: Unsuspecting native herbs and shrubs

How you can help: Prevent it, Recognize it, Report it, and Remove it

Citations:

http://www.fs.fed.us/database/feis/plants/shrub/rosmul/all.html#managementconsiderations
http://na.fs.fed.us/spfo/invasiveplants/factsheets/pdf/multiflora-rose.pdf
http://contentinacottage.blogspot.com/20120/05/wildflowers-common-fleaband-and.html

Wanted Poster Fact Sheet: Japanese Honeysuckle

WANTED

***Lonicera japonica*–** Alias: Japanese Honeysuckle

Mugshot
2014

Description: Perennial woody vine that twines around objects, Flowers are fragrant with 5 white petals that occur in pairs and bloom from April to October, Petals turn yellow with age, Black fruits form in August, Leaves are oblong or oval

Hometown: Eastern Asia

Oklahoma Classification: No current legal status

Habitat: Open natural communities, but can thrive in a wide range of environmental conditions (i.e., successional fields, old home sites, forests)

Crime: Suppression of native vegetation by forming dense blankets, alteration of forest structure, encircling of trees and stems which cuts off water flow to plant

Instructions for "Capture": For small communities, hand-pulling the entire plant and mowing can be effective. For larger communities, applying a glyphosate herbicide when green leaves are present is recommended.

Sightings: Approximately 46 counties in Oklahoma

Victims: Unsuspecting native herbs and shrubs

How you can help: Prevent it, Recognize it, Report it, and Remove it

Citations: http://plants.ifas.ufl.edu/parks/japanese_honeysuckle.html
http://www.nps.gov/plants/alien/fact/loja1.htm
http://www.cnseed.org/japanese-honeysuckle-seeds-lonicera-japonica-seeds.html

NON-TWINING MILKWEED VINES OF OKLAHOMA: AN OVERVIEW OF *MATELEA BIFLORA* AND *MATELEA CYNANCHOIDES* (APOCYNACEAE)

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Key words: distribution, ecology, morphology, taxonomy

ABSTRACT

Matelea (Apocynaceae, Asclepiadoideae) is a genus of approximately 225 species in milkweed subtribe Gonolobinae. This New World genus is predominantly found in tropical to subtropical regions and is represented in Oklahoma by four species. Two of these, *M. biflora* and *M. cynanchoides,* are closely related, non-twining perennial herbs that have long confused amateur and professional botanists alike due to similar morphological features. This paper includes a brief review of their taxonomic history and describes the morphology, ecology, and distribution of these species in Oklahoma and neighboring states. Photographs, a distribution map, and a key to the species of *Matelea* in Oklahoma are included.

INTRODUCTION

Milkweeds in Oklahoma from Apocynaceae subfamily Asclepiadoideae (the former Asclepiadaceae) display an array of diversity. Species include erect and prostrate herbs and herbaceous vines in five genera (*Asclepias* L., *Cynanchum* L., *Funastrum* E. Fourn., *Gonolobus,* and *Matelea* Aubl.). In addition to variation in growth form, they exhibit a variety of corolla forms and variation in the distinctive features of the milkweed subfamily: fusion of male and female floral whorls forming a gynostegium, and an additional floral whorl, the corona.

Matelea is a large genus of approximately 225 species in the milkweed subtribe Gonolobinae. This New World genus consists mostly of vines and is found in tropical and subtropical regions. *Matelea* is known to be broadly polyphyletic (i.e., consisting of multiple lineages that are not necessarily closely related) and is a good candidate for taxonomic dissolution (Krings, Thomas, and Xiang 2008; Parks 2008; McDonnell and Fishbein, in prep). In Oklahoma, *Matelea* is represented by four species that form two morphologically distinct pairs; *Matelea baldwyniana* (Sweet) Woodson and *Matelea decipiens* (Alexander) Woodson are vines most common in the eastern part of the state, and *Matelea biflora* (Nutt. ex Raf.) Woodson and *Matelea cynanchoides* (Engelm. and A. Gray) Woodson are prostrate to decumbent species, present throughout much of the eastern two-thirds of the state. Pending additional phylogenetic and morphological study, the four species will likely be placed in two genera, distinct from *Matelea* in the strict sense, which will be restricted to species native to Central and South America.

One of these Oklahoman *Matelea* species pairs, the non-twining herbaceous species *M. biflora* (Figs. 1A, 1C) and

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M. cynanchoides (Figs. 1B, 1D), are closely related and possess similar morphological features. Both species currently reside in *Matelea* subgenus *Chthamalia*, a group of approximately 30 milkweeds that are apparently adapted to arid habitats, have a center of diversity in northern Mexico, and are the focus of my dissertation research. This paper will clarify the taxonomic history and morphological differences between the species and will also provide a key to identify the species native to Oklahoma.

Figure 1 *Matelea biflora* and *Matelea cynanchoides*. (A) *M. biflora* habit, note prostrate stem. Photo by Mark Fishbein. (B) *M. cynanchoides* habit, note decumbent-ascending stem. (C) *M. biflora* flowers, note pubescent corolla and reflexed corolla margins. (D) *M. cynanchoides* flowers and buds, note glabrous corolla and planar corolla margins. Photo by Mark Fishbein.

METHODS

Specimen records (336 total, 205 of which were viewed, see appendix for list of viewed specimens) for *Matelea biflora* and *M. cynanchoides* were downloaded from online data repositories including: the Global Biodiversity Information Facility (GBIF http://www.gbif.org); Tropicos (http://tropicos.org); SEINet (http://swbiodiversity.org/portal/index.php); and herbarium websites, such as the Oklahoma Vascular Plants Database (OVPD http://www.oklahomaplantdatabase.org).

Specimen loans (abbreviations follow Thiers [2014]) were obtained from the US National Herbarium (US), the New York Botanical Garden (NY), the Missouri Botanical Garden (MO), Harvard University Herbaria (A, ECON, GH), Arizona State University (ASU), University of Texas at Austin (TEX, LL), Kansas State University (KSC), University of Arizona (ARIZ), University of New Mexico (UNM), and Louisiana State University (LSU). Specimens at the Oklahoma State University Herbarium (OKLA), Botanical Research Institute of Texas (BRIT), Sul Ross State University (SRSC), and the University of Oklahoma (OKL) were examined on visits to those herbaria. Additional data were obtained from my field collections and the unaccessioned collections and database of Mark Fishbein (Oklahoma State University). Occurrence data were curated manually to confirm or change species identifications and for georeferencing. The resulting specimen database was used to plan fieldwork across the range of each species. Fieldwork in Oklahoma and Texas was carried out in the summers of 2011, 2012, and 2013. For each population located in the field, specimens were collected and the following data recorded: latitude and longitude coordinates obtained with a handheld GPS device (usually a Garmin® GPSMAP 76), elevation obtained by GPS and checked in Google Earth®, substrate, relative local abundance, vegetation type, co-occurring species, occurrence of interacting arthropods (flower visitors and herbivores), and morphological notes.

Specimens obtained from loans and field collections were used for morphological study. Measurements of floral and vegetative characters were carried out using Olympus® cellSens Entry 1.6 imaging software and an Olympus® SZX10 dissecting microscope outfitted with an Olympus® SC30 CMOS color camera.

A distribution map (Fig. 2) for both species was produced using a combination of Google Earth®, Adobe® Illustrator, and Adobe® Photoshop software. The points on the map include specimens examined and records downloaded from databases for which specimens were not examined. Due to imprecise locality data, not all records could be accurately mapped. Records with ambiguous or incomplete locality data were excluded.

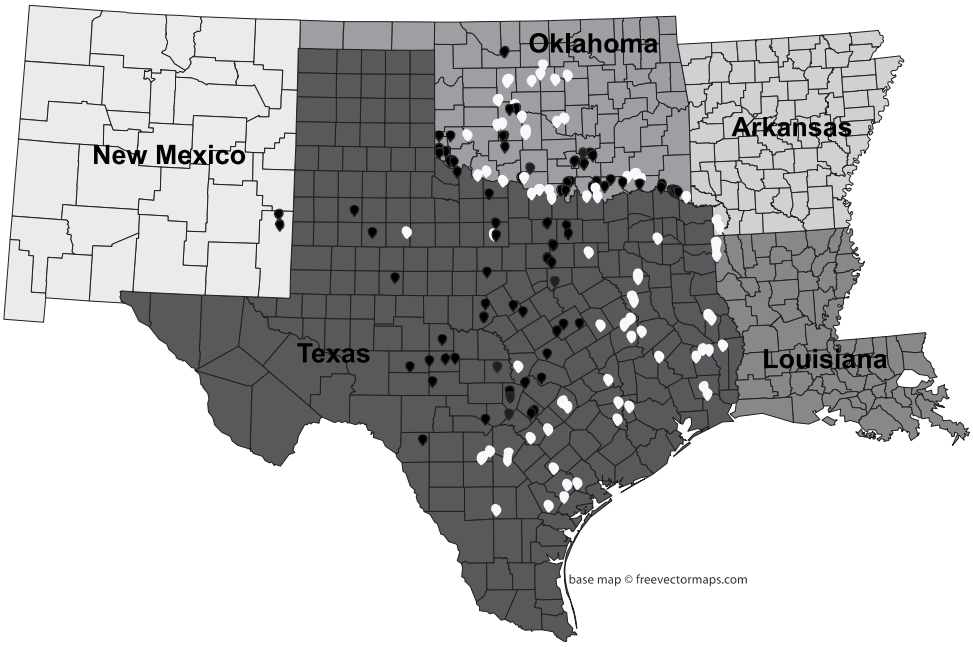

Figure 2 Distribution map showing ranges of *Matelea biflora* (black) and *M. cynanchoides* (white)

RESULTS AND DISCUSSION

Matelea biflora (Nutt. ex Raf.) Woodson

Gonolobus biflorus Nutt. ex Raf.
Gonolobus biflorus Nutt. ex Torr., nom. illeg.
Chthamalia biflora (Nutt. ex Raf.) Decne.
Gonolobus biflorus Nutt. ex Raf. var. *wrightii* A. Gray

Purple milkweed vine, star milkvine, two-flowered milkvine

Taxonomic History

The type specimens of what would eventually be named *Matelea biflora* (see Figs. 1A, 1C) were collected by intrepid English botanist Thomas Nuttall near the Red River in the Arkansas Territory during his travels between October 2, 1818, and February 18, 1820. The collection date was not recorded by the collector or by subsequent taxonomists working with the material. The specimens were probably collected in the summer of 1819, the only time during his trip when flowering specimens were likely abundant. At the time, the Arkansas Territory included all of present day Arkansas and most of present day Oklahoma (the northernmost counties and the panhandle of Oklahoma were excluded). According to his journal and the interpretations of later scholars, Nuttall doesn't appear to have crossed the border into Texas, which was then owned by Spain. The specimens were likely collected on the Oklahoma side of the Red River, in either Choctaw or McCurtain County (Lottinville 1980; Tyrl and Shryock 2014). The specimens were labeled in Nuttall's handwriting "Gonolobus *biflorus Nutt". The asterisk denotes his convention of marking a species name as new (McLean 1980; Stuckey 1966).

Many of the *Gonolobus biflorus* specimens Nuttall collected received additional labels and were distributed to several herbaria. Currently, there are at least eight duplicate

sheets held at herbaria of the Academy of Natural Sciences, Philadelphia (PH); Royal Botanic Gardens, Kew (K); Smithsonian Institution (US); and the New York Botanical Garden (NY). Significantly, *G. biflorus* was never mentioned in Nuttall's *Collections towards a Flora of the Territory of Arkansas* (1837), the publication in which he describes many new taxa from the region, nor in any of his other publications. Thus, the name indicated as new on Nuttall's labels was never published by him. Like other species discovered and named but not published by Nuttall, *G. biflorus* was apparently validated by John Torrey (1859) in his *Report on the United States and Mexican Boundary Survey*. Therefore, some sources cite the authority for this species as *G. biflorus* Nutt. ex Torr.

However, even before Nuttall's (1837) report on the flora of the Arkansas Territory was published, Constantine Samuel Rafinesque, a self-educated professor of botany and natural history who elicited considerable controversy from his contemporaries (Boewe 2003; Warren 2004), published a *New Flora of North America* (1836). In this work, Rafinesque was the first to describe and validly publish *Gonolobus biflorus* from a specimen he saw at the herbarium of Zaccheus Collins, a Philadelphia merchant and avid collector of herbarium specimens. According to correspondence held by the American Philosophical Society, the two men were friendly and discussed botanical findings, travels, reading habits, and finance (Collins 1805–1827, Redfield 1876). In 1833, two years after Collins' death, most of his herbarium was sold to Rev. Lewis David von Schweinitz, and a small portion of the collection was sold to Rafinesque shortly thereafter (Stuckey 1971). Rafinesque does not describe the morphology of the specimen in his publication. He also fails to cite the collector of the specimen he studied. He does state that the plant is from "the Red River in Arkanzas and Texas", nearly the precise locality from which Nuttall collected, except for the inclusion of Texas. However, there are no records showing that Nuttall traveled in Texas. Notably, Rafinesque used the exact epiphet, "biflora" indicated by Nuttall on the slips accompanying his specimens.

Collins seems to be the link between Rafinesque and Nuttall. Nuttall named the Plantaginaceae genus *Collinsia* for him in 1817 and called Collins "a gentleman whose talents as a botanist and a mineralologist are deservedly acknowledged". During Nuttall's trip to the Arkansas Territory, he and Collins exchanged letters (Lawson 2004), and after the trip, Collins received a complete set of duplicates (Stuckey 1971). Rafinesque must have examined the *G. biflorus* specimen Nuttall sent to Collins between 1820 and 1833. Apparently having realized that the name for this species had not been published, Rafinesque seized the opportunity.

Later workers have variably indicated either Nuttall or Rafinesque as the author of *G. biflorus*. It is not clear whether crediting Nuttall as the author was a repeated accident or an intentional snub toward Rafinesque. Eight years after Rafinesque's publication of *G. biflorus*, Decaisne (1844) included the species in his newly described genus, *Chthamalia* Decne., citing Nuttall as the author of the basionym. Asa Gray also cited the species with Nuttall as the author in his *Synoptical Flora of North America* (1878).

More than 120 years after Nuttall's specimen was first collected, milkweed specialist Robert Everard Woodson, Jr. lumped *Chthamalia*, including *Chthamalia biflora*, into the genus *Matelea*, along with over 100 species in more than 20 genera (Woodson 1941). Currently, floras and databases indicate the authorship of this species as either *M. biflora* (Nutt.) Woodson or *M. biflora* (Raf.) Woodson. However, because Nuttall did not validly publish *Gonolobus biflorus*, and because Rafinesque, when validly publishing *G. biflorus* had

apparently taken up the name suggested by Nuttall, the proper authorship is *G. biflorus* Nutt. ex Raf. and in *Matelea*, *M. biflora* (Nutt. ex Raf.) Woodson.

Species description

Plants prostrate, usually with 5–20+ stems from a thickened taproot, stem length in flower 10–50 cm, lengthening in fruit, malodorous throughout; the largest leaves with petioles 0.7–2.5 cm long, blades broadly lanceolate to broadly ovate or nearly triangular, 1.5–5.0 cm long and 1.0–3.2 cm wide, bases deeply to shallowly cordate, apices acute, youngest leaf bases with a pair of rounded colleters; inflorescences of axillary pairs or solitary flowers; peduncles 0–10 mm; pedicels 0.2–1.1 cm; calyx lobes ovate to triangular, 2.0–3.5 mm long; corolla shallowly campanulate-rotate usually with spreading lobes, maroon to dark brown, 8–13 mm in diameter, deeply 5-lobed; lobes elliptic to narrowly deltoid, margins often reflexed at maturity, densely pilose adaxially and sparsely pilose abaxially; corona consisting of a fleshy disk arising at the junction of the gynostegial column and the corolla, with 5 fleshy, incurved lobes, maroon to dark brown, approximately triangular in cross section, incumbent on anthers; anthers with entire, white, membranous, apical appendages; fruit a muricate, ellipsoid follicle, 5–10 cm long, protuberances numerous (≥5 per 5 cm of follicle length).

Distribution and Ecology

Matelea biflora has been found most commonly on or adjacent to the Edwards Plateau in Texas. The range extends north to the Glass (Gloss) Mountains in Major County, Oklahoma. The easternmost collection was made near Idabel in McCurtain County, Oklahoma. The western edge of its range is near the Texas-New Mexico state line, where two specimens have been collected from Lea County, New Mexico (see Fig. 2). In Oklahoma, *M. biflora* is most commonly found south of I-40 in the southern tier of counties, particularly in areas with shale, dolomite, gypsum, limestone, or sandstone substrates (USGS 2005). It is also found west of Oklahoma City in Comanche, Caddo, Canadian, and Major counties on sandstone, shale and limestone. To the southeast of Oklahoma City, it has been collected in Murray, Pontotoc, Johnston, and Carter counties on limestone, shale and conglomerates. In the proximity of the Ouachita Mountains, it has been collected on shale and limestone.

Matelea biflora is generally found on hillsides or plains, in intact or disturbed prairies, pastures, ditches, or roadsides, where the soils generally include clay, rocks and sand. Due to its prostrate, highly branched growth form, *M. biflora* tolerates mowing quite well and is often locally common when found in mown habitats. Among the Level III ecoregions of Texas and Oklahoma (Griffith et al. 2004; Woods et al. 2005), this species has been collected in parts of the High Plains, the Central Great Plains, and the Cross Timbers. It is also found throughout the Edwards Plateau ecoregion of Texas (Griffith et al. 2004). Within Oklahoma, *M. biflora* is also found within the South Central Plains ecoregion (Woods et al. 2005).

Few collectors have noted associated species; however, available data suggest that these are numerous and diverse. They include graminoids in the genera *Aristida, Bothriochloa, Bouteloua, Bromus, Carex, Dicanthelium, Erioneuron,* and *Poa.* Other herbaceous associates include species of *Aphanostephanus, Asclepias, Ambrosia*, *Artemisia, Atriplex, Centaurea, Callirhoe, Calylophus, Chrysopsis, Croton, Cuscuta, Dalea, Desmanthus, Euphorbia, Gaillardia, Grindelia, Hedeoma, Hedyotis, Hymenoxys, Krameria, Lesquerella, Linum, Melampodium, Opuntia, Plantago, Ruellia, Solanum, Salvia, Stillingia, Teucrium, Thamnosma, Thelesperma,* and *Tragia.*

Woody associates include species of *Juniperus, Prosopis, Quercus,* and *Ziziphus.*

Though almost nothing is known about faunal interactions with *M. biflora*, including potential pollinators, I have observed dung beetles in the genus *Euphoria* on flowers twice, but with no pollinia attached (these have also been observed by Mark Fishbein, pers. comm.). Near Fort Worth, Texas, I have observed blister beetles from the family Meloidae on the foliage. Additionally, I've seen a variety of ants and flies on and around flowers.

Matelea cynanchoides (Engelm. & A. Gray) Woodson

Gonolobus cynanchoides Engelm. & A. Gray
Vincetoxicum cynanchoides (Engelm. & A. Gray) A. Heller

Prairie milkvine

Taxonomic History

Matelea cynanchoides (see Figs. 1B, 1D) was first described as *Gonolobus cynanchoides* by George Engelmann and Asa Gray in 1845. Ferdinand Lindheimer collected the type specimen during his second collecting trip in Texas in 1844. The holotype is held at MO. There are also four duplicates: one at K, two at GH, and one at University of Michigan (MICH). According to the accompanying label, the specimen was collected in "Sandy soil, in open woods, near Industry. April-June". Lindheimer was contracted by Engelmann and Gray to collect specimens in Texas, and many new species discovered by Lindheimer were described by these two leading botanists of their time (Blankinship 1907). On the 1844 collecting trip, Lindheimer traveled from the Brazos River, near San Felipe, to Industry and then west to the Colorado River. Industry, where the specimen was collected, is a small community in Austin County between the cities of Austin and Houston. In the introductory remarks to Engelmann and Gray's (1845) published enumeration of Lindheimer's collections, they noted this region had rocks of secondary sandstone, cacti, and prairies with large numbers of anthills.

The morphology of *G. cynanchoides* was described by Engelmann and Gray as follows: "Stems 6 to 15 inches high, diffuse; leaves 1-2 inches long, cordate, with an open sinus, the uppermost sometimes almost truncate at the base. Corolla greenish purple, about two lines [i.e., 0.2 in] in diameter". They also described the coronal structure and pollinia characters in some detail. Interestingly, they concluded that this taxon is a likely congener of Decaisne's *Chthamalia biflora* (=*Matelea biflora*, see above). *Gonolobus cynanchoides* was differentiated primarily by its glabrous corolla. Engelmann and Gray did not take up Decaisne's (1844) generic name, *Chthamalia*, published the previous year, because they argued that the characters possessed by *G. cynanchoides* were accommodated by the range of variation in *Gonolobus*, as understood by botanists of that time, including Decaisne. Thus, they rejected Decaisne's concept of *Chthamalia* as a genus (Decaisne 1844; Engelmann and Gray 1845) and maintained the morphological diversity housed within *Gonolobus*.

After the initial description of *G. cynanchoides*, Amos Arthur Heller transferred the species to the genus *Vincetoxicum* (Heller 1900). In doing so, he adopted a then current taxonomic opinion that *Vincetoxicum* was the correct generic name for *Gonolobus*, but this opinion was overturned a few decades later. Just under 100 years after the first *G. cynanchoides* specimens were collected, Woodson (1941) placed *G. cynanchoides* into *Matelea* (along with many other species, including *M. biflora*).

Species description

Plants erect, decumbent or prostrate, usually with 3–10+ stems from a thickened

taproot, stem length in flower 20–40 cm, lengthening in fruit, malodorous throughout; the largest leaves with petioles 0.7–1.3 cm long, blades broadly ovate to deltoid, 1.5–4 cm long and 1.5–3.2 cm wide, bases truncate to deeply cordate or sagittate, apices acute to rounded, youngest leaf bases with 2–4 elongated, pointed colleters; inflorescences of axillary (sometimes appearing terminal) fascicles or shortly pedunculate umbels; peduncles 0–13 mm; pedicels 3–6 mm long; calyx lobes ovate to elliptic, 2–3 mm long; corolla shallowly campanulate-rotate, usually with ascending lobes, green to maroon or dark brown, 6-9 mm in diameter, 5-lobed; lobes ovate to deltoid, margins not reflexed at maturity, glabrous to sparsely pilose adaxially and glabrous abaxially; corona consisting of a fleshy disk arising at the junction of the gynostegial column and the corolla, with 5 fleshy incurved lobes, green, yellow, or maroon, approximately rhombic in cross section, incumbent on anthers, anthers with lobed, white, membranous, apical appendages; fruit a sparsely muricate, broadly ellipsoid follicle, 7–10 cm long, protuberances few (≤3 per 5 cm of follicle length).

Distribution and Ecology

Matelea cynanchoides is most commonly found along the Gulf Coastal Plain in Texas. The distribution extends northward to Oklahoma and is strongly associated with Quaternary dunes and alluvial deposits, especially those near the Red, Canadian, and North Canadian Rivers (USGS 2005). To the east, the range of *M. cynanchoides* extends to Miller County in the southwest corner of Arkansas and Caddo Parish in the northwest corner of Louisiana. To the west, this species largely circumvents the Edwards Plateau in central Texas, but does reach isolated outposts in Kent County in north-central Texas, where a specimen was collected from a sand sheet deposit. It has also been found at an isolated site in Greer County, Oklahoma, where it is associated with terraces of the North Fork of the Red River, near Lake Altus-Lugert (see Fig. 2). Along both sides of the Red River, *M. cynanchoides* populations are found on alluvial deposits (mostly Cretaceous sands) intercalated between *M. biflora* populations that occur along upland bluffs on sedimentary substrates. Populations in southern and eastern Texas are found on various sandy deposits that include Queen City sand, Carrizo sand, the Lissie formation, the Willis formation, and the Catahoula formation as well as mudstone, sandstone, siltstone, and alluvium.

Matelea cynanchoides is typically found in openings in cross timbers and pine-oak forests and in prairies. It is strongly associated with stabilized dune systems. This species tolerates disturbance and is regularly found in weedy sites along roads, in pastures, and other deforested areas. Unlike its congener, this species is decumbent-upright, but it seems to recover well from the effects of mowing by producing branches from the base or from low axillary buds. In Texas and Oklahoma, *M. cynanchoides* has been well collected from two Level III ecoregions (Griffith et al. 2004; Woods et al. 2005): the South Central Plains and the East Central Texas Plains. The westernmost collection of *M. cynanchoides* is from a sand sheet near the Lubbock area, in the High Plains ecoregion. There are also many collections from within the Western Gulf Coastal Plains ecoregion of Texas (Griffith et al. 2004). In Oklahoma, *M. cynanchoides* also occurs in the Central Great Plains and the Cross Timbers (Woods et al. 2005).

Though few specimens record associated species, available data suggest that the associated species are numerous and diverse. These include graminoids in the genera *Aristida, Cenchrus, Dichanthelium, Digitaria, Eragrostis, Eustachys, Panicum, Paspalum,* and *Sporobolus.* Other herbaceous associates include species of *Acalypha,*

Aristolochia, Asclepias, Berlandiera, Chenopodium, Cnidoscolus, Croton, Commelina, Dalea, Diodia, Ditaxis, Erigeron, Eriogonum, Eupatorium, Gaillardia, Galactia, Helenium, Helianthus, Heliotropium, Hymenopappus, Hypericum, Indigofera, Lantana, Lepidium, Mimosa, Monarda, Opuntia, Phyllanthus, Physalis, Richarida, Rudbeckia, Sida, Sphaeralcea, Stillingia, Tetragonotheca, Triodanis, Verbena, Vernonia, and *Yucca.* Woody associates include species of *Callicarpa, Carya, Celtis, Diospyros, Juniperus, Pinus, Prosopis, Prunus, Quercus, Rhus, Vaccinium,* and *Vitis.*

There are no known pollinators or other faunal interactions for *M. cynanchoides*, but there has been one observation (Fishbein, pers. comm.) of a small, unidentified weevil (Curculionidae) visiting the flowers, apparently feeding on nectar.

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KEY TO THE SPECIES OF *MATELEA* IN OKLAHOMA

The following key includes the four species of *Matelea* native to Oklahoma and a version will appear in the next edition of the *Flora of Oklahoma: Keys and Descriptions* (Tyrl et al., in prep). *Gonolobus* is included in the key to aid in distinguishing *G. suberosus*, which has sometimes been placed in *Matelea* as *M. gonocarpa.*

1. Flowers with dorsal anther appendages. Follicles thick-walled, winged. ..... *Gonolobus*
1. Flowers lacking dorsal anther appendages. Follicles thin-walled, smooth or muricate, but not winged. ..... *Matelea*
    2. Plants non-twining herbs with multiple prostrate to ascending stems from the base, 10–50 cm long. Leaf blades 1–6 cm long, conspicuously and generally pubescent. Corolla rotate-campanulate with lanceolate to deltoid lobes.
        3. Stems nearly to fully prostrate. Corolla lobes narrowly deltoid to lanceolate, usually spreading, margins reflexed at maturity. Adaxial surface of calyx and corolla with dense, thick hairs. ..... *M. biflora*
        3. Stems decumbent, ascending, or nearly erect. Corolla lobes deltoid, usually ascending, margins planar. Adaxial surface of calyx and corolla glabrous. ..... *M. cynanchoides*
    2. Plants vines with 1-few stems from the base, 100–300 cm long. Leaf blades 6–18 cm long, inconspicuously puberulent with hairs mostly limited to veins. Corolla campanulate with narrowly lanceolate to linear, twisted lobes.
        4. Corolla white or cream. ..... *M. baldwyniana*
        4. Corolla maroon or brown-purple. ..... *M. decipiens*

APPENDIX

Specimens of *Matelea biflora* and *M. cynanchoides* that were examined are listed below. Data are presented in the following format: taxon: provenance, voucher (acronym of herbarium deposition). Specimens collected by more than one person are listed here by the first name on the label.

Matelea biflora (Nutt. ex Raf.) Woodson

U.S.A., New Mexico: Lea Co.: *Hutchins 9411* (NMU), *Sivinski 8456* (NMU)

U.S.A., Oklahoma: Bryan Co.: *Blain 131* (US), *Taylor 608* (OKL), *Taylor 1413* (OKL), *Taylor 24871* (OKL), Caddo Co.: *Magrath 9764* (OCLA, 2 sheets), *Nighswonger 1375* (OKL), *Hoagland 2909* (OKL), *Hoagland 2433* (OKL), Carter Co.: *Fryxell 1367* (NY), *Goodman 7841* (OKL), Choctaw Co.: *Leavenworth s.n.* (NY, 2 sheets), *Magrath 16036* (OCLA), Comanche Co.: *Thompson S0377* (OKL), Cotton Co.: *Waterfall 7275* (OKL), Harmon Co.: *Stevens 1169* (GH, NY), *Waterfall 7784* (OKL), Jackson Co.: *Buthod AB-7372* (OKL), *Buthod AB-10028* (OKL), Johnston Co.: *Taylor 528* (OKL), Love Co.: *Taylor 3605* (OKL), Major Co.: *Rein 41* (OKLA), *Fishbein 6593* (OKLA), McCurtain Co.: *Waterfall 17257* (GH, CAS), *Demaree 12644* (OKL), *Buthod AB-7197* (OKL), Murray Co.: *Johnson 67* (OKL), Pontotoc Co.: *Goodman 5454* (OKL), *Waterfall 11425* (OKL), *Johnson PON0154* (OKL), Stephens Co.: *Magrath 16541* (OCLA), Tillman Co.: *Smith 54* (OKL), County Uncertain: *Nuttall s.n.* (NY, type), *Merrill 301* (US)

U.S.A., Texas: Bastrop Co.: *Tharp 1697* (US), Bell Co.: *Nesom 6432*, Bexar Co.: *Harvard 30* (US, GH), *Schulz 512* (US), *Jermy s.n.* (US), Blanco Co.: *Prinzie 221* (MO, OKLA), Brown Co.: *Carr 12728* (TEX), *Rein 40* (OKLA), Comanche Co.: *Lehto L25070* (ASU), Concho Co.: *Dorr 1563* (TEX), Dallas Co.: *Lehto L25114* (ASU), *Reverchon 2310* (GH, NY, 4 sheets, US), *Bush 623* (GH, NY, 2 sheets, US), *Reverchon s.n.* (NY, 2 sheets), *Bodin 234* (US), *Reverchon 619* (US), Denton Co.: *Lundell 8423* (GH), *Cory 53715* (NY, US), Eastland Co.: *Johnston 73* (ASU), Edwards Co.: *Cory 39042* (GH), Erath Co.: *Hoisington 244* (OKL), Garza Co.: *Hutchins 546* (TEX), *Wooton s.n.* (US), Hamilton Co.: *Tharp, s.n.* (GH), *Holland 10093* (KSC), Hardeman Co.: *Ball 1121* (US), Hockley Co.: *Thurow s.n.* (US), Johnson Co.: *Lehto L25208* (ASU), Kerr Co.: *Heller 1681* (GH, NY, US), Llano Co.: *Bray 336* (US), Lubbock Co.: *Wooton s.n.* (US), *Demaree 7717* (US), *Demaree 7699* (US), McLennan Co.: *Smith 535* (NY), *Prinzie 229* (MO, OKLA), *Massey 940* (OKL), Menard Co.: *McVaugh 8291* (GH), *Rein 38* (OKLA), Mitchell Co.: *Tracy 7974* (US, GH, NY, 2 sheets), Schleicher Co.: *Turner 21-840* (TEX), *Rein 39* (OKLA), Sutton Co.: *Cory 39624* (GH), Tarrant Co.: *Correll 32752* (GH), *Ruth 93* (KSC, US, 2 specimens, GH, NY, 3 specimens), *Cory 54532* (TEX), *Carr 12833* (TEX), *Pond s.n.* (US, NY), *Killian 6799* (US), Taylor Co.: *Williams s.n.* (GH), Tom Green Co.: *Tweedy s.n.* (NY, US), Travis Co.: *Poud s.n.* (US), *Young s.n.* (GH), *Carr 11100* (TEX), *Tharp 1691* (US), *Tharp 1329* (US), Wichita Co.: *Whitehouse 10883* (NY), Williamson Co.: *Baird 3796* (NY), Wise Co.: *McDonnell 150* (OKLA), *McDonnell 172* (OKLA), *Bridges 13625* (TEX), Young Co.: *Vollum s.n.* (US, 2 sheets), *Cory 13144* (GH), County Uncertain: *Wright s.n.* (GH, 2 sheets, NY), *Lindheimer s.n.* (GH), *Wright 545* (GH, 2 sheets), *Degener 5050* (NY), *Hayes s.n.* (NY), *Stanfield s.n.* (NY), *Ward s.n.* (NY, US), *Stevenson s.n.* (US), *Bebb 2394* (OKL), *Bebb 2508* (OKL)

Matelea cynanchoides (Engelm. & A. Gray) Woodson

U.S.A., Arkansas: Miller Co.: *Thomas 134244* (KSC, LSU), *Kral 65495* (TEX)

U.S.A., Louisiana: Caddo Parish: *MacRoberts 88691 & 6891* (TEX, LSU, NY, US), *Reid 5569* (LSU), *Reid 5578* (LSU), Parish Uncertain: *Leavenworth s.n.* (NY)

U.S.A., Oklahoma: Atoka Co.: *Fishbein 6775* (OKLA), *Lewallen 2636* (OKL), *Rein 56* (OKLA), *Rein 57* (OKLA), Blaine Co.: *Rein 42* (OKLA), *Waterfall 7071* (OKL), Bryan Co.: *Taylor 1654* (OKL), *Taylor 2294* (OKL), Caddo Co.: *Pettijohn 139* (OCLA), *Bittle 160* (OKL), Canadian Co.: *Goodman 5846* (GH), *Goodman 7523* (OKL), Choctaw Co.: *Waterfall, 16031* (KSC), *Hoagland HUGO396* (OKL), Cleveland Co.: *Stevens 1569* (GH), *Jeffs s.n.* (OKL), *Barkley s.n.* (OKL), *Smith 604* (OKL), *Hawk 3* (OKL), *Pusonett 16* (OKL), Custer Co.: *Waterfall 2226* (OKL), *Waterfall 7347* (OKL), Grady Co.: *McDonnell 195* (OKLA), *Pettijohn 217* (OCLA), *Bowers 224* (OCLA), *Goin 6* (OCLA), *Rein 43* (OKLA), *Rein 44* (OKLA), Greer Co.: *Joseph s.n.* (OKL), Jefferson Co.: *Goodman 7198* (OKL), *Taylor 3632* (OKL), Kingfisher Co.: *Bollenbach 47* (OKL), *Folley 330* (OKL), Logan Co.: *Carleton 154* (US, KSC), *Smith 539* (OKL), *Smith 393* (OKL), Marshall Co.: *Goodman 5926* (OKL), McCurtain Co.: *Schwenn 105* (OCLA), Payne Co.: *Stratton 3046* (OKL), Pushmataha Co.: *Magrath 11930* (OCLA), *Magrath 15549* (OCLA), *Magrath 11254* (OCLA), Tillman Co.: *Johnson HF0071* (OKL), County Uncertain: *Carleton s.n.* (KSU), *Palmer 182* (NY, US, 2 sheets)

U.S.A., Texas: Anderson Co.: *Rein 107* (OKLA), Angelina Co.: *Rein 105* (OKLA), Aransas Co.: *Berlandier 561* (GH), Atascosa Co.: *Orzell 6696* (TEX), Austin Co.: *Lindheimer 273* (GH, 2 sheets, type), Bastrop Co.: *Lott 5093* (TEX), *Lott 4497* (TEX), Bee Co.: *Carr 24543* (TEX), Bexar Co.: *Thurber 185* (GH), Brazos Co.: *Fryxell 2380* (NY), Burnet Co.: *Wolff 1551* (US), Cooke Co.: *Lusk s.n.* (NMU), De Witt Co.: *Drushel 10771* (US), Franklin Co.: *Worcester 164* (OKLA), Freestone Co.: *Thomas 133705* (NY), Frio Co.: *Palmer 33883* (NY), Gonzales Co.: *Cory 5781* (GH), *Cory 8348* (GH), *Bogusch 1873* (US), *Goodman 6215* (OKL), *Warnock 164* (TEX), Guadalupe Co.: *Rein 54* (OKLA), Harris Co.: *Hall 520* (GH, US, NY, 2 sheets), *Thuron s.n.* (US), Henderson Co.: *Correll 22110* (NY), Jasper Co.: *Orzell 11045* (TEX), Kent Co.: *Correll 22110* (NY), Leon Co.: *Kral 67245* (GH), *Palmer 13418* (US), Limestone Co.: *Holmes 7116* (TEX), Navarro Co.: *Joor 96* (US), Newton Co.: *Allen 22175* (LSU, 2 sheets), Parker Co.: *Quayle 566* (TEX), Refugio Co.: *Hill 10613* (GH, NY), Shelby Co.: *Thomas, 129199* (NY), Tyler Co.: *Prinzie 225* (MO, OKLA), Upshur Co.: *Holmes 9964* (TEX), Van Zandt Co.: *Rein 108* (OKLA), *Correll 16211* (GH), Wilbarger Co.: *Correll 16211* (GH), County Uncertain: *Tharp s.n.* (GH), *Tharp 566* (NY), *Hayes s.n.* (NY), *Bigelow s.n.* (NY), *Drummond 203* (NY), *Wright s.n.* (NY), *Wright 545* (GH, 2 sheets)

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Critic's Choice Essay

POLLINATION ECOLOGY OF OUR NATIVE PRAIRIE PLANTS

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The Oklahoma prairie in the summer is an ideal place and time to study pollination ecology. With its "cornucopia" pattern of flowering, where many plants flower synchronously, it has many flowers available every day. This past summer at the Oklahoma Department of Wildlife Conservation's Arcadia Conservation Education Area, Dr. Rebecca Pace, an entomologist, and I taught a course in pollination ecology for the University of Central Oklahoma. I was glad to once again slow down and really pay attention to our native plants.

The goals for each student were to choose an insect-pollinated species and determine its flowering phenology, i.e. the timing of the life cycle, its mating system, attractants, and pollinators; to gain an understanding of diverse pollination strategies; and to learn how synchronously-flowering plants within a community compete for and share pollinators.

Students often study members of the sunflower family (Compositae) because they are so common here. Although composites are intimidating because of their tiny flowers that are difficult to manipulate, the students quickly come to appreciate them as they see the diversity of pollinators they attract as well as the intricate details of their phenology. Some students, especially those studying winecup (*Callirhoe involucrata*) and trailing ratany (*Krameria lanceolata*), dealt with high levels of herbivory or florivory. Although it is frustrating to find buds with holes and extensive damage by insect larvae, this is an important phenomenon that affects fruit and seed set in natural populations and that can have long-term effects on the distribution of plant species.

How are such pollination ecology studies conducted? The students first become familiar with their flowers — the numbers and degree of fusion of parts, their symmetry, and whether or not the flowers are aggregated into inflorescences. All these traits influence the orientation and behavior of insect visitors, the placement of pollen on an insect's body, and the subsequent deposition of pollen on stigmas.

Viewing the petals under high magnification allowed students to determine the type(s) of color-producing pigments. If the cells appear to be filled with colored "water balloons", the pigments are water-soluble and are in the cell's large vacuole. If the color is scattered in "dots" within the cells, the pigments are water-insoluble and are located in tiny cellular structures called plastids.

By recording observations each day in the field, students determined their species' phenological events. They described the sequence in which flowers open throughout the life of their plant or inflorescence and described all flower stages from tight buds to withering. The flowers of some species opened early in the morning, but students studying the lazy daisy (*Aphanostephus skirrhobasis)*, sleepy daisy (*Xanthisma texanum)*, and passion flower (*Passiflora incarnata*) had to patiently wait for them to "wake up" by mid-day. By opening at different times of day, flowering species of a community can share pollinators.

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At close inspection, the differences among flowers become apparent, including size and color of the various parts, and position of parts relative to one another. The position of the anthers and stigmas is of crucial importance, as well as how the anthers release their pollen; different species might share pollinators by placing pollen on different parts of a pollinator's body, so that pollen of each species is transferred to a stigma of a flower of the same species. Within a single flower, the anthers sometimes release pollen before the stigma is receptive to it, or vice versa. This difference in timing of the male and female parts of a flower reduces self-pollination.

Nectar production is often associated with the peak activity time of pollinators, but can be highly variable. Tiny capillary tubes can be inserted into nectaries at various stages and times of day to draw out any available nectar. Nectaries are often hidden, located within the flowers, or they may be extra-floral. For example, those of the passion flower (*Passiflora incarnata*) are on the leaf stalk where they attract ants that defend it against herbivores.

Flowers can signal insects that they have pollen and nectar rewards. For example, prairie gaillardia has bright yellow styles and stigmas that contrast with the maroon disk flower petals when rewards for insects are available. As the flowers get older, the styles and stigmas turn maroon. Older flowers might help attract pollinators to the inflorescence, but pollinators will visit younger more-rewarding flowers once they land. The flowers of most composites open from the periphery to the center of the inflorescence, so there are often concentric rings of flowers in various stages.

Students could determine whether their flowers self-pollinated, self-fertilized, or even produced seeds without sex! Pollen-producing stamens were removed from some flowers; then, the flower was bagged and later checked to see if seeds were produced. Some flowers were pollinated by hand with pollen from another flower on the same plant, while others were cross-pollinated with pollen from different plants. Students added pollen to flowers left open to determine whether or not it increased fruit and seed set and to determine if pollinators are sufficient.

From dawn to dusk, students recorded insect visitors to their species. To determine whether insects were just "visitors" or effective pollinators, they gathered pollen from flowers, viewed it under a scanning electron microscope, and compared it with the pollen loads on insect visitors to the same plant. This allowed them to determine whether the visitors were able to carry pollen, and whether they had visited flowers of a single species or several species at the same time. Bees are generally the most efficient insect pollinators; they are able to carry large amounts of pollen, can learn to tell differences among flowers, can learn to "handle" them, and they show floral constancy by revisiting flowers of the same species.

If you would like to delve into and be amazed at what is currently known about pollination biology across the world, I suggest the comprehensive and up-to-date (2011) book *Pollination and Floral Ecology* by Pat Willmer, published by the Princeton University Press.

Halictid bee visiting passion flower (*Passiflora incarnata*). Note the extra-floral nectaries on the leaf stalk.

Pollinators visit newly-opened flowers of *Gaillardia aestivalis*.

Lanceleaf gaillardia (*Gaillardia aestivalis*). Note ring of styles emerging from newly-opened flowers.

Bumblebee on *Dalea candida*. All photos by Gloria Caddell.

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Five Year Index to *Oklahoma Native Plant Record*

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In this issue of Oklahoma Native Plant Record Volume 14, December 2014:
