TAXONOMIC INVESTIGATIONS OF

THE FLORA OF OKLAHOMA

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CHAPTER I

ORGANIZATION OF DISSERTATION

This dissertation comprises three parts each of which encompasses one component of the doctoral research conducted between 1984 and the present. Chapters II - X describe the results of a floristic study of the vascular plants in a study area within northwestern Oklahoma. Chapter XI describes the results of an examination of the seed coats of Nama hispidum and Nama stevensii (Hydrophyllaceae) via scanning electron microscopy. In Chapters XII - XVI, taxonomic treatments of Oklahoma species of the Chenopodiaceae and Crassulaceae are presented. To facilitate readability, each section is complete in itself and is written in the format traditionally used in taxonomic journals or floras.

PART ONE

THE VASCULAR FLORA

OF

A STUDY AREA IN

NORTHWEST OKLAHOMA

CHAPTER II

INTRODUCTION

The northwestern portion of Oklahoma, where the Panhandle meets the body of the state, is geologically and botanically interesting. It is a region of diversity! Five geomorphic provinces--High Plains, Western Sandstone Hills, Western Sand Dune Belts, Cimarron Gypsum Hills, and Central Redbed Plains--are present (Curtis and Ham, 1972). Soil maps of the area (Gray and Galloway, 1959) reveal a diversity of soil series and associations. There is a similar diversity of vegetation. Kuchler (1964) maps five vegetation types: the Grama-Buffalograss Prairie, the Bluestem-Grama Prairie, the Sandsage Bluestem Prairie, the Crosstimbers, and Shinnery; while Duck and Fletcher (1943) map eight types: Shortgrass-High Plains, Sandsage Grassland, Mixed-grass Eroded Plains, Tallgrass Prairie, Post Oak-Blackjack Forest, Shinnery Oak Grassland, Bottomland (Floodplain), and Stabilized Dune. McPherson (unpublished) in his treatment of the state's grasslands indicates that the tallgrass, mixed grass, and shortgrass prairies occur in the region.

Although floristic studies such as Rowell's (1967) survey of the Texas Panhandle have been conducted in

adjacent areas, little work has been done in the region. Moreover, the research conducted has involved primarily ecological or range management topics (Frank, 1950; McCullough, 1959; Hanson, 1960; Jones, 1964; Ungar, 1966; McIlvain and Armstrong, 1966; Donaldson, 1965, 1969). Therefore, the objective of this study was to conduct a floristic investigation of the vascular flora of a portion of northwestern Oklahoma.

The study area included Harper, Woodward, and Ellis counties and portions of Beaver, Major, and Dewey. The Canadian River was designated the southern boundary, US HWY 281 the eastern, the Cimarron River and the Oklahoma/ Kansas border the northern, and OK HWY 23 and the Oklahoma/Texas border the western (Figure 1). The work involved a systematic collection of vascular plants from as many locations and habitats as possible. Twelve hundred and two specimens were collected during the 1985, 1986, and 1987 growing seasons. Collecting trips -- April, June, July, August, September, and October -- were timed in order to collect plants in both flower and fruit. Each trip last 3-4 or 5-7 days. The study area was traversed by car via the federal and state highways and county section roads. Stops to collect plants were made when there was a change in plant community or geological formation. Stops were also made when "unusual" or distinctive plants were observed. Plants were collected from the road rights-of-way, from adjacent fields and

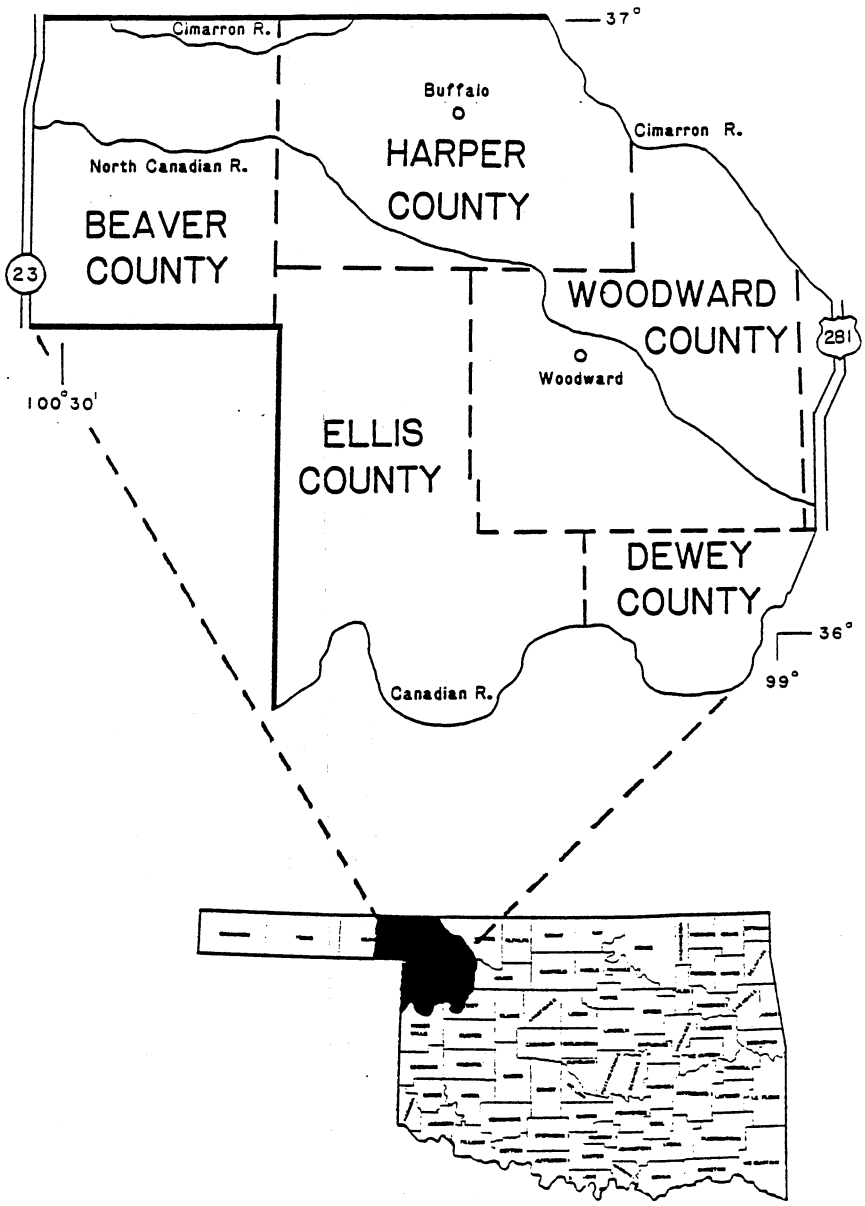

Figure 1. Counties of Northwest Oklahoma and Study Area. Boundaries of the area are the Canadian River on the south, US Hwy 281 on the east, the Cimarron River and Oklahoma/Kansas border the north, and OK Hwy 23 and the Oklahoma/ Texas border on the west.

pastures or rangeland. Plants were also collected during forays on foot away from the roadside; in gullies, along waterways, across mesas or buttes, across dunes, and across rangelands. Plants were collected according to standard taxonomic techniques and voucher specimens were deposited in the OSU herbarium (OKLA). Approximately 200-250 accessions were made on each trip. Duplicate specimens were distributed to other state herbaria. Specimens collected by other botanists and deposited at Northwestern Oklahoma State University also were examined.

In the following chapters, aspects of the geology, climate, vegetation, and history of botanical exploration of northwest Oklahoma as well as the lists of the plants encountered are presented. Hopefully, the results of this study will contribute to our knowledge of the state's flora and will be useful to those now writing a manual for the identification of the state's flora.

CHAPTER III

PHYSIOGRAPHY, TOPOGRAPHY, AND GEOLOGY

Physiographic Provinces

The study area encompasses a transition region between two major physiographic provinces -- the Central Lowlands and the Great Plains (Fenneman, 1931; Hunt, 1967; Figure 2). The boundary between the two provinces is traditionally delimited as the 2,000 foot elevation contour which extends through the center of the study area (Figure 3). Interestingly, this contour corresponds roughly to the eastern limits of Tertiary geological formations in Oklahoma (Figure 4), the 20-24 inch isohyets and the eastern limits of the shortgrass prairies Along the boundary between the two provinces, there is a pronounced escarpment strongly dissected by the creeks and rivers flowing eastward. This escarpment which may be 200-500 feet high extends south into Texas and north into Kansas. It has been called the "break of the plains" by Fenneman (1931) who recognized it as a boundary of a subdivision of the Great Plains Province which he called the Plains Border Section.

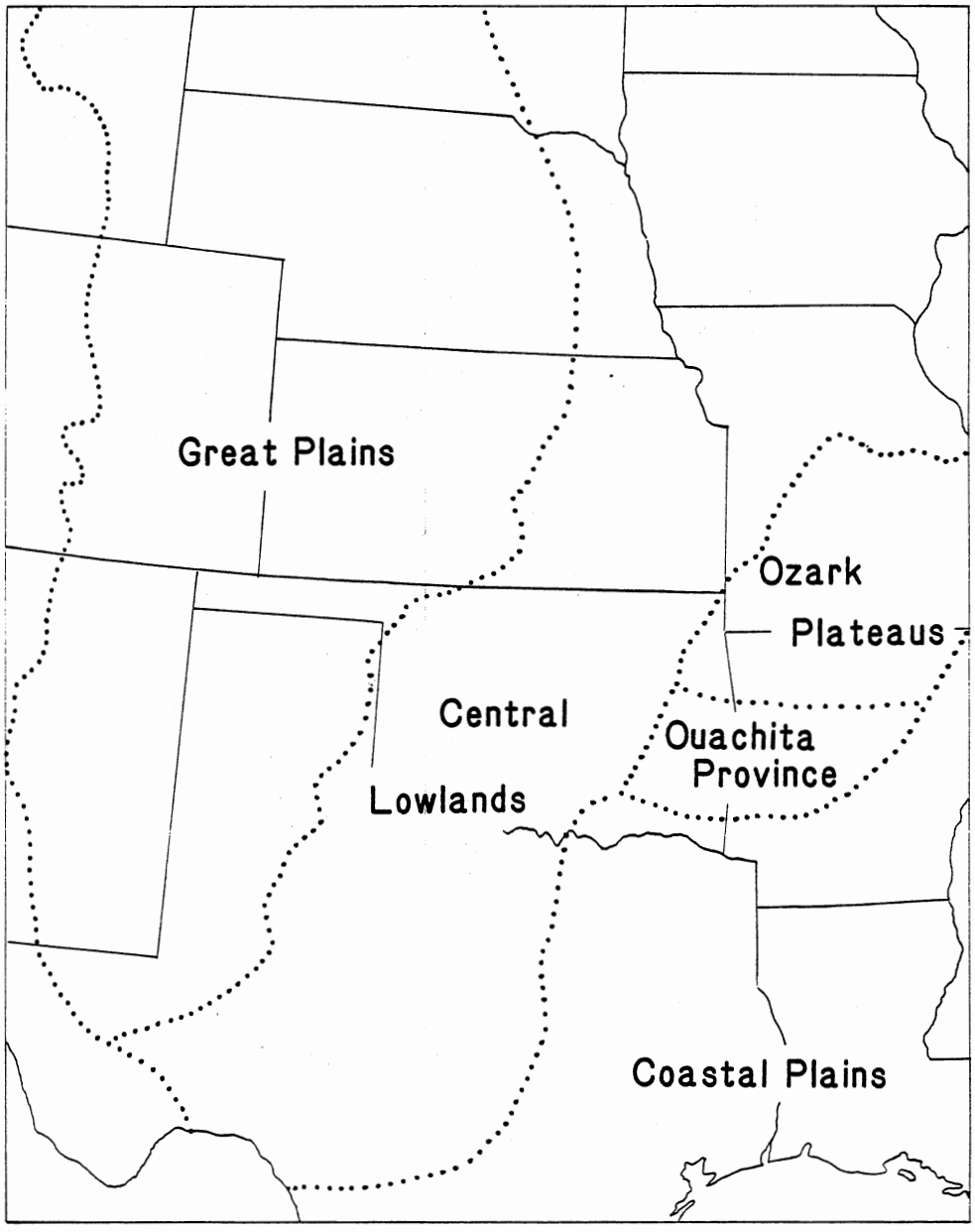

Figure 2. Physiographic Provinces of the Central United States. Figure adapted from those of Fenneman (1931) and Hunt (1967).

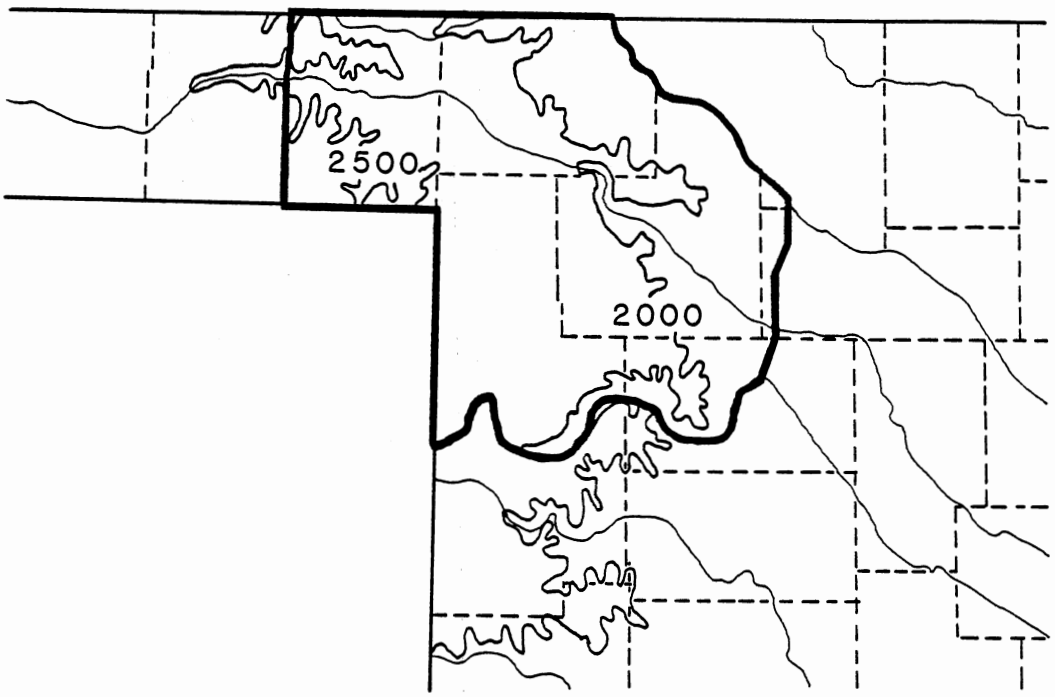

Figure 3. Principal Elevation Contours Within Study Area. Values in feet. Figure adapted from that of Johnson (1979).

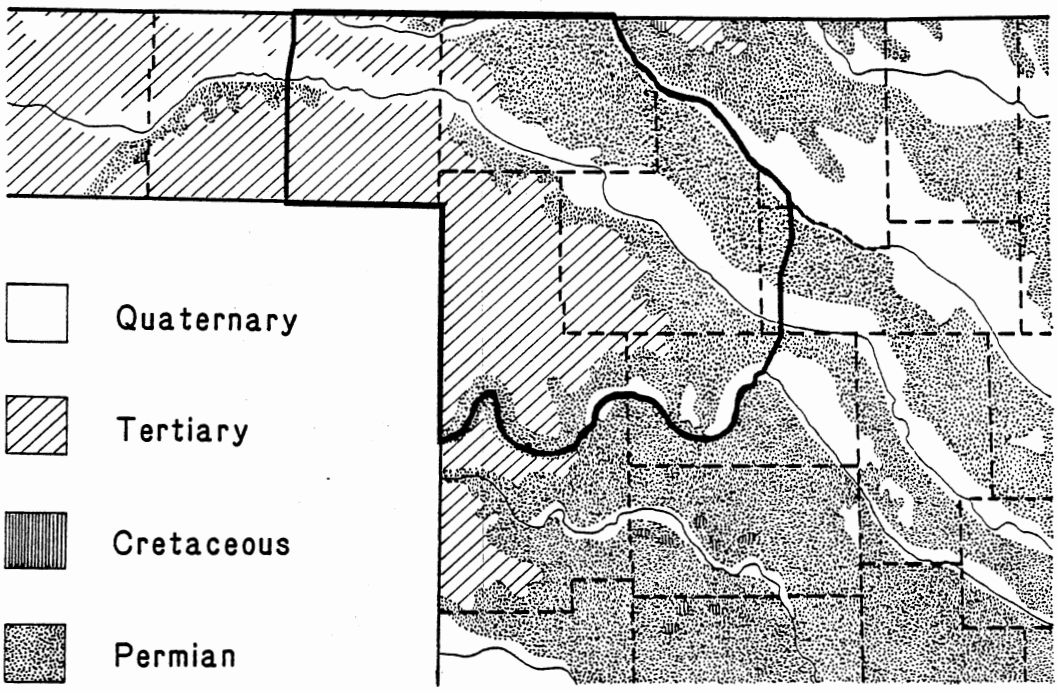

Figure 4. Principal Geological Formations Within Study Area. Figure adapted from that of Branson and Johnson (1979).

Geomorphic Provinces

Five geomorphic provinces -- large regions of similar landforms resulting from erosion and/or deposition -- are present (Myers, 1969; Curtis and Ham, 1972). They are the High Plains, Western Sandstone Hills, Western Sand Dune Belts, Cimarron Gypsum Hills, and Central Redbed Plains (Figure 5). Curtis and Ham describe each in the following manner:

> The High Plains is a region of featureless flat uplands on Tertiary and Pleistocene alluvial sands that is deeply dissected along rivers and major streams.
>
> The Western Sandstone Hills are gently rolling hills of soft, flat-lying red Permian sandstones cut by steep-walled canyons.
>
> The Western Sand Dune Belts are hummocky fields of grass covered sand dunes primarily on the north sides of rivers and streams and composed of Quaternary alluvium.
>
> The Cimarron Gypsum Hills consist of escarpments and badlands that have developed on Permian deposits of interbedded gypsum and shale.
>
> The Central Redbed Plains are gently rolling hills and broad, flat plains formed from red Permian shales and sandstones.

As is apparent from these descriptions, there is considerable diversity in both topography and geological formations exposed within the study area. This diversity is illustrated further by brief descriptions and comparisons of several parts of the study area. For example, the eastern portion of Beaver County within the study area (Figure 1) is a region of relatively little

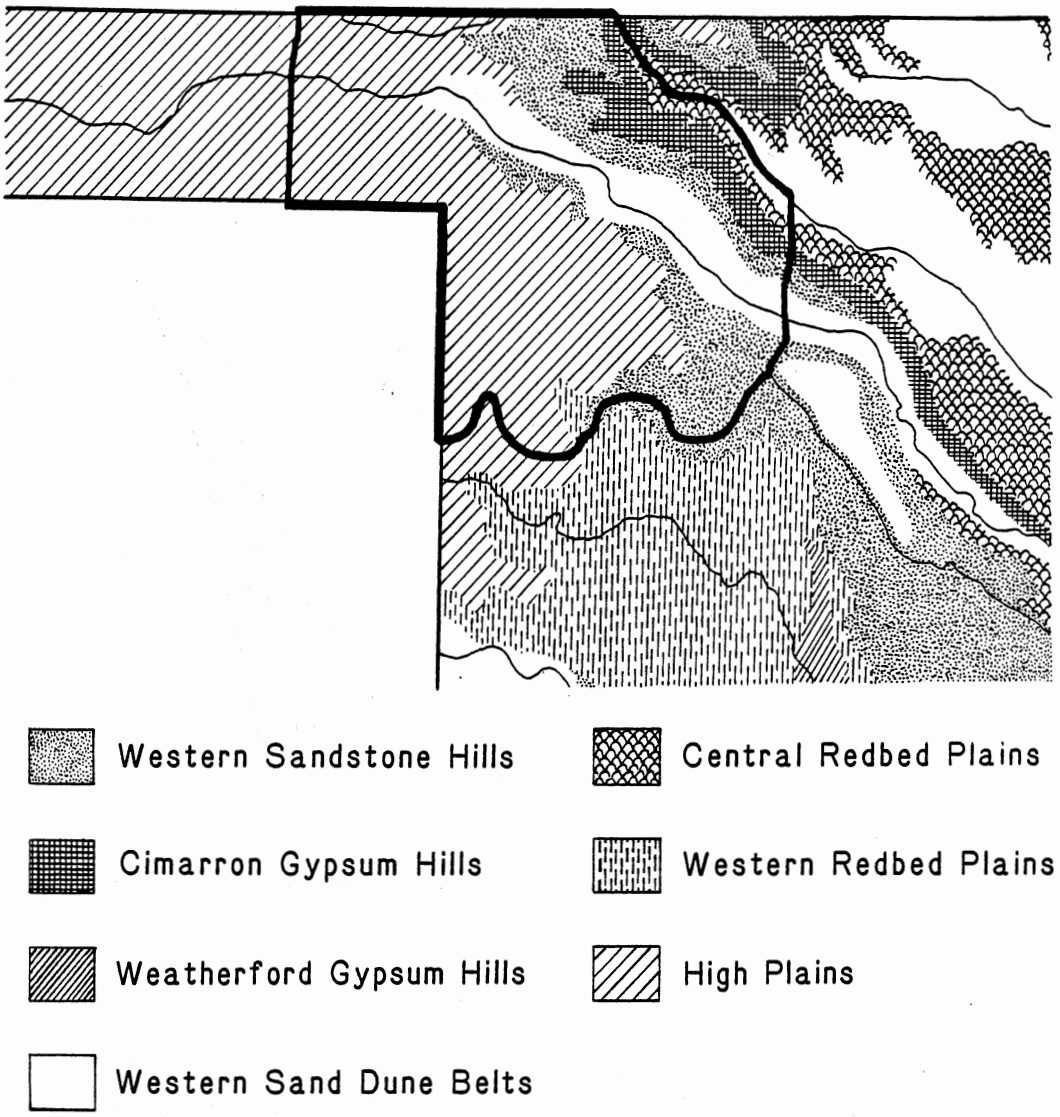

Figure 5. Geomorphic Provinces Within Study Area. Figure adapted from that of Curtis and Ham (1979).

relief which slopes gently to the east -- about 12.5 feet per mile. According to Gould and Lonsdale (1926), early in its geological history, it was part of a vast sloping plain with a comparatively smooth and even surface without drainage channels. The unevenness seen today is the result of the erosive action of water and the cutting of stream valleys, the major ones being those of the Cimarron and North Canadian (locally called the Beaver) rivers. The relief between the river bottoms and the uplands is approximately 200 feet. In contrast, the topography of Ellis County is quite varied (Kitts, 1965). Along the major streams and rivers, resistant sandstone layers form distinct escarpments. In some places, the escarpments have been dissected into a series of small buttes and steep-walled canyons. Away from the drainages, gently sloping hills of moderate relief are present.

Drainage

The study area is drained by three rivers and their tributaries (Figure 1). The Cimarron River enters the area at its northwestern corner in Beaver County and flows toward the southeast. The North Canadian River traverses the study area more or less parallel to the Cimarron. The two rivers are separated by the geomorphic provinces of the Cimarron Gypsum Hills and Western Sandstone Hills (Figure 5). The Cimarron, however, has cut its bed approximately 400 feet lower than the North Canadian and

its tributaries have conspicuously dissected the gypsum hills (Myers, 1959). Most of these tributaries have narrow, steep-sided valleys. Escarpments over 100 feet high occur along the Cimarron. The North Canadian River and its tributaries drain a plain that encompasses the Western Sandstone Hills geomorphic province and a portion of the High Plains province. This plain varies from relatively flat to rolling hills with slight relief and gently slopes towards the river (Myers, 1959). Forming the southern border of the study area, the Canadian River flows in a meandering course of large curves from west to east. It cuts rather deeply through the plains and gently rolling hills of the High Plains and Western Sandstone Hills provinces (Myers, 1959).

Geology

According to Gould and Lonsdale (1926), Johnson (1971), and Curtis and Ham (1972), the geological formations present in northwestern Oklahoma are few in number and simple in arrangement. The surface rocks of the study area belong to four geologic ages, Permian, Cretaceous, Tertiary, and Quaternary (Figure 4). Each is described briefly in the following paragraphs.

Permian. The greater part of western Oklahoma, along with the panhandle of Texas and western Kansas, is covered by a series of red clay shales and sandstones commonly known as the Permian Redbeds (Gould and Lonsdale, 1926).

They were deposited approximately 270 million years ago. These redbeds are both exposed at the surface and covered by a blanket of Tertiary strata. The Permian formations represented in the study area are called the Enid, Blaine, Dog Creek, Whitehorse, Dog Creek, and Cloud Chief formations. Clifton's (1930) descriptions of these formations are summarized in the following paragraphs.

> The Enid Formation appears at the surface in a small area along the Cimarron River and in the valley of Buffalo Creek in Harper County. This formation consists of brick-red clays and shales with some interbedded ledges of white and red sandstones.
>
> The Blaine Formation occupies a narrow and irregular belt immediately west of the Enid Formation. Its area of exposures consists of approximately 120-125 square miles. It is composed of two massive beds of gypsum with intervening shales and beds of dolomite and anhydrite.
>
> The Dog Creek Formation is represented by a narrow band of shale or red clay and shale exposures west of the Blaine outcrops across the northeastern portion of the study area. The formation is exposed in the northern and eastern parts of Harper County and is represented in Woodward County by a narrow band of exposures that cap the youngest of the Whitehorse Formation exposures. In Ellis County, the Dog Creek formation occurs in northeast and east, primarily as small outcrops that appear when erosion has removed the mantle of younger Tertiary and Quaternary beds. In this area, the formation consists of two beds of dolomite separated by a thin shale bed.
>
> Consisting of red shales, some clays and sandstones, the Whitehorse Formation appears at the surface in several areas. It is present in the northeast quarter and western half of Harper County (Myers, 1959) and in the eastern and central portions of Beaver County (Six, 1930). It outcrops immediately southwest of the Dog Creek exposures across the northeastern

> portion of the county and in other areas along the North Canadian River starting 10 miles east of Woodward and extending upstream into Harper County. It is also found in northeastern Ellis County.
>
> The Cloud Chief Formation, comprising gypsum, red clays, sandstones, and shale, outcrops in the southwest part of Harper County, in the southeast part of Woodward County, and the southern and northern parts of Ellis County. Its principal exposures are along the North Canadian River and its southern tributaries. In Beaver County, it is the only Permian formation exposed at the surface and is found along the Cimarron River (Gould and Lonsdale, 1926).

Cretaceous. Strata of the lower Cretaceous (Comanchean) period appear at the surface in areas of small extent in Harper County and as limited exposures in Woodward and Dewey counties. A cross-section of a Cretaceous deposit from north of Fort Supply in Woodward County comprised clay, shale, clay, sandstone, and clay from the top to the bottom. Another deposit east of Cestos in Dewey County consisted of shell bed, yellowish limestone, light blue to gray limestone, and clay (Bullard, 1928). There are no cretaceous deposits in Ellis County and it is questionable whether beds of Cretaceous "shell rock" are present in Beaver County (Gould and Lonsdale, 1926).

Tertiary: Strata of the Tertiary period occupy an area of about 100 square miles in the southwestern part of Woodward County and are exposed in central and western Ellis County. The most widespread surface exposure within the study area is in Beaver County and consists of a

blanket of rocks, sands, and clays uncomformably covering the underlying Permian Redbeds (Gould & Lonsdale, 1926). In the extreme southwest part of Harper County, there is an area of about five square miles where Tertiary strata appear at the surface. The rocks are for the most part shale, sand, and gravel, although the beds possibly contain deposits of calcareous clays in places (cf. comments above). There are two formations of Tertiary deposits in the study area --Laverne and Ogallala.

Beds of the Laverne Formation are exposed in Ellis, Harper, and Beaver counties. The formation consists of sand, gravel, caliche, limestone, silt, and clay. In Ellis County the Laverne Formation is overlain by sediments typical of the Ogallala Formation. The Ogallala Formation occupies the southwest corner of Woodward County, the northwest corner of Dewey County and most of Ellis County. The formation is continuous with beds which cover the northeastern part of the Texas Panhandle. Ogallala sediments consist of fine to medium grained sands, silt, and clays. Gravels are relatively sparse. This formation, the economically important Ogallala aquifer, is the source of ground water for much of the Great Plains as well as the Panhandle of Oklahoma.

Quaternary. In the flood plains and terraces of the rivers and their large tributaries are Quaternary deposits of alluvial sands, silts, clays and gravels. Along the north and east sides, are wind carried deposits of sand which are seen today as stabilized and moving sand dunes.

CHAPTER IV

SOILS

A variety of soils occur within the study area. They are mainly deep to moderately deep, sandy, loamy, or sand loamy, and gently to strongly sloping. Rarely are they nearly level. They have developed under a cover of native grasses characteristic of the mixed and shortgrass prairies except for the wooded areas (shinnery oak) in the south-central part and along the streams. Soil scientists (Nance et al., 1960, 1963; Allgood, 1962, 1968 ; Steers et al., 1963; Cole et al., 1966) have described 42 soil series in the study area. About half of these are abundant.

The soil series is useful on a local scale for farmers, ranchers, and professional agriculturalists. However, the classificatory unit of the soil association is far more valuable for floristic taxonomists than the soil series. Soil associations are different kinds of soils that occur together, cover large geographic areas, and are recognizable in the field by their topography and the distinctive potential vegetation they support. Thirty-six associations occur within the study area (Nance et al., 1960, 1963; Allgood et al., 1962; Cole et al.,

1966; Steers et al., 1963). They are presented in Table 1. Aspects of the ten most abundant associations are summarized in Table 2.

TABLE 1. Soil Associations Present Within Study Area. Information extracted from Nance et al. (1960, 1963), Allgood (1962, 1968), Steers et al. (1963), and Cole et al. (1966).

Brokenland-Berthoud-Enterprise
Carey-St. Paul-Tipton
Dalhart-Pratt
Gypsum Outcrop
Las Animas-Lincoln Spur-Canadian
Lincoln-Las Animas
Lincoln-Spur
Lincoln-Yahola-Loamy Alluvial Land
Mansik-Richfield
Mansik-Woodward-Carey
Mansker-Dalhart
Mansker-Potter
Nobscot-Brownfield
Nobscot-Pratt
Otero-Mansker
Otero-Pratt
Port
Pratt
Pratt-Quinlan-Enterprise
Pratt-Tivoli
Quinlan-Woodward
Quinlan-Woodward-Rough Brokenland
Richfield-Mansic
Richfield-Mansker-Mansic
Richfield-Puttman
Spur-Pratt
St. Paul-Carey
St. Paul-Carey-Holdreg
St. Paul-Carey-Woodward
St. Paul-Manter-Dalhalt
Tip-Enterprise-Lincoln
Tivoli-Pratt-Likes
Tivoli-Pratt-Oterio
Ulysses-Richfield
Vernon-Badland
Vernon-Cottonwood
Vernon-Tillman-Badland
Weymouth-Vernon
Woodward-Carey
Woodward-Quinlan

Table 2. Aspects of the Ten Most Abundant Soil Associations in Study Area. Information extracted from Nance et al. (1960, 1963), Allgood (1962, 1968), Steers et al. (1963), and Cole et al. (1966).

Association	Soil Texture	Soil Depth	Topography	Vegetation	Land Use
Nobscot-Brownfield	sandy	deep (15-25 inches)	hummocky or dune; smooth to gentle slopes	shinnery oak	90% rangeland, 10% cultivated
Woodward-Quinlan	loamy		sloping to rolling uplands, sometimes dissected by large gullies	buffalograss and side-oats grama	combination of cultivation and rangeland
Pratt	sandy	deep	sand dunes or hummocky	sandage and tallgrasses	50% cultivated 50% rangeland
Pratt-Tivoli	loamy fine sand or fine sand	deep	steep sand dunes	sandsage, sand bluestem and little bluestem	rangeland
Mansker-Richfield	loamy	shallow	moderately sloping uplands dissected by drainageways	buffalograss, little bluestem, and grama grasses	75-80% cultivated 25-20% rangeland
St. Paul-Carey-Woodward	loamy	deep (24 inches or more)	uplands	short and mid-grasses	70% cultivated 30% rangeland
Mansker-Potter	loamy	moderately deep or shallow	sloping uplands, dissected by gully-like drainageways	side-oats grama, little bluestem, and hairy grama	67-95% rangeland 33-5% cultivated

Association	Soil Texture	Soil Depth	Topography	Vegetation	Land Use
St. Paul-Manter-Dalhart	loamy	deep	gently sloping or moderately sloping to nearly level	buffalo grass, little bluestem, and sandsage	50% cultivated 50% rangeland
Tivoli-Pratt-Otero	very sandy	deep, rarely relatively shallow	stabilized sand dunes	bluestem and sandsage	pasture
Likes-Otero	limy, sandy	shallow (4-5 inches)	hummocky and undulating uplands	sand bluestem, grama grasses and sandsage	95% range 5% cultivated
Vernon-Cottonwood	clayey-loamy	shallow	wide range of slopes	tall-mid-and short grasses	rangeland, small areas farmed

CHAPTER V

CLIMATE

The climate of northwest Oklahoma is described as dry to subhumid continental because of its position in the interior of North America, and warm temperate because of its latitudinal position, between 36° and 37° N. The summers typically are long and hot while the winters are moderately cold and dry. The four seasons are distinct. Although there are rapid and considerable changes in both temperature and precipitation, extremes normally do not occur. Specific aspects of the climate of northwest Oklahoma and the study area have been compiled by Nance et al. (1960, 1963), Allgood (1962, 1968), Steers et al. (1963), and Cole et al. (1966). A synopsis of these data follows.

The average temperature is 38°F in the winter, 57.8° in the spring, 80.5° in the summer, and 60.6° in fall. The mean annual temperature is about 59°F (Table 3). Temperatures often rise to between 100°F and 105°F during the daytime in the summer, although the nights are relatively cool due to the low humidity in the area. Extremes of 110° and -18° were recorded in Ellis County in 1911 and 1912, respectively.

The growing season or the length of frost-free season averages 190-192 days. In general, the last killing freeze is about April 7 in Woodward County and April 13 in Harper County. The latest freeze recorded in the area was May 11, 1946 in Ellis County. The average of the earliest killing frost in the fall is October 20 in Harper County and October 30 in Woodward County. Frost, however, has occurred as early as September 26 in Harper County.

Approximately 78 percent of the average annual precipitation falls from April to October. The average annual precipitation in Ellis County is 21.8 inches, 22.2 inches in Harper County and 25.0 inches in Woodward County (Table 4). There is an east-west gradient of precipitation (Figure 6). About one-third of the precipitation occurs in light rains and adds little moisture to the subsoil and about one-fourth of it falls as heavy, dashing rains of one inch or more. Precipitation is triggered by the passage of frontal systems generally from the west and northwest. These fronts usually cause the temperature to drop rapidly in the winter and produce violent rainstorms and hailstorms in the spring and summer.

The average annual snowfall is slightly more than 13 inches. The snow seldom persists on the ground for more than 4-5 days, but occasionally remains for several weeks when accompanied by extremely low temperatures.

The prevailing winds are from the southwest and blow almost every day. There is sufficient wind to operate

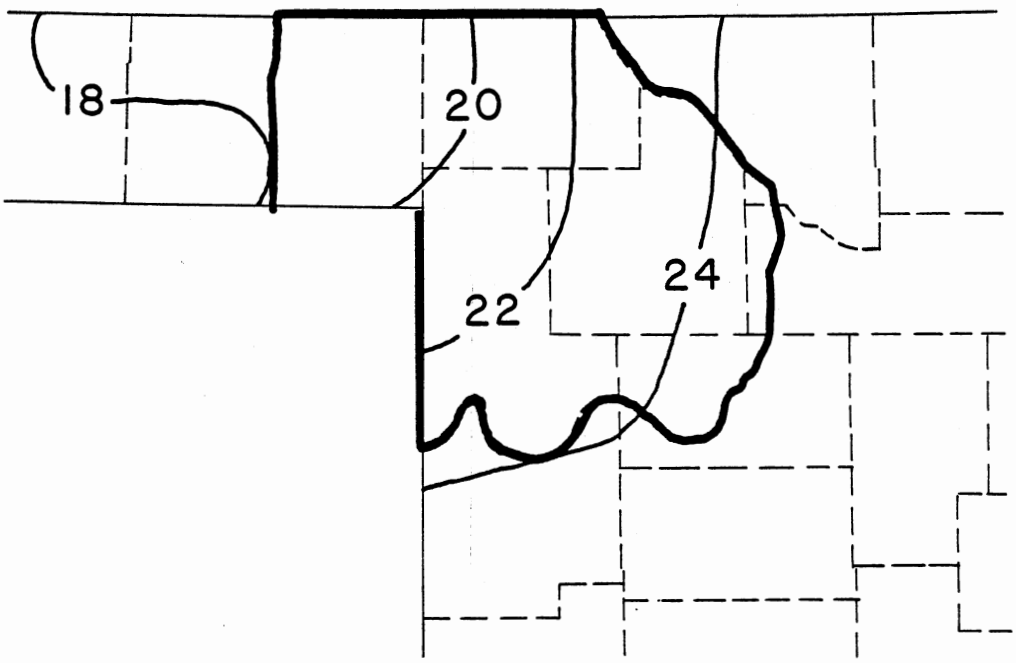

Figure 6. Principal Precipitation Isohyets Within Study Area. Values in inches. Figure adapted that of Pettyjohn, White, and Dunn (1983).

Table 3. Average Monthly Temperatures (F°) for Three Counties Within Study Area.

Information extracted from Cole et al. (1966) and Nance et al. (1960, 1963).

Reporting Station/County Elevation	Month												Annual Average
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	
Arnett, Ellis County[1] Elev. 2,460 ft.	35.8	39.8	46.8	57.4	66.2	75.1	80.6	80.5	72.2	60.8	46.7	38.9	58.4
Buffalo, Harper County[2] Elev. 1,800 ft.	36.0	39.7	48.9	56.3	66.3	76.9	82.8	81.8	73.4	61.4	47.6	36.0	59.0
Woodward, Woodward County[3] Elev. 1,908 ft.	36.1	39.7	48.5	58.9	67.9	77.5	82.4	81.6	73.3	60.6	47.9	37.8	59.4

[1]Average temperature based on 29-year record through 1960.

[2]Average temperature based on 49-year record through 1955.

[3]Average temperature based on 64-year record through 1955.

Table 4. Average Monthly Precipitation (Inches) for Three Counties Within Study Area.

Information extracted from Cole et al. (1966) and Nance et al. (1960, 1963).

Reporting Station/County Elevation	Month												Annual Average
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	
Arnett, Ellis County[1] Elev. 2,460 ft.	0.66	0.96	1.17	2.12	3.68	3.42	2.28	2.38	1.66	2.07	0.74	0.69	21.83
Buffalo, Harper County[2] Elev. 1,800 ft.	0.67	0.91	1.28	1.95	3.12	3.42	2.12	2.49	2.50	1.68	1.16	0.90	22.20
Woodward, Woodward County[3] Elev. 1,908 ft.	0.75	1.05	1.38	2.47	3.53	3.45	2.62	2.60	2.55	2.29	1.44	0.94	25.07

[1]Average precipitation based on 29-year record through 1960.

[2]Average precipitation based on 49-year record through 1955.

[3]Average precipitation based on 64-year record through 1955.

windmills which are common throughout the study area. Winds of varying velocity occur in the spring and at least one damaging wind of more than 40 miles per hour can be expected. Continual, hot dry winds are characteristic of the summer.

As would be expected with such high temperatures and wind movements, evapotranspiration is high (Figure 7) and the precipitation effectiveness index is low. Evapotranspiration is an expression soil moisture deficiencies and is calculated by subtracting streamflow from average annual precipitation (Pettyjohn, White, and Dunn, 1983). The precipitation effectiveness index is an expression of the ratio of precipitation to evaporation and is calculated by dividing the amount of precipitation in a 24 hour period by the amount of open pan evaporation in the same period (Thornthwaite, 1948).

Precipitation in July and August is often rapidly evaporated. At times, the crops are damaged to such an extent by the winds that they do not recover. Crops growing on clay soils are the most susceptible to summer drought and blowing wind.

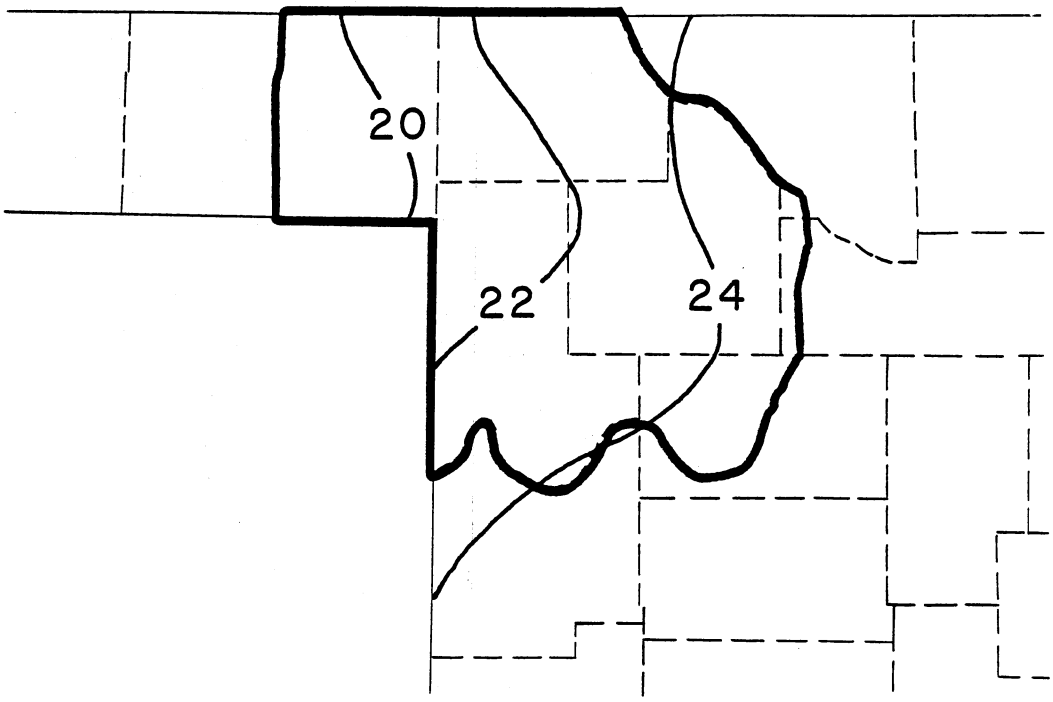

Figure 7. Principal Evapotranspiration Values Within Study Area. Values in inches. Figure adapted from that of Pettyjohn, White, and Dunn (1983).

CHAPTER VI

VEGETATION

The vegetation of the state changes dramatically from east to west (Bruner, 1931; Duck and Fletcher, 1943). In the east with relatively high levels of precipitation, forests are encountered. There is a well-developed oak-hickory forest in the northeast and a rich oak-pine forest in the southeast. As one travels westward, precipitation decreases and the forest becomes less abundant. Openings of grassland appear on sites less favorable for the growth of woody plants. As one proceeds further west, the trees and shrubs continue to decrease in numbers and the grasslands cover more and more area. As the rainfall becomes meager, there is a marked transition from the crosstimbers type of vegetation to continuous grasslands -- tallgrass prairies are encountered first. These tallgrass prairies reach their limits in the western parts of the body of the state where annual precipitation has further decreased. Some of the tallgrass prairies's drought tolerant species intermix with species of the shortgrass prairie forming the mixed-grass prairie. Although trees and shrubs are still present, they are restricted to mesic habitats, e.g., gullies, draws, and

waterways, where they can survive the summer drought. Further west, the members of the tallgrass prairie give way to the species of the shortgrass prairie; trees and shrubs become very sparse.

The vegetation of northwestern Oklahoma has been studied by a number of individuals. Depending upon the ecologist and his classification scheme, there are two, five, or eight vegetation types present in the study area. Blair and Hubbell (1938) recognized two biotic districts which they called the shortgrass plains and the mixed-grass plains. According to Kuchler (1964) there are five potential vegetation types in the study area (Figure 8). They are the Grama-Buffalograss Prairie, the Bluestem-Grama Prairie, the Sandsage Bluestem Prairie, the Crosstimbers, and Shinnery. Duck and Fletcher (1943) map eight vegetation types -- Tallgrass Prairie, Mixedgrass Eroded Plains, Shortgrass-High Plains, Postoak-Blackjack Forest, Sand-Sage Grassland, Shinnery Oak-Grassland, Stabilized Dune, and Bottomland or Flood Plain (Figure 9). Their map perhaps reflects the changes in potential since the advent of European man in Oklahoma. In the following paragraphs, these eight vegetation types will be described as they occur in the study area. Nomenclature of the taxa representative of each vegetation type generally follows that of Waterfall (1969), however, names due to currently accepted changes in taxonomic concepts and resolution of nomenclatural problems are substituted in some instances.

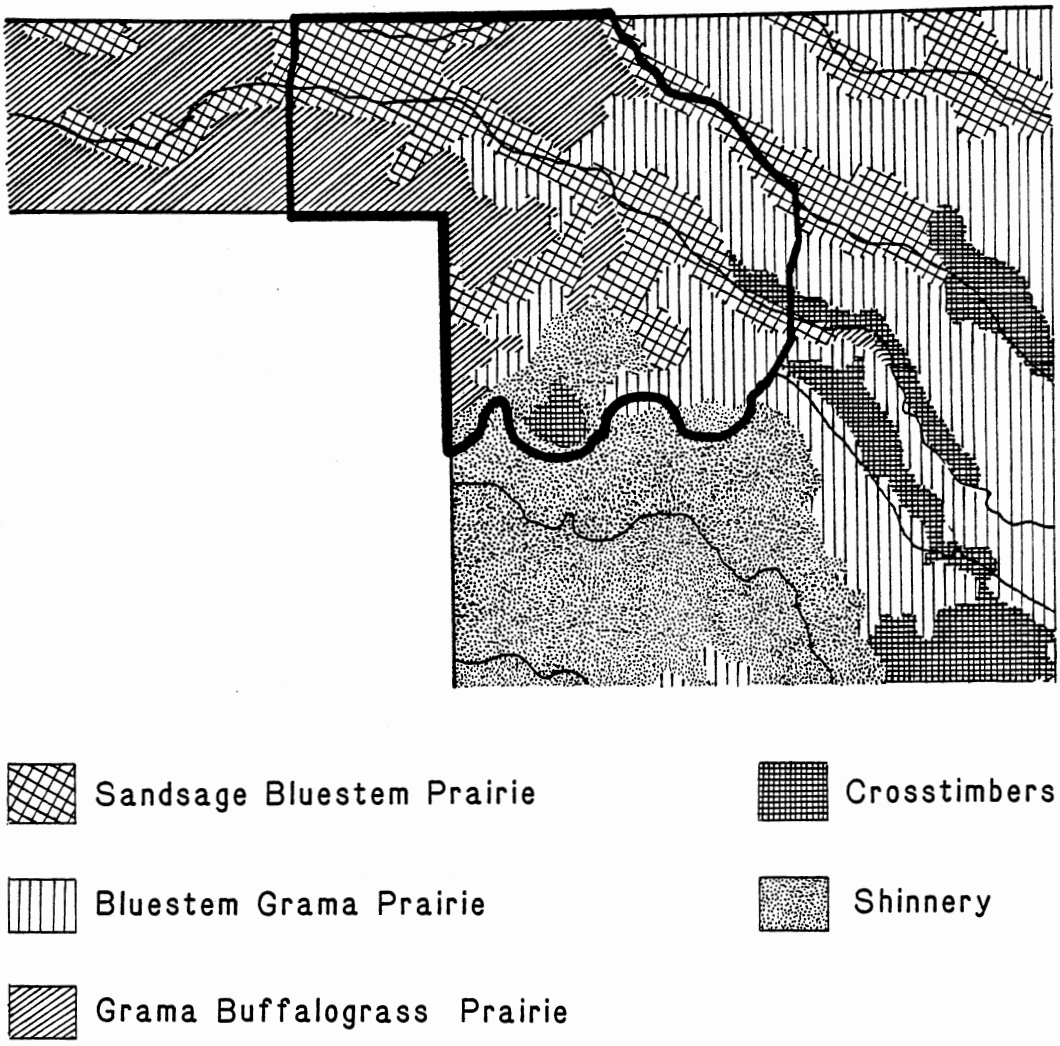

Figure 8. Potential Vegetation Types Within Study Area Mapped by Kuchler (1964).

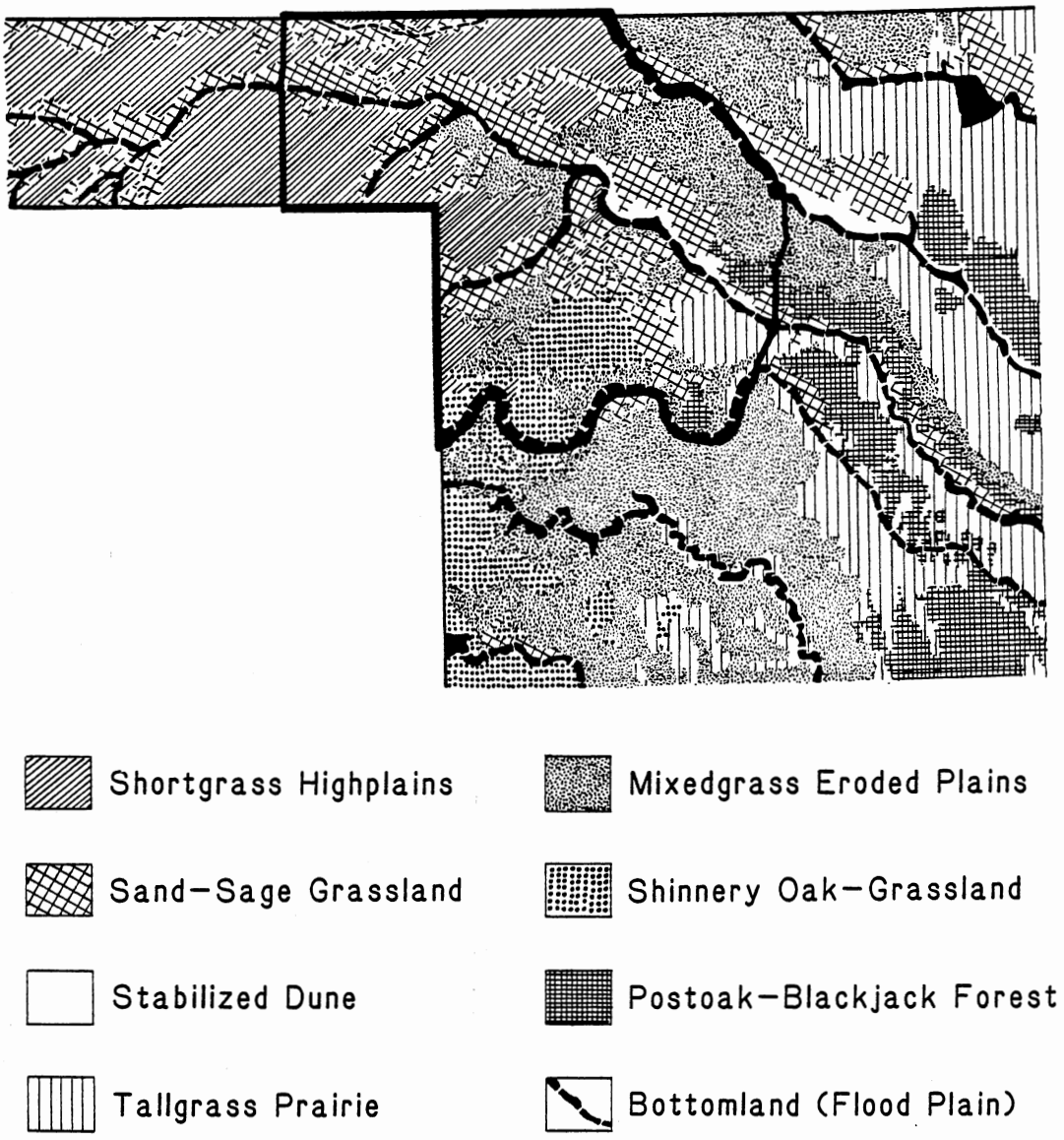

Figure 9. Vegetation Types Within Study Area Mapped by Duck and Fletcher (1943).

Tallgrass Prairie

The tallgrass prairie occurs in the north central part of Dewey County and the southwestern corner of Woodward County, and forms a continuous area of about 250 square miles (Figure 10). It occupies the most fertile soils suitable for cultivation, nearly level loamy soils or soils with a high percent of loam. More than 75 percent of the land covered by this vegetation type has been converted to cropland. The species commonly encountered included: Andropogon gerardii (big bluestem), Andropogon scoparius or Schizachyrium scoparium (little bluestem), Sorghastrum nutans (indiangrass), and Panicum virgatum (switchgrass). Forbs common in the tallgrass prairie are Aster ericoides (heather aster), Liatris punctata, (dotted gayfeather) and Solidago missouriensis (Missouri goldenrod). Shrubs such as Rhus glabra (smooth sumac) and Prunus angustifolia (sand plum) are also well represented.

Mixedgrass Eroded Plains

The mixedgrass eroded plains type of vegetation occurs primarily through the center of the study area (Figure 9). It is found on moderate slopes with loamy or shale-clay soils. This vegetation type is dominated by a mixture of tallgrass and shortgrass species including: Schizachyrium scoparium, Panicum virgatum, Sorghastrum nutans, Bouteloua gracilis (blue grama), and

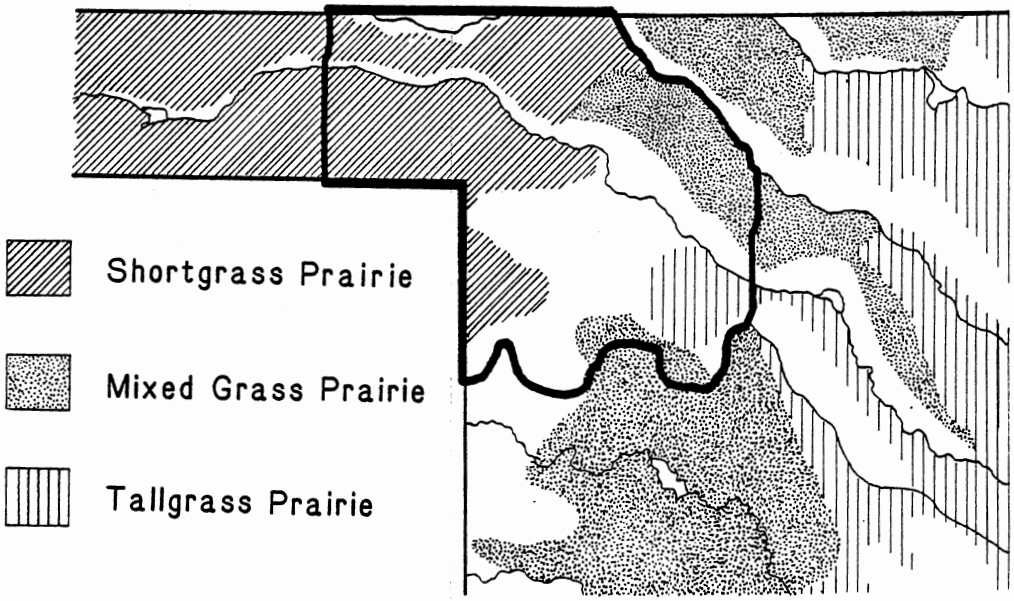

Figure 10. Grasslands Within Study Area Mapped by McPherson (Unpublished).

B. curtipendula (side-oats grama). Forbs also present are Aster ericoides, Liatris punctata, Solidago missouriensis, Artemisia ludoviciana (white sage), Mentzelia stricta (blazing star), Oenothera serrulata (plains yellow primrose), Psilostrophe villosa (paper flower), and Chrysopsis villosa (golden aster).

The area occupied by the mixedgrass eroded plains vegetation is dissected by deep ravines which create protected habitats for trees, shrubs, and aquatic plants in pools which are often present in the bottom. Woody plants such as Quercus macrocarpa (bur oak), Juniperus virginiana (eastern red cedar), Ulmus americana (American elm), Cornus drummondii (roughleaf dogwood), Salix nigra (black willow), Populus deltoides (cottonwood), Rhus glabra (smooth sumac), Vitis vulpina (winter grape), and Celtis occidentalis (hackberry) are common species at the bottoms and along the sides of these ravines. Aquatic plants are represented by Ranunculus sceleratus (cursed crowfoot), Lobelia cardinalis (cardinal flower), Juncus torreyii (Torrey's rush), Pluchea purpurascens (stinkweed), Samolus parviflorus (water pimpernel), Cyperus odoratus (umbrella sedge), Aster subulatus var. ligulatus (saltmarsh aster), Echinochloa crusgalli (barnyard grass), Polygonum persicaria (lady's thumb), and Bidens frondosa (beggar-ticks). At the edge of deep draws, Schizachyrium scoparium and Sorghastrum nutans are

common. Tridens flavus (purpletop) is very common along road embankments crossing some of the draws.

In the northeast corner of Woodward County, there are numerous scattered trees of Prosopis glandulosa (mesquite). Opuntia macrorhiza (plains pricklypear) also is common in this area. Bouteloua gracilis and B. curtipendula are likewise abundant. Thus this area although described by Duck and Fletcher as covered by Mixedgrass Eroded Plains vegetation is perhaps better classified as Mesquite Grasslands.

Shortgrass High Plains

The Shortgrass High Plains vegetation type of Duck and Fletcher occurs in the extreme northwestern corner of the body of the state and in the Panhandle. It covers dark colored loams and clay loams. Shortgrass species typify this vegetation type --grasses such as Buchloe dactyloides (buffalograss), Bouteloua gracilis, B. curtipendula, and Aristida purpurea (purple threeawn). Perennials such as Yucca glauca (plains yucca), Opuntia macrorhiza, and Gutierrezia sarothrae (matchweed) are also common. Sporobolus airoides (alkali sacaton) occupies a large area in Harper County. In the same area, Distichlis spicata var. stricta (inland saltgrass) is common along the roadsides. Dalea enneandra (prairie clover) dominates in the summer months. Bothriochloa saccharoides (silver bluestem) covers some fields and roadsides; its white

inflorescences sometimes make the ground appear as if it was covered with snow when viewed from a distance.

Post Oak-Blackjack Forest

The Post Oak-Blackjack Forest is found in Woodward County in an area of about 35 square miles. It extends from south of Curtis through Cedardale and into Major County. It is also found around Webb in Dewey County where it covers about 178 square miles. This vegetation type forms on deep sandy soils mainly of the Nobscot-Pratt Association. The trees typically are found on the Nobscot soils, while the tallgrasses are present on Pratt soils.

The forest is characterized by Quercus stellata (post oak) Q. marilandica (blackjack oak), Q. muehlenbergii (chinquapin oak), Bumelia lanuginosa (chittamwood), Maclura pomifera (Osage orange), Sapindus drummondii (soapberry), Celtis reticulata, Juniperus virginiana, and Juglans microcarpa (river walnut) as overstory species. Cercis canadensis (redbud), Cornus drummondii, Symphoricarpos orbiculatus (buckbrush), Smilax bona-nox (greenbrier), Vitis acerifolia (wild grape), V. vulpina, and Parthenocissus quinquefolia (Virginia creeper) form the understory species. The stands of tallgrass prairie among the forest stands are dominated by typical prairie species.

Sand-Sage Grassland

Sand-Sage Grassland vegetation is distributed throughout the study area along the north and east sides of the major streams. It covers the sand dunes with their deep sandy soils of the Pratt and Pratt-Tivoli associations. As its name implies, the Sand-Sage Grassland type is dominated by Artemisia filifolia (sandsage), Andropogon hallii (sand bluestem), Calamovifla gigantea (giant sandreed), Sporobolus cryptandrus (sand dropseed), and Eragrostis trichodes (sand lovegrass). Rhus aromatica (lemon sumac), Prunus angustifolia (sand plum), Yucca glauca and Celtis reticulata are characteristically present. Senecio riddellii (sand groundsel) and Gaura villosa (hairy gaura) are common herbaceous perennials. During the summer months, Heterotheca latifolia (camphorweed) is conspicuous because of its yellow ray and disk floret. Other annuals are also abundant.

In some areas, as for example in south-central Harper County, the sandsage has been cleared and replaced by pasture monoculture seedings of grasses such as Eragrostis curvula (weeping lovegrass) and E. trichodes or crops such as wheat. Some planted grasses are species of Bothriochloa commonly known as the Old World bluestems; undoubtedly more will be planted in the future.

Shinnery Grassland

The Shinnery Grassland occurs in the southwestern parts of the study area, primarily on soils of the Nobscot-Brownfield Association. This vegetation type is typified by the clone-forming Quercus havardii (shinnery oak), Rhus aromatica, and Prunus angustifolia. Intermixed with these woody species are Schizachyrium scoparium, Erigonum annuum (annual buckwheat), Bouteloua hirsuta (hairy grama),and Eragrostis trichodes. In Dewey County, large thickets of Robinia pseudo-acacia (black locust) are invading the shinnery grasslands.

Stabilized Dune

Duck and Fletcher's Stabilized Dune vegetation type is found on the sand dunes on the north sides of the North Canadian and Cimarron rivers. The soils are those of the Pratt-Tivoli and Pratt associations. Stands of Sapindus drummondii are common in this type of vegetation. Other common woody species are Ulmus pumila (Siberian elm), Celtis reticulata, Bumelia lanuginosa, Quercus stellata and Q. marilandica. Associated with these taxa are low shrubs and vines such as Prunus angustifolia, Cornus drummondii, Rhus aromatica, Vitis vulpina, and V. acerifolia. The deeper sandy soils are covered by Andropogon hallii and Eragrostis trichodes. Artemisia

filifolia, Croton texensis, (Texas croton), Aphanostephus skirrhobasis (lazy daisy) and Dithyrea wislizenii (spectacle pod).

Bottomland (Floodplain)

As the names imply, bottomland or floodplain vegetation is found along watercourses. In the study area, many of the bottomlands lack well developed stands of trees that are found elsewhere in the state. In contrast, scattered stands of Populus deltoides, Salix nigra, S. interior (sandbar willow), Acer negundo (boxelder), and Tamarix gallica (saltcedar) occur. Common herbaceous species are Sorghum halepense (johnsongrass), Cynodon dactylon (bermudagrass), and Xanthium strumarium (cocklebur). Extensive portions of the bottomlands within the study area are used for pasture, production of alfalfa hay, or cultivation of wheat.

A particularly interesting bottomland was encountered in Ellis County 0.2 mile south of Commission Creek bridge on OK Hwy 46 (R26W, T18N, Sec. 13). Trees and vines form a dense cover. Morus rubra (red mulberry), Rosa setigera (climbing rose) Ampelopsis cordata (raccoon grape), Geum canadense (white avens), and Parietaria pennsylvania (Pennsylvania pellitory) are common. This particular combination of species was not observed elsewhere in the study area.

Plants of Various Habitats

In addition to the natural vegetation types described above, a number of other habitats -- aquatic, wetland, old fields, borrow ditches, and disturbed areas -- occur in the study area and are occupied by a number of taxa. For example, the edges of farm ponds, flood control reservoirs, and intermittent streams provide habitats for aquatics such as Juncus torreyii, Cephalanthus occidentalis (buttonbush), Typha angustifolia (narrowleaf cattail), T. latifolia (broadleaf cattail), Amorpha fruticosa (false indigo), Salix interior, Lycopus americanus (American bugleweed), Scirpus americanus (bulrush), Apocynum cannabinum (Indian hemp), and Polygonum bicorne, P. coccinum, P. lapathifolium, P. persicaria, and P. pensylvanicum (the smartweeds). Other species encountered in water saturated soils of streams or wet sites are Nasturtium officinale (water cress), Ranunculus sceleratus, Pluchea purpurascens, Heteranthera limosa (mud plantain), and Ammania auriculata (toothcup).

Floating and immersed vascular plants dominate some ponds; species include: Potamogeton nodosus (longleaf pondweed), P. pusillus (baby pondweed), Lemna minor (duckweed), Spirodela polyrhiza (duckmeat), Najas guadalupensis (water naiad) and Ceratophyllum demersum (coontail).

Disturbance due to man's activities is clearly indicated by localized abundance of various taxa. In the early spring, Lamium amplexicaule (henbit), Descurainia pinnata (tansy mustard), Lesquerella gordonii (bladderpod), Sisymbrium altissimum (tumbling mustard), and Viola rafinesquii (Johnny jumpup) appear. Overgrazed pastures or old fields are dominated by Ambrosia psilostachya (western ragweed), Gutierrezia dracunculoides (annual broomweed), Vernonia baldwinii (ironweed), and Cirsium undulatum (thistle). Grasses such as Bothriochloa saccharoides, Aristida oligantha (annual threeawn), Tridens flavus, and Eragrostis spectabilis (purple lovegrass) also are common in these fields.

Highly disturbed sites such as rights-of-way, borrow ditches (= bar ditch), and fence rows provide habitats for numerous weedy species including Kochia scoparia (summer cypress), Salsola kali (Russian thistle), Amaranthus hybridus (pigweed), A. palmeri (pigweed), Rumex crispus (curlydock), Solanum elaeagnifolium (silverleaf nightshade), Convolvulus arvensis (bindweed), Haplopappus ciliatus (wax goldenweed), Helianthus annuus (annual sunflower), and Cenchrus pauciflorus (sandbur).

Hedge rows and windbreaks consist mainly of Maclura pomifera, Chilopsis linearis (desert willow), Catalpa speciosa (northern catalpa), Amorpha fruticosa, and Ulmus pumila.

Man's Use of Land

The study area encompasses about 4,769 square miles and has a population of some 46,800 individuals (Oklahoma Employment Security Commission, 1986). The largest city is Woodward, the county seat of Woodward County which has a population of 21,172 individuals. Ellis County has 5,900 persons; the town of Shattuck is its county seat. Harper County has 4,700 residents and Buffalo is the seat. Seiling is the seat of Dewey County which has 6,400 individuals. Beaver County has 7,500 and its county seat is the town of Beaver.

Sorghum and wheat are the principal crops grown in Woodward, Beaver, and Harper counties. Cattle production is also important. In Ellis County, the economy is based on wheat, sorghum, beef, and dairy products. In contrast, wheat and cotton are the main cash crops in Dewey County. Much of the county's acreage is used for range; alfalfa and sorghum are grown mostly as feed for livestock.

In Beaver and Harper counties, there are giant gas fields, while Dewey and Woodward have gas processing plants. An oil refinery is located in Ellis County.

CHAPTER VII

BOTANICAL EXPLORATION IN WESTERN OKLAHOMA

The first Europeans to visit the area of modern day Oklahoma were Vasques de Coronado and his men in 1450 (Dale and Rader, 1930). Leading a large expedition in search of the seven great cities, Coronado is believed (Henson, 1941) to have traversed the western part of Oklahoma because in his report to the King of Spain he wrote, "...there is not any kind of wood in all these plains, away from the gullies and rivers, which are very few". Although de Coronado did mention plants when describing the general appearance of the country through which he passed, he did not make a formal list of plants seen. Unfortunately, he was not accompanied by a botanist. The next Spanish expedition to enter Oklahoma was led by Juan de Orate, the Governor of New Mexico, in 1601. His maps show that he traveled in the state (Henson, 1941).

About one hundred years after the Spanish expeditions, the French began exploration of the Mississippi River valley and its tributaries (Dale and Rader, 1930). In 1718, Bernard de la Harpe began a series of expeditions to take possession of land on the upper

waters of the Red River. In the course of his explorations, he visited what is today eastern Oklahoma. His account of his journeys gives an excellent description of the region and the people inhabiting it.

The first official American expedition was that of Lieutenant Albert Pike in 1806 who was charged with exploration of the southern part of the Louisiana Purchase. He was accompanied by Lt. James B. Wilkinson who explored the Arkansas River in 1807. In spite of his ill health, Wilkinson was careful to keep notes of his trip and his report is the earliest description by an American explorer of the Arkansas River valley in Oklahoma (Dale and Rader, 1930). Most of his accounts, however, were concerned primarily with geographical and topographical features rather than botany and it is probable that he did not botanize the area (Henson, 1941).

The intrepid collector Thomas Nuttall was probably the first botanist to botanize in Oklahoma (McKelvey, 1955; Bruner, 1967).. He entered the state in the spring of 1819 by way of the Arkansas River in the company of a small military expedition. His journey took him across the Poteau River, through the Ouachita Mountains, and south to the Red River more or less along the course of the Kiamichi River. He returned to Fort Smith and then up the Arkansas River to the mouth of the Neosho (=Grand) River. He also explored a portion of the Verdigris River.

Later, he extended his explorations westward through the crosstimbers region of the state to the mouth of the Cimarron River.

Nuttall always described the country he was passing through, carefully describing the nature of the vegetation whether woodland, prairie, or aquatic habitat. His enthusiasm led him to linger behind the main party and to be separated for several days or weeks at a time as he studied and collected new plants (Dale and Rader, 1930; Henson, 1941). He discovered many new species of plants and his discoveries extended the known range of many eastern species (Featherly, 1943). In 1834, he published a list of 550 species from Arkansas and Oklahoma. Nuttall's travels were confined to the eastern half of the state and, unfortunately, he did not reach northwestern Oklahoma.

In 1820, Major Stephen H. Long's expedition to the Rocky Mountains passed through the state along the Canadian River, the southern boundary of the study area. He was accompanied by Dr. James Edwin, a botanist who described the vegetation of the regions the expedition passed through as well as many individual plants. In describing a plant he often provided in addition to the scientific name, the common name, the meaning of the name, justification of the name, the uses of the plant (Henson, 1941). Another botanist, John R. Bell, also accompanied Long. His journal was published in 1857.

In the eastern portion of the state, further observations of the vegetation were recorded by Washington Irving, Henry Ellsworth, and Charles Latrobe. The three men traveled together and each published his account of what was seen. Irving described his explorations in the now famous A Tour of the Prairies first published in 1835 (McDermott, 1956). Ellsworth also published his accounts (Williams, 1937) as did Latrobe (Featherly, 1943). Each gave details not found in the others work. Because none of them were botanists, their accounts were typically more of events than descriptions of the flora.

Between 1831 and 1840, Josiah Gregg, a Santa Fe trader made eight expeditions across the western prairies (Gregg, 1844). On two trips, he traversed the central part of Oklahoma following the Canadian River. He more frequently passed through the northwestern part of the state. His descriptions of the country were of a general nature, but he did describe clearly outstanding vegetational features.

Army officers Sitgreaves and Woodruff (1858) in 1849-1850 surveyed the northern boundary line of the Creek Indian Country. Dr. S.W. Woodhouse was the physician and naturalist for the expedition of 35 men. The party traveled west from the Verdigris River along the 36° parallel to nearly the 99th meridian. The expedition just reached the southeastern corner of the study area, perhaps

the present town of Seiling or its vicinity. The return was via the North Canadian River. General features of the vegetation encountered were mapped. Dr. Woodhouse collected 709 specimens, many of them duplicates, representing 27 families and 58 genera (Sitgreaves and Woodruff, 1858).

The next army expedition was led by Captain R.B. Marcy in 1852 to explore the boundary of the Red River between Oklahoma and Texas. The group entered Oklahoma in the vicinity of Cache Creek, passed through the Wichita Mountains, and followed the North Fork of the Red River. Dr. G.G. Shumard, who was the group's surgeon, collected about two hundred species of plants. Subsquently identified by John Torrey, about half were collected within the present boundaries of the state (Marcy, 1854; Henson, 1941; Featherly, 1943).

Interest in the construction of a railroad between the Mississippi River and California prompted Congress to appropriate money for five surveying parties to determine the best route in 1853 and 1854. Captain Whipple surveyed a route near the 35th parallel. Starting at Fort Smith, he moved westward south of the Canadian River, but north of the Washita River until he left Oklahoma in the Antelope Hills region of present day Roger Mills County. He was accompanied by Dr. J.M. Bigelow, physician and botanist, who carefully described the terrain and flora and collected about 125 species of plants. His plants

also were identified by Torrey. A separate report on the Cactaceae collected was published by George Engelmann and Bigelow. An account of the botany of the expedition was published in 1857 by Bigelow.

In 1858, Lt. Col. J.E. Johnston commanded a party charged with surveying the southern boundary of Kansas and determining the most practical route for a railroad from southeastern Kansas to the Rio Grande (Johnston, 1858). The westward survey was completed in the fall; the party then moved southward into Oklahoma and divided into two groups somewhere between the North Canadian River and the Cimarron River. One contingent traveled south to the bend of the Canadian River near the 99th meridian and then northeast. The other traveled east. Although general observations of the terrain and vegetation were made, neither group did any botanical collecting.

In the next 50 years, a number of individuals, including T.E. Wilcox, B. Shimek, J.C. Neal, E.E. Bogue, A.H. Van Vleet, and C.W. Shannon, made collections in western Oklahoma (Featherly, 1943; Henson, 1941). Although these individuals collected and published lists of Oklahoma plants, the work of G.W. Stevens is generally acknowledged as the first intensive study of the state's flora (Goodman, et al., 1978). A science professor at what is now Northwestern Oklahoma State University at Alva, Stevens collected throughout the state, accumulated thousands of specimens, and compiled a list of over 1600

species. Major collecting trips were made in 1913 and 1914. His list of species was the basis of a doctoral dissertation on the flora of Oklahoma completed in 1916 at Harvard University. The manuscript unfortunately was never published, but is available at the University of Oklahoma and in the library of Hrvard University.

Stevens was frequently in areas where no or few collectors had preceeded him (Goodman et al, 1978). For example, he was probably the first botanist to explore Red Rock Canyon near Hinton and was the first or second person to collect on Black Mesa. However, Goodman's critique of his work (Goodman et al, 1978) seems to suggest that Stevens did not botanize in Ellis County or in the western half of Dewey County, although he did collect in the northeast corner of Woodward County.

C.W. Prier, a botanist at Northeastern State College between 1917-1927, made collecting forays in the Cherokee Hills area immediately south of the study area (Henson, 1941). Grasses were of special interest, and his collection is deposited in the herbarium of Oklahoma State University. It was the most complete collection of the state's grasses until the late 1920's.

The collecting of U.T. Waterfall, Professor of Botany and Curator of the Oklahoma State University Herbarium, represents the second intensive study of the state's flora. His efforts began in the late 1930's and continued until his death in 1971. Seven collecting trips were

conducted in northwestern Oklahoma (Waterfall, 1969).

Other investigations of the flora of northwestern Oklahoma are relatively limited. Rowell (1967) surveyed the vascular plants of the Texas Panhandle adjacent to the study area, while Springer (1978) compiled a checklist of the woody species present in the northwestern corner of the state. Ecological and range management topics have been the focus of studies such as those conducted by Frank (1950), McCullough (1959), Ungar (1966), McIlvain and Armstrong (1966), and Donaldson (1966).

In summary, it is apparent that although numerous botanists have passed through in the study area, there has been no systematic collection of the vascular plants until this investigation.

CHAPTER VIII

LIST OF TAXA OCCURRING IN STUDY AREA

All native or naturalized taxa known by the author to occur in the study area are listed below. Two thousand two hundred and two accessions representing 93 families, 274 genera, and 445 species and 7 infraspecific taxa were collected. Two lists are given below. In the first, genera, species, and infraspecific taxa are listed alphabetically. The second comprises families and their included taxa, also arranged alphabetically. The two lists are based on specimens collected by the author and deposited in the herbarium of Oklahoma State University (OKLA) and on specimens collected by other individuals deposited in the herbarium of Northwestern Oklahoma State University. Nomenclature follows that of Waterfall (1969), Correll and Johnston (1970), Great Plains Flora Association (1986), Fernald (1950), Gleason (1952), Kartesz and Kartesz (1980), U.S.D.A. S.C.S. National List of Scientific Plant Names (1982), and various taxonomic monographs. Because of its widespread use in the state, Waterfall was the primary reference for names. However, changes in taxonomic concepts and nomenclatural discoveries since its publication required use of the other references.

List of Genera, Species, and Infraspecific Taxa

Abbreviations in parantheses following species names indiate counties in which specimens were collected (B =Beaver; D =Dewey; E =Ellis; H =Harper; W =Woodward). Names without county indications are represented by specimens collected by other individuals.

Acalypha ostryaefolia Riddell (D,E)
Acer negundo L. (B)
Allium
A. canadense L. var. fraseri Ownbey
A. nuttallii S. Wats.
Amaranthus
A. albus L. (B)
A. graecizans L. (E,W)
A. hybridus L. (E,M,W)
A. palmeri S. Wats. (E,W)
A. retroflexus L. (B)
Ambrosia
A. psilostachya DC., var. lindheimeriana (Scheele) Blankenship (W)
A. trifida L. (W)
Ammannia
A. auriculata Willd. (E)
A. coccinea Rottb. (W)
Amorpha
A. canescens Pursh, f. canescens (E)
A. fruticosa L. (E,H,W)
Ampelopsis cordata Michx. (E)
Andropogon
A. gerardii Vitman (M,W)
A. hallii Hack. (W)
Aphanostephus skirrhobasis (DC.) Trel. (E,W)
Apocynum
A. cannabinnun L. var. glaberrimum A. DC. (E,W)
A. cannabinnun L. var. hypericifolium Gray (E)
Arenaria stricta Michx. var. texana Robinson (E)
Argemone squarrosa Greene (H,W)
Argythamnia mercurialina (Nutt.) Muell. Arg. (E)
Aristida
A. oligantha Michx. (E,M,W)
A. purpurea Nutt. (B,E,M,W)
Artemisia
A. filifolia Torr. (H,M,W)
A. glauca Pallas (M,W)
A. ludoviciana Nutt. (E,M,W)

Asclepias
A. arenaria Torr. (B,W)
A. asperula (Dcne.) Woodson (E)
A. engelmanniana Woodson (E,M,W)
A. latifolia (Torr.) Raf. (B,E)
A. pumila (Gray) Vail (H,W)
A. speciosa Torr. (E)
A. stenophylla A. Gray (W)
A. tuberosa L. (E)
A. viridiflora Raf. var linearis (Gray) Fern (E)
A. viridiflora Raf. var viridiflora (E)
Aster
A. ericoides L. (W)
A. fendleri Gray (E)
A. patens Ait. (E)
A. subulatus Michx. var. ligulatus Shinners (E,W)
A. tanacetifolius HBK.
Astragalus
A. gracilis Nutt. (E)
A. missouriensis Nutt (E)
Atriplex
A. argentea Nutt. (W,M)
A. patula L. var. hastata (L.) Gray (E,W,S)
Avena sativa L. (E)
Bacopa rotundifolia (Michx.) Wettst. (E)
Baptisia australis (L.) R. Br. var. minor (Lehm.) Fern.(E)
Berlandiera texana DC. var. texana (E,W)
Berula pusilla (Nutt.) Fern (E)
Bidens
B. cernua L. (L)
B. comosa (Gray) Wiegand (W)
B. frondosa L. (W)
Bifora americana (DC.) Watson (E)
Bothriochloa
B. caucasica (Trin.) C.E. Hubb. (E)
B. saccharoides (Sw.) Rydb. (B,E,H,W)
Bouteloua
B. curtipendula (Michx.) Torr. (B,D,E,H,W)
B. gracilis (Willd. ex H.B.K.) Lag. ex Steud.
B. hirsuta Lag. var. hirsuta
Bromus
B. japonicus Thunb. (B,E,M)
B. tectorum L. (E)
Buchloe dactyloides (Nutt.) Engelm. (B,W)
Bumelia lanuginosa (Michx.) Pers. (D,W)
Calamovilfa gigantea (Nutt.) Scribn. and Merr. (B,E,W)
Callirhoe
C. involucrata (Nutt. ex Torr.) Gray var. involucrata
C. leiocarpa Martin (E)
C. papaver (Cav.) Gray (E,H,W)
Carex vulpinoidea Michx. (E)

Cassia fasciculata Michx. (M,W)
Castilleja indivisa Engelm. (E)
Catalpa speciosa Warder (B,D)
Ceanothus herbaceus Raf. (E)
Celastrus scandens L.
Celtis
    C. laevigata Willd.
    C. occidentalis Pursh (W)
    C. reticulata Torr. (P,E,H,W)
    C. tenuifolia Nutt.
Cenchrus pauciflorus Benth. (W)
Centaurea americana Nutt. (D)
Cephalanthus occidentalis L. (E,W)
Cerastium
Ceratophyllum demersum L. (E,H)
Cercis canadensis L. (D,E)
Chara vulgaris (W)
Chamaesaracha conioides (Moric.) Britt. (E,W)
Cheilanthes feei Moore
Chenopodium
    C. album L. (B,E,W)
    C. berlandieri Moq. (W)
    C. pratericola Nutt. ex Moq. (M,W)
    C. gigantospermum Aellen (W)
Chilopsis linearis (Cav.) Sweet. (H,W)
Chloris
    C. verticillata Nutt. (W)
    C. virgata Swartz. (E,W)
Chrysopsis
    C. villosa (Pursh) Nutt. var. canescens Gray (E,H,W)
    C. villosa (Pursh) Nutt. var. stenophylla Gray (B,E,M)
Cirsium undulatum (Nutt.) Spreng. (B,E,W)
Cocculus carolinus (L.) DC. (W)
Comandra pallida A.DC.
Commelina erecta L. var. angustifolia (Mich.) Fern (E,H,M,WS,W)
Convolvulus arvensis L. (B,E,H,W)
Conyza canadensis (L.) Cronq. (B,M,W)
Corispermum nitidum Kit. (W)
Corydalis aurea Willd.
Cornus drummondii Meyer (E,W)
Croton
    C. glandulosus L.
    C. monanthogynus Michx. (M)
    C. texensis (KL) Muell. Arg. (E,M,W)
Cryptantha jamesii (Torr.) Payson (E)
Cucurbita foetidissima H.B.K. (E,H)
Cuscuta cuspidata Engelm. (E,W)
Cyclanthera dissecta (Torr. & Gray) Arn. (D)
Cycloloma atriplicifolium (Spreng.) Coult. (E,W)
Cynodon dactylon (L.) Pers. (E)

Cyperus
- C. acuminatus Torr. & Hook (E,W)
- C. esculentus L. (M)
- C. filiculmis Vahl. (E)
- C. odoratus L. (W)
- C. schweinitzii Torr. (E,W)

Dalea
- D. aurea Nutt. ex Pursh (E)
- D. enneandra Nutt. ex Fraser (B,E,H,M,W)

Datura meteloides DC. (E)
Descurainia pinnata (Walt.) Britt. (W)
Desmanthus illinoensis (Michx.) MacM. (D,E,H,M,W)
Desmodium
- D. glutinosum (Muhl. ex Willd.) Wood
- D. sessilifolium (Torr.) Torr. & Gray (M)

Digitaria sanguinalis (L.) Scop. (W)
Diospyros virginiana L.
Distichlis spicata L. var. stricta (Torr.) Beetle (H)
Dithyrea wislizenii Engelm. var. palmeri Payson (E,H,W)
Draba reptans (Lam.) Fern. (W)
Dyssodia papposa (Vent.) Hitchc. (E)
Echinacea angustifolia DC. (E,W)
Echinocereus reichenbachii (Tersch.) Haage (E)
Echinochloa crusgalli (L.) Beauv. (B,E,W)
Eclipta alba (L.) Hassk. (W)
Elaeagnus angustifolia L. (W)
Eleocharis
- E. macrostachya Britt. (E)
- E. obtusa (Willd.) Schultes, var. lanceolata (Fern.) Gilly (E)

Elephantopus carolinianus Willd.
Elymus canadensis L. (D,E,W)
Engelmannia pinnatifida Torr. & Gray (B,E,W)
Eragrostis
- E. barrelieri Daveau (W)
- E. cilianensis (All.) E. Mosher (E,M,WS,W)
- E. curtipedicellata Buckl.
- E. curvula (Schrad.) Nees (E,M,W)
- E. diffusa Buckle, in Hitchcock (B)
- E. oxylepis (Torr.) Torr. (W)
- E. pilosa (L.) Beauv. (W)
- E. trichodes (Nutt.) Nash var. trichodes (M,W)

Erigeron
- E. bellidiastrum Nutt. (B)
- E. strigosus Muhl. ex Willd. (E)

Eriogonum
- E. alatum Torr. (E)
- E. annuum Nutt. (E,M,W)
- E. lachnogynum Torr.
- E. longifolium Nutt.

Erioneuron pilosum (Buckl.) Nash (E)
Eupatorium
- E. altissimum L. (E)
- E. serotinum Michx. (W)

Euphorbia
- E. albomarginata Torr. & Gray (E)
- E. dentata Michx. (M,W)
- E. fendleri Torr. & Gray (E)
- E. geyeri Engelm. (W)
- E. gylptosperma Engelm. (E,W)
- E. hexagona Nutt. (E,M,W)
- E. marginata Pursh (M,W)
- E. missurica Raf. (E,M,W)
- E. serpens H.B.K. (M)
- E. strictospora Engelm. (B,E,H,W)

Eurytaenia texana Torr. & Gray (E)
Eustoma grandiflorum (Raf.) Shinners, forma grandiflorum (W)
Evolvulus nuttallianus R. & S. (E)
Flaveria campestris T. R. Johnson
Fraxinus pennsylvanica Marsh.
Froelichia
- F. floridana (Nutt.) Moq. (M,W)
- F. gracilis (Hook.) Moq. (E,M)

Fuirena simplex Vahl. (E)
Gaillardia
- G. lanceolata Michx. (E)
- G. pulchella Foug (B,E,H,W)

Galium pilosum Alt.
Gaura
- G. coccinea Nutt. (W)
- G. parviflora Dougl. (E,H,W)
- G. villosa Torr. var. villosa (E,M,W)

Geranium carolinianum L. (E)
Geum canadense Jacq. var. camporum (E)
Gilia longiflora (Torr.) Don. (D,E,W)
Gleditsia triacanthos L.
Glycyrrhiza lepidota Nutt. ex Pursh (B)
Grindelia
- G. lanceolata Nutt. (W)
- G. squarrosa (Pursh.) Dun. var. nuda (Wood) Gray

Gutierrezia
- G. dracunculoides (DC.) Blake (E,H,W)
- G. sarothrae (Pursh) Britt. & Rusby (E,W)

Gymnocladus dioica (L.) K. Koch (W)
Halimodendron hadodendron (L.) Voss. (E,W)
Haplopappus
- H. ciliatus (Nutt.) DC. (M,W)
- H. divaricatus (Nutt.) Gray var. hookerianus (Torr. & Gray) Waterfall (B,D,E,M,W)
- H. phyllocephalus DC. var. annuus (Rydb.) Waterfall
- H. spinulosis (Pursh) DC. (E,M,W)

Hedyotis nigricans (Lam.) Fosb. (D,E)
Hedysarum boreale Nutt. (E)
Helianthus
- H. annuus L. (E,W)
- H. maximiliani Schrad. (E)

H. petiolaris Nutt. (D,E,M,W)
H. tuberosa L. (W)
Heliotropium convolvulaceum (Nutt.) Gray (E,H,M)
Heteranthera limosa (SW.) Willd. (E)
Heterotheca latifolia Buckl. (H,M,WS,W)
Hoffmanseggia jamesii Torr. & Gray (W)
Hordeum leporinum L.
Hymenopappus
H. filifolius Hook. (E,W)
H. flavescens Gray (E)
H. tenuifolius Pursh (E,M)
Hymenoxys scaposa (DC.) Parker (E)
Indigofera miniata Ortega var. leptosepala (Nutt.) Turner (B,D,E,H,M,W)
Ipomoea leptophylla Torr. (B,E,W)
Iva ciliata Willd. (W)
Juglans
J. microcarpa Berl. (E,W)
J. nigra L. (D)
Juncus torreyii Coville (B,E,H,W)
Juniperus virginiana L. (D,E,W)
Kochia scoparia (L.) Schrad. (B,M,W)
Krameria secundiflora DC. (E)
Kuhnia eupatorioides L. var. corymbulosa Torr. & Gray (B,E,M,W)
Lamium amplexicaule L. (W)
Lechea tenuifolia Michx. (W)
Leerzia oryzoides (L.) SW.
Lemna minor L. (B,H)
Lepidium densiflorum Schrad. (E)
Lespedesa stuevei Nutt. (M,W)
Lesquerella gordonii (Gray) Wats. (W)
Leucelene ericoides (Torr.) Greene (E,W)
Liatris
L. punctata Hooker var. punctata (E,W)
L. punctata Hooker var. nebraskensis Gaiser (D,M)
L. squarrosa (L.) Michx. (W)
Linum
L. rigidum pursh (E,W)
L. sulcatum Riddel (E)
Lobelia cardinalis L. (W)
Ludwigia palustris (L.) Ell. (B,E)
Lycopus americanus (L.) var. scabrifolius Fern. (E,H)
Lygodesmia juncea (Pursh) D. Don (E)
Lysimachia lanceolata Walter var. hybrida (Michx.) Gray (W)
Lythrum alatum Pursh (E)
Maclura pomfera (Raf.) Schneid.
Marrubium vulgare L. (D)
Marsilea mucronata A. Br. (W)
Melampodium leucanthum Torr. & Gray (E,W)
Melilotus
M. alba Desv. (M,W)
M. officinalis (L.) Lam. (E,H,M,W)

Melothria pendula L. (D)
Menispermum canadense L.
Mentha piperita L. (W)
Mentzelia
    M. decapetala (Pursh) Urban & Gilg. (M)
    M. oligosperma Nutt. (E,W)
    M. stricta (Osterhout) Stevens ex Little (D,E,M,W)
Mimosa borealis Gray (E)
Mimulus glabratus H.B.K. var. jamesii (Torr. & Gray) Gray
Mirabilis
    M. albida (Walt.) MacM. (E,W)
    M. carletonii (Standl.) Standl.
    M. linearis (Pursh) Heimerl var. linearis (B,E,M,W)
Mollugo verticillata L. (D,E,H,W)
Monarda
    M. citriodora Cerv. ex Lagasca (E)
    M. punctata L. var. occidentalis (Epl.) Palm. & Steyerm. (E)
Morus
    M. alba L. (B)
    M. nigra L. (B)
    M. rubra L. (E)
Muhlenbergia asperifolia (Nees & Mey.) Parodi (B)
Munroa squrrosa (Nutt.) Torr.
Najas guadalupensis (Spreng.) Magnus (B,E,W)
Nama stevensii C.L. Hitchc. (E,W)
Nasturtium officinale R.Br. (B,E,H,W)
Oenothera
    O. albiculis Pursh.
    O. biennis L. (W)
    O. hartwegii Benth. (E)
    O. heterophylla Spach. var. rhombipetala (Nutt.) Fosberg (D,E,W)
    O. laciniata Hill var. grandiflora (Wats.) Robinson (H)
    O. lavandulifolia Torr. & Gray
    O. macrocarpa Nutt. var. incana (Gray) Reveal (E)
    O. macrocarpa Nutt. var. oklahomensis (Norton) Reveal (E)
    O. serrulata Nutt. (D,E,W)
    O. spachiana Torr. & Gray (E)
Onsmodium hispidissimum Mack. (E)
Opuntia macrorhiza Engelm. (M)
Oxalis dillenii Jacq. (E,M)
Panicum
    P. capillare L. (E,M,W)
    P. hillmanii Chase (M,W)
    P. obtusum H.B.K. (E)
    P. oligosanthes Shultz. (M,W)
    P. virgatum L. (M,W)
Parietaria pennsylvanica Muhl. (E)
Paronychia
    P. jamesii Torr. & Gray (W)
    P. virginica Spreng. var. scoparia (Small) Cory (E)

Parthenocissus quinquefolia (L.) Planch. (E,W)
Paspalum setaceum Michx. (E,W)
Pellaea atropurpurea (L.) Link (W)
Penstemon buckleyi Pennel (E)
Petalostemum
- P. candidum Willd. var. oligophyllum (Torr.) Hermann (B,E,W)
- P. purpureum (Vent.) Rydb. (E,W)
- P. tenuifolium Gray (B,E)
- P. villosum Nutt. (W)

Phacelia integrifolia Torr. (E,W)
Phlox oklahomensis Wherry (WS)
Phragmites australis (Cav.) Trin. ex Sterid. (W)
Phyla
- P. cuneifolia (Torr.) Greene (E)
- P. incisa Small (E,W)
- P. lanceolata (Michx.) Greene (B,E,W)

Physalis
- P. angulata L. var. angulata (E,M)
- P. lobata Torr. (E,H,W)
- P. virginiana Miller var. hispida Waterfall (E)
- P. virginiana Miller var. sonorae Waterfall (E,H,W)
- P. viscosa L. spp. mollis (Nutt.) Waterfall, var. mollis (M)
- P. viscosa L. var. cinerascens (Dunal) Waterfall (E,W)
- P. pubescens L. var. integrifolia (Dunal) Waterfall (E)

Phytolacca americana L. (W)
Plantago
- P. major L. (B)
- P. purshii R. & S. var. purshii (E)
- P. rhodospermum Dcne. (E)

Pluchea purpurascens (SW.) DC. (E,WS,W)
Poa
- P. annua L. (W)
- P. arachnifera Torr.
- P. arida Vasey

Polanisia dodecandra L. (E,W)
Polygala alba Nutt. (E)
Polygonum
- P. bicorne Raf. (E,M,W)
- P. coccinium Muhl. (E)
- P. lapathifolium L. (W)
- P. pensylvanicum L. (B,E)
- P. persicaria L. (W)
- P. punctatum Ell. (E)
- P. ramosissimum Michx. (W)

Polypogon monspeliensis (L.) Desf. (E,W)
Populus deltoides Marsh (W)
Portulaca mundula I.M. Johnston (WS)
Potamogeton
- P. nodosus Poiret (B,E,W)
- P. pusillus L. (W)

Potentilla milligrana Engelm. (E)
Proboscidea louisianica (Miller.) Thel. (M,W)
Prosopis glandulosa Torr. (M,W)
Prunus
    P. angustifolia Marsh (E)
    P. gracilis Engelm. & Gray
    P. serotina Ehrh. (D)
    P. virginiana L.
Psilostrophe villosa Rydb. (D,E,W)
Psoralea
    P. linearifolia Torr. & Gray (E,W)
    P. tenuiflora Pursh (M,W)
Pyrrhopappus scaposus DC.
Quercus
    Q. havardii Rydb. (E,W)
    Q. macrocarpa Michx. (D,E,W)
    Q. marilandica Muench. (W)
    Q. muehlenbergii Engelm. (E)
    Q. stellata Wang. (W)
Ranunculus
    R. abortivus L. (E)
    R. cymbalaria Pursh (W)
    R. longirostris Godr. (E)
    R. sceleratus L. (E,W)
Ratibida columnifera (Nutt.) E.& S. forma columnifera (E,H)
Ribes odoratum Wendl. (E)
Rhus
    R. aromatica Ait. (B,D,E,W)
    R. glabra L. (D,E,M,W)
Robinia pseudoacacia (D)
Rorippa obtusa (Nutt.) Britt.
Rosa setigera Michx.
Rumex altissimus Wood (B,E,H)
Sagittaria latifolia Willd. (B,E)
Salix
    S. interior Rowlee (B.W)
    S. nigra Marsh (W)
Salsola
    S. iberica Senn. & Pau. (H,M,W)
Salvia azurea Lam. (M,W)
Sambucus canadensis L. (E)
Samolus parviflorus Raf. (W)
Sanicula canadensis L.
Sapindus drummondii H. & A. (E,W)
Schizachyrium scoparium (Michx.) Nash (W)
Schrankia uncinata Willd. (B,E)
Scirpus
    S. acutus Muhl.
    S. americanus Pers. (E,H,W)
    S. paludosis A. Nels (E)
Scutellaria
    S. drummondii Benth. (W)

S. resinosa Torr.
S. wrightii Gray (E)
Senecio riddellii Torr. & Gray (E,W)
Setaria
S. glauca L. (D)
S. lutescens (Wiegel) F.T. Hubb. (W)
S. viridis (L.) Beauv. (E,W)
Sisymbrium altissimum L. (E,M)
Smilax
S. bona-nox L. (W)
S. tamnoides L.
Solanum
S. carolinense L. (E)
S. elaeagnifolium Cav. (B,H,W)
S. nigrum L. (D,E,W)
S. rostratum Dunal. (B,W)
Solidago
S. gigantea Ait. var. leiophylla Fern. (W)
S. missouriensis Nutt. var fasciculata Holz. (M,W)
S. mollis Bratl. (M)
S. petiolaris Ait. (W)
Sonchus asper (L.) Hill (B,H,W)
Sorghastrum nutans (L.) Nash (W)
Sorghum halepense (L.) Pers. (B,W)
Spiranthes cernua (L.) Richard
Spirodela polyrhiza (L.) Shleiden (H)
Sporobolus
S. airoides (Torr.) Torr. (H)
S. cryptandrus (Torr.) Gray (B,D,E,M,WS,W)
Stenosiphon virgatus (Spach.) Hook.
Stillingia sylvatica L. (H)
Streptanthus hyacinthoides Hook. (E)
Strophostyles leiosperma (Torr. & Gray) Piper (E,M,W)
Stylosanthes biflora (L.) BSP
Symphoricarpos orbiculatus Moench. (D,W)
Syringa vulgaris L. (W)
Talinum calycinum Engelm. (E)
Tamarix gallica L. (E,H,W)
Taraxacum officinale Wiggens (W)
Tephrosia
T. onobrachoides Wood
T. virginiana (L.) Pers.
Teucrium canadense L. (E,W)
Thelesperma
T. ambigum Gray (D,E,WS,W)
T. megapotamicum (Spreng.) Kuntze (E,M,W)
Toxicodendron radicans (L.) O. Ktze. (W)
Tradescantia
T. occidentalis (Britt.) Smyth (E)
T. ohiensis Raf. var. ohiensis
Tragia
T. betonicifolia Nutt. (M)
T. ramosa Torr. (E)

Tragopogon major Jacq. (B,W)
Tribulus terrestris L. (E,M,W)
Tridens
T. albescens (Vasey) Woot. & Standl. (E)
T. flavus (L.) Hitchc. (W)
T. muticus (Torr.) Nash. var. elongatus (Buckl.) Shinners
Triodanis perfoliata (L.) Nieuw. (E)
Triplasis purpurea (Walt.) Champ. (W)
Tripsacum dactyloides (L.) L. (E)
Typha
T. angustifolia L. (E)
T. latifolia L. (E)
Ulmus
U. americana L. (W)
U. pumila L. (B,W)
Verbena
V. bracteata Lag. & Rodr. (D,H)
V. hastata L. (B)
V. pumila Greene (E)
V. stricta Vent. (E,W)
Verbesina encelioides (Cav.) B.& H. (E)
Vernonia
V. baldwinii Torr. (B,E,H,M,W)
V. texana (Gray) Small (B)
Veronica anagalis-aquatica L. (B)
Vicia villosa Roth. (E)
Viola rafinesquii Greene (W)
Vitis
V. acerifolia Raf. (B,E)
V. riparia Michx.
V. vulpina L. (W)
Vulpia octoflora (Walt.) Rydb. (W)
Wolffia columbiana Karstens (H)
Xanthium strumarium L. (E,W)
Yucca glauca Nutt. (E)
Zinnia grandiflora L. (E)

List of Families

Aceraceae
Acer negundo L.
Aizoaceae
Mollugo verticillata L.
Alismataceae
Sagittaria latifolia Willd.
Amaranthaceae
Amaranthus
A. albus L.
A. graecizans L.

A. hybridus L.
A. palmeri S. Wats.
A. retroflexus L.
Froelichia
F. floridana (Nutt.) Moq.
F. gracilis (Hook.) Moq.
Anacardiaceae
Rhus
R. aromatica Ait.
R. glabra L.
Toxicodendion radicans (L.) O. Ktze.
Apiaceae
Berula pusilla (Nutt.) Fern
Bifora americana (DC.) Watson
Eurytaenia texana Torr. & Gray
Sanicula canadensis L.
Apocynaceae
Apocynum
A. cannabinum L. var. glaberrinum DC.
A. cannabinum L. var. hypericifolium Gray
Asclepiadaceae
Asclepias
A. arenaria Torr.
A. asperula (Dcne.) Woodson
A. engelmanniana Woodson
A. latifolia (Torr.) Raf.
A. stenophylla A. Gray
A. pumila (Gray) Vail
A. speciosa Torr.
A. tuberosa L.
A. viridiflora Raf. var. linearis (Gray) Fern
A. viridiflora Raf. var. viridiflora
Asteraceae
Ambrosia
A. psilostachya DC., var. lindheimeriana (Scheele)Blankenship
A. trifida L.
Aphanostephus skirrhobasis (DC.) Trel.
Artemisia
A. filifolia Torr.
A. glauca Pallas
A. ludoviciana Nutt.
Aster
A. ericoides L.
A. fendleri Gray
A. patens Ait.
A. subulatus Michx. var. ligulatus Shinners
Berlandiera
B. texana DC. var. texana
Bidens
B. cernua L.
B. comosa (Gray) Wiegand
B. frondosa L.

Centaurea americana Nutt.
Chrysopsis
    C. villosa (Pursh.) Nutt. var. canescens Gray
    C. villosa (Pursh.) Nutt. var. stenophylla Gray
Cirsium undulatum (Nutt.) Spreng.
Conyza canadensis (L.) Crong.
Dyssodia papposa (Vent.) Hitchc.
Echinacea angustifolia DC.
Eclipta alba (L.) Hassk.
Elephantopus carolinianus Willd.
Engelmannia pinnatifida Torr. & Gray
Erigeron
    E. bellidiastrum Nutt.
    E. strigosus Muhl. ex Willd.
Eupatorium
    E. altissimun L.
    E. serotinum Michx.
Flaveria campestris T.R. Johnson
Gaillardia
    G. lanceolata Michx.
    G. pulchella Foug.
Grindelia
    G. lanceolata Nutt.
    G. squarrosa (Pursh) Dun var. nuda (Wood) Gray
Gutierrezia
    G. dracunculoides (DC.) Blake
    G. sarothrae (Pursh) Britt. & Rusby
Haplopappus
    H. ciliatus (Nutt.) DC.
    H. divaricatus (Nutt.) Gray var. hookerianus
        (Torr. & Gray)Waterfall
    H. spinulosis (Pursh.) DC.
Helianthus
    H. annuus L.
    H. maximiliani Schrad.
    H. petiolaris Nutt.
    H. tuberosa L.
Heterotheca latifolia Buckl.
Hymenopappus
    H. filifolius Hook.
    H. flavescens Gray
    H. tenuifolius Pursh
Hymenoxys scaposa (DC.) Parker
Iva ciliata Willd.
Kuhnia eupatorioides L. var. corymbulosa Torr. & Gray
Leucelene ericoides (Torr.) Greene
Liatris
    L. punctata Hook.
    L. squarrosa (L.) Michx.
Lygodesmia juncea (Pursh) D. Don
Melampodium leucanthum Torr. & Gray
Pluchea purpurascens (SW.) DC.
Psilostrophe villosa Rydb.

Pyrrhopappus scaposus DC.
Ratibida columnifera (Nutt.) E. & S. f. columnifera
Senecio riddellii Torr. & Gray
Solidago
S. gigantea Ait. var. leiophylla Fern.
S. missouriensis Nutt. var. fasciculata Holz.
S. mollis Bratl.
S. petiolaris Ait.
Sonchus asper (L.) Hill
Taraxacum officinale Wieg.
Thelesperma
T. ambigum Gray
T. megapotamicum (Spreng.) Kuntze
Tragopogon major Jacq.
Verbesina encelioides (Cav.) B. & H.
Vernonia
V. baldwinii Torr.
V. texana Gray
Xanthium strumarium L.
Zinnia grandiflora L.

Bignoniaceae
Catalpa speciosa Warder
Chilopsis linearis (Cav.) Sweet.

Boraginaceae
Cryptantha jamesii (Torr.) Payson
Onsmodium hispidissimum Mack.

Brassicaceae
Descurainia pinnata (Walt.) Britt.
Dithyrea wislizenii Engelm. var. palmeri Payton
Draba reptans (Lam.) Fern.
Lepidium densiflorum Schrad.
Lesquerella gordonii (Gray) Wats.
Nasturtium officinale R. Br.
Rorripa obtusa (Nutt.) Britt.
Sisymbrium altissimum L.
Streptanthus hyacinthoides Hook.

Cactaceae
Echinocereus reichenbachii (Tersch.) Haage
Opuntia macrorhiza Engelm.

Caesalpinaceae
Cercis canadensis L.
Gleditsia triacanthos L.
Gymnocladus dioica (L.) K. Koch.
Hoffmanseggia jamesii Torr. & Gray

Campanulaceae
Triodanis perfoliata (L.) Nieuw

Capparidaceae
Polanisia dodecandra L.

Caprifoliaceae
Sambucus canadensis L.
Symphoricarpos orbiculatus Moench.

Caryophyllaceae
Arenaria stricta Michx. var. texana Robinson
Cerastium sp.

Celastraceae
- Celastrus scandens L.

Ceratophyllaceae
- Ceratophyllum demersum L.

Characeae
- Chara vulgaris

Chenopodiaceae
- Atriplex
  - A. argentea Nutt.
  - A. patula L. var. hastata (L). Gray
- Chenopodium
  - C. album L.
  - C. berlanderi Moq.
  - C. pratericola Rydb.
  - C. gigantospermum Aellen
- Corispermum nitidum Kit.
- Cycloloma atriplicifolium (Spreng.) Coult.
- Kochia scoparia (L.) Schrad.
- Salsola
  - S. iberica Sen. & Pau.

Cistaceae
- Lechea tenuifolia Michx.

Commelinaceae
- Commelina erecta L. var. angustifolia (Michx.) Fern.
- Tradescantia
  - T. occidentalis (Britt.) Smyth
  - T. ohiensis Raf. var ohiensis

Convolvulaceae
- Convolvulus arvensis L.
- Cuscuta cuspidata Engelm.
- Evolvulus nuttallianus R. & S.
- Ipomoea leptophylla Torr.

Cornaceae
- Cornus
  - C. drummondii Meyer

Cucurbitaceae
- Cucurbita foetidissima H.B.K.
- Cyclanthera dissecta (Torr. & Gray) Arn.
- Melothria pendula L.

Cyperaceae
- Carex vulpinoidea Michx.
- Cyperus
  - C. acuminatus Torr. & Hook.
  - C. esculentus L.
  - C. odoratus L.
  - C. schweinitzii Torr.
- Eleocharis
  - E. macrostachya Britt.
  - E. obtusa Willd.
- Fuirena simplex Vahl.
- Scirpus
  - S. acutus Muhl.
  - S. americanus Pers.
  - S. paludosis A. Nels.

Elaeagnaceae
- *Elaeagnus angustifolia* L.

Ebenaceae
- *Diospyros virginianum* L.

Euphorbiaceae
- *Acalypha ostryaefolia* Riddell
- *Argythamnia mercurialina* (Nutt.) Muell. Arg.
- *Croton*
  - *C. glandulosus* L.
  - *C. monanthogynus* Michx.
  - *C. texensis* (KL) Muell. Arg.
- *Euphorbia*
  - *E. albomarginata* Torr. & Gray
  - *E. dentata* Michx.
  - *E. fendleri* Torr. & Gray
  - *E. geyeri* Engelm.
  - *E. glyptosperma* Engelm.
  - *E. hexagona* Nutt.
  - *E. marginata* Pursh.
  - *E. missurica* Raf.
  - *E. serpens* H.B.K.
  - *E. strictospora* Engelm.
- *Stillingia sylvatica* L.
- *Tragia*
  - *T. betonicifolia* Nutt.
  - *T. ramosa* Torr.

Fabaceae
- *Amorpha*
  - *A. canescens* Pursh, f. *canescens*
  - *A. fruticosa* L.
- *Astragalus*
  - *A. gracilis* Nutt.
  - *A. missouriensis* Nutt.
- *Baptisia leucantha* Torr. & Gray
- *Dalea*
  - *D. aurea* Nutt. ex Pursh
  - *D. enneandra* Nutt. ex Fraser
- *Desmodium*
  - *D. sessilifolium* (Torr.) Torr. & Gray
  - *D. glutinosum* (Muhl. ex Willd.) Wood
- *Glycyrrhiza lepidota* Nutt. ex Pursh
- *Halimodendron hadodendron* (L.) Voss.
- *Hedysarum boreale* Nutt.
- *Indigofera miniata* Ortega, var. *leptosepala* (Nutt.) Turner
- *Lespedesa stuevei* Nutt.
- *Melilotus*
  - *M. alba* Desv.
  - *M. officinalis* (L.) Lam.
- *Petalostemum*
  - *P. candidum* Willd. var. *oligophyllum* (Torr.) Hermann.
  - *P. purpureum* (Vent.) Rydberg

P. tenuifolium Gray
P. villosum Nutt.
Psoralea
P. linearifolia Torr. & Gray
P. tenuiflora Pursh
Robinia pseudoacacia
Strophostyles leiosperma (Torr. & Gray) Piper
Stylosanthes biflora (L.) B.S.P.
Tephrosia
T. onobrychoides Wood
T. virginiana (L.) Pers.
Vicia villosa Roth.
Fagaceae
Quercus
Q. havardii Rydb.
Q. macrocarpa Michx.
Q. marilandica Muench.
Q. muehlenbergii Engelm.
Q. stellata Wang.
Fumariaceae
Corydalis aurea Willd.
Gentianaceae
Eustoma grandiflorum (Raf.) Shinners f. grandiflorum
Geraniaceae
Geranium carolinianum L.
Hydrophyllaceae
Nama stevensii C.L. Hitchc.
Phacelia integrifolia Torr.
Illecebraceae
Paronychia
P. jamesii Torr. & Gray
P. virginica Spreng. var. scoparia (Small) Cory
Juglandaceae
Juglans
J. microcarpa Berl.
J. nigra L.
Juncaceae
Juncus torreyii Coville
Krameriaceae
Krameria secundiflora DC.
Lamiaceae
Lamium amplexicaule L.
Lycopus americanus (L.) var. scabrifolius Fern.
Marrubium vulgare L.
Mentha piperita L.
Monarda
M. citriodora Cerv. ex Lagasca
M. punctata L. var. occidentalis (Epl.) Palm. & Steyerm.
Salvia azurea Lam.
Scutellaria
S. drummondii Bentham
S. resinosa Torr.
S. wrightii Gray

Teucrium canadense L.
Lemnaceae
Lemna minor L.
Spirodela polyrhiza (L.) Shleiden
Wolffia columbiana Karstens
Liliaceae
Allium
A. canadense L.
A. nuttalli S. Wats
Yucca glauca Nutt.
Linaceae
Linum
L. rigidum Pursh
L. sulcatum Riddel.
Loasaceae
Mentzelia
M. decapetala (Pursh) Urban & Gilg.
M. oligosperma Nutt.
M. stricta (Osterhout) Stevens ex Little
Lobeliaceae
Lobelia cardinalis L.
Lythraceae
Ammannia
A. auriculata Willd.
A. coccinea Rottb.
Lythrum alatum Pursh
Malvaceae
Callirhoe
C. involucrata (Nutt. ex Torr.) Gray var. involucrata
C. leiocarpa Martin
C. papaver (Cav.) Gray
Marsileaceae
Marsilea mucronata A. Br.
Martyniaceae
Proboscidea louisianica (Miller.) Thel.
Menispermaceae
Cocculus carolinus (L.) DC.
Menispermum canadense L.
Mimosaceae
Desmanthus illinoensis (Michx.) MacM.
Mimosa borealis Gray
Prosopis glandulosa Torr.
Schrankia uncinata Willd.
Moraceae
Morus
M. alba L.
M. nigra L.
M. rubra L.
Najadaceae
Najas guadalupensis (Spreng.) Magnus
Nyctaginaceae
Mirabilis
M. albida (Walt.) MacM.

- *M. carletonii* (Standl.) Standl.
- *M. linearis* (Pursh) Heimerl. var. *linearis*

Oleaceae
- *Fraxinus pennsylvanica* Marsh.
- *Syringa vulgaris* L.

Onagraceae
- *Gaura*
  - *G. coccinea* Nutt.
  - *G. parviflora* Dougl.
  - *G. villosa* Torr. var. *villosa*
- *Ludwigia palustris* (L.) Ell.
- *Oenothera*
  - *O. albiculis* Pursh.
  - *O. biennis* L.
  - *O. hartwegii* Benth.
  - *O. heterophylla* Spach. var. *rhombipetala* (Nutt.) Fosberg
  - *O. laciniata* Hill var. *grandiflora* (Wats.) Robinson
  - *O. lavandulifolia* Pursh
  - *O. macrocarpa* Nutt. var. *incana* (Gray) Reveal
  - *O. macrocarpa* Nutt. var. *oklahomensis* (Norton) Reveal
  - *O. serrulata* Nutt.
  - *O. spachiana* Torr. & Gray
- *Stenosiphon virgatus* Spach

Orchidaceae
- *Spiranthes cernua* (L.) Richard

Oxalidaceae
- *Oxalis dillenii* Jacq.

Papaveraceae
- *Argemone squarrosa* Greene

Phytolaccaceae
- *Phytolacca americana* L.

Pinaceae
- *Juniperus virginiana* L.

Plantaginaceae
- *Plantago*
  - *P. major* L.
  - *P. purshii* R. & S. var. *purshii*
  - *P. rhodospermum* Dcne.

Poaceae
- *Andropogon*
  - *A. gerardii* Vitman
  - *A. hallii* Hack.
  - *A. ternarius* Michx.
- *Aristida*
  - *A. oligantha* Michx.
  - *A. purpurea* Nutt.
- *Avena sativa* L.
- *Bothriochloa*
  - *B. caucasica* (Trin.) C.E. Hubb.
  - *B. saccharoides* (Sw.) Rydb.

Bouteloua
- B. curtipendula (Michx.) Torr.
- B. gracilis Willd. ex (H.B.K.) Lag. ex Steud.
- B. hirsuta Lag. var. hirsuta

Bromus
- B. japonicus Thunb.
- B. tectorum L.

Buchloe dactyloides (Nutt.) Engelm.
Calamovilfa gigantea (Nutt. ex. Torr.) Gray
Cenchrus pauciflorus Benth.
Chloris
- C. verticillata Nutt.
- C. virgata Swartz.

Cynodon dactylon (L.) Pers.
Digitaria sanguinalis (L.) Scop.
Distichlis spicata L. var. stricta (Torr.) Beetle
Echinochloa crusgali (L.) Beauv.
Elymus canadensis L.
Eragrostis
- E. barrelieri Davaeu
- E. cilianensis (All.) E. Mosher
- E. curtipedicellata Buckl.
- E. curvula (Schrad.) Nees
- E. diffusa Buckle
- E. oxylepis (Torr.) Torr.
- E. pilosa (L.) Beauv.

Erioneuron pilosum (Buckl.) Nash
Hordeum Leporinum L.
Leersia oryzoides (L.) SW.
Muhlenbergia asperifolia (Nees & Mey), Parodi
Munroa squarrosa (Nutt.) Torr.
Panicum
- P. capillare L.
- P. hillmanii Chase
- P. obtusum H.B.K.
- P. oligosanthes Shultz.
- P. virgatum L.

Paspalum
- P. ciliatifolium Michx.
- P. setaceum Michx.

Phragmites australis (Cav.) Trin. ex Sterid.
Poa
- P. annua L.
- P. arachnifera Torr.
- P. arida vasey

Polypogon monspeliensis (L.) Desf.
Schizachyrium scoparium (Michx.) Nash
Setaria
- S. glauca L.
- S. lutescens (Wiegel) F. T. Hubb
- S. viridis (L.) Beauv.

Sorghastrum nutans (L.) Nash
Sorghum halepense (L.) Pers.

Sporobolus
S. airoides Torr.
S. cryptandrus (Torr.) Gray
Tridens
T. albescens (Vasey) Woot. & Standl.
T. flavus (L.) Hitchc.
T. muticus (Torr.) Nash., var. elongatus (Buckley) Shinners
Triplasis purpurea (Walt.) Champ.
Tripsacum dactyloides (L.) L.
Vulpia octoflora (Walt.) Rydb.
Polemoniaceae
Gilia longiflora (Torr.) Don.
Phlox oklahomensis Wherry*
Polygalaceae
Polygala alba Nuttall
Polygonaceae
Erigonum
E. alatum Torr.
E. annuum Nutt.
E. lachnogynum Torr.
E. longifolium Nutt.
Polygonum
P. bicorne Raf.
P. coccinium Muhl.
P. lapathifolium L.
P. persicaria
P. pensylvanicum L.
P. ramosissimum Michx.
Rumex altissmus Wood
Polypodiaceae
Cheilanthes feei Moore
Pellaea atropurpurea (L.) Link
Pontederiaceae
Heteranthera limosa (SW.) Willd.
Portulacaceae
Portulaca mundula I.M. Johnston
Talinum calycinum Engelm.
Potamogetanaceae
Potamogeton
P. nodosus Poir.
P. pusillus L.
Primulaceae
Lysimachia lanceolata Walter var. hybrid (Michx.) Gray
Samolus parviflorus Raf.
Ranunculaceae
Rannuculus
R. abortivus L.
R. cymbalaria Pursh
R. longirostris Godr.
R. sceleratus L.

Rhamnaceae
- Ceanothus herbaceus Raf.

Rosaceae
- Geum canadense Jacq., var. camporum
- Potentilla milligrana Engelm.
- Prunus angustifolia Marsh.
  - P. gracilis Engelm & Grey
  - P. virginiana L.
- Rosa setigera Michx.
  - R. woodsii lindl. var fenderi (Crepin) Bydb.

Rubiaceae
- Cephalanthus occidentalis L.
- Galium pilosum Ait.
- Hedyotis nigricans (Lam.) Fosb.

Salicaceae
- Populus deltoides Marsh.
- Salix
  - S. interior Rowlee
  - S. nigra Marsh

Santalaceae
- Comandra pallida A.DC.

Sapindaceae
- Sapindus drummondii H.&A.

Sapotaceae
- Bumelia lanuginosa (Michx.) Pers.

Saxifragaceae
- Ribes odoratum Wendl.

Scrophulariaceae
- Bacopa rotundifolia (Michx.) Wettst.
- Castilleja indivisa Engelm.
- Mimulus glabratus H.B.K. var. jamesii (Torr. & Gray) Gray
- Penstemon buckleyi Pennell
- Veronica anagalis-aquatica L.

Smilacaceae
- Smilax bona-nox L.

Solanaceae
- Chamaesaracha conioides (Moric.) Britt.
- Datura meteloides DC.
- Physalis
  - P. angulata L. var. angulata
  - P. lobata Torr.
  - P. virginiana Miller var. hispida Waterfall
  - P. virginiana Miller var. sonorae Waterfall
  - P. viscosa L. ssp. mollis (Nutt.) Waterfall, var. mollis
  - P. viscosa L. var. cinerascens (Dunal) Waterfall
  - P. pubescens L. var. intergrifolia (Dunal) Waterfall
- Solanum
  - S. carolinense L.
  - S. elaeagnifolium Cav.

- *S. nigrum* L.
- *S. rostratum* Dunal

Tamaricaceae
- *Tamarix gallica* L.

Typhaceae
- *Typha*
  - *T. angustifolia* L.
  - *T. latifolia* L.

Ulmaceae
- *Celtis*
  - *C. laevigata* Willd.
  - *C. occidenlalis*
  - *C. reticulata* Torr.
  - *C. tenuifolia* Nutt.
- *Ulmus*
  - *U. americana* L.
  - *U. pumila* L.

Urticaceae
- *Parietaria pensylvanica* Muhl.

Verbenaceae
- *Phyla*
  - *P. cuneifolia* (Torr.) Greene
  - *P. incisa* Small
  - *P. lancelota* (Michx.) Greene
- *Verbena*
  - *V. bracteata* Lag. & Rodr.
  - *V. hastata* L.
  - *V. pumila* Greene
  - *V. stricta* Vent., forma *stricta*

Violaceae
- *Viola rafinesquii* Greene

Vitaceae
- *Ampelopsis cordata* Michx.
- *Parthenocissus quinquefolia* (L.) Planch.
- *Vitis*
  - *V. acerifolia* Raf.
  - *V. vulpina* L.

Zygophyllaceae
- *Tribulus terrestris* L.

CHAPTER IX

ACCESSIONS OF SPECIAL SIGNIFICANCE

As noted previously, 93 families, 274 genera, and 445 species, and 7 infraspecific taxa were collected in this study of the flora of northwestern Oklahoma. The presence of two taxa is worthy of comment.

One population of Potentilla milligrana Engelm. [=Potentilla rivalis Nutt. var. milligrana (Engelm.) S. Wats.] was discovered in the summer of 1985 near the edge of a pond in Ellis County (Accession Number 1130; R21W, T18N, Sec. 11; G. Bryant Ranch, 2 miles W of Dewey County Line on county road adjacent to Turkey Creek). Waterfall (1969) listed the taxon and indicated that it was reported from the state, but that he had not seen the specimen ("none seen", page 117). Only two collections have been made of this taxon heretofore; one from Stephens County and one from Kay County. There are differences of opinion as to whether the taxon is a distinct species. McGregor in his treatment of P. rivalis for Flora of the Great Plains (Great Plains Flora Association, 1986) comments (page 389) that:

> "Most of our plants have no more than 3 leaflets on all leaves and have sometimes

> been referred to the species or var. millegrana. The more rare and scattered plants with basal or lower leaves pinnately compound have been referred to var. rivalis...A careful search of nmearly all large colonies of this species will reveal a few plants with each of these characters, and taxonomic distinctions seem without value."

The taxon is distributed from Saskatchewan and British Columbia south to Texas, New Mexico, and Mexico (Correll and Johnston, 1970; Great Plains Flora Association, 1986).

Because it is so minute and easily overlooked when not in great abundance, Wolffia columbiana Karst. was collected inadvertently when specimens of Lemna minor and Spirodela polyrhiza were collected. Although likely to be encountered almost anywhere in the world, the species had not been collected in northwest Oklahoma before now (Nelson and Couch, 1985).

CHAPTER X

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PART TWO

EXAMINATION OF THE SEED COATS OF NAMA HISPIDUM AND NAMA STEVENSII (HYDROPHYLLACEAE) BY SCANNING ELECTRON MICROSCOPY

CHAPTER XI

EXAMINATION OF THE SEED COATS OF *NAMA HISPIDUM* AND *NAMA STEVENSII* (HYDROPHYLLACEAE) BY SCANNING ELECTRON MICROSCOPY

Introduction

Nama is the second largest genus in the Hydrophyllaceae and comprises some 18 annual species and 20 perennial species which occur primarily in dry habitats of the southwestern United States and northern Mexico. Five species are found in South America, two in the Caribbean, and one in Hawaii. Many of the taxa are restricted to a particular soil type (Hitchcock, 1933a, 1933b, 1939).

Only two species occur in Oklahoma (Hitchcock, 1933b; Waterfall, 1969; Correll and Johnson, 1970). One is *Nama stevensii* collected by G.W. Stevens in 1913 from near Alva in Woods County, Oklahoma. It was named and described by C.L. Hitchcock when he monographed the genus in 1933. It is an obligate gypsophile found growing only on gypsum soils of western Oklahoma, Texas, and Mexico (Figure 1). The second species is *Nama hispidum* which was described by Asa Gray in 1861. It is a widespread and variable taxon

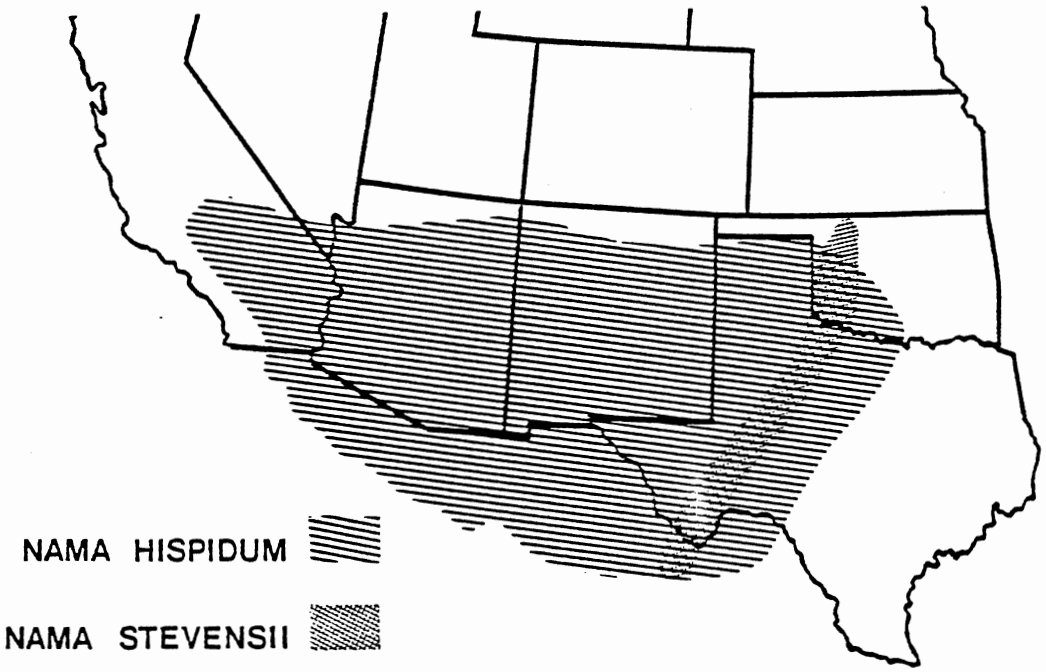

Figure 1. Distribution of Nama stevensii and Nama hispidum in the United States and Mexico.

found in sandy or gravelly soils throughout the southwest. Plants typically are not found in gypsum soils, although they may occur in soils that are mixtures of sand and gypsum. Populations of N. hispidum occur from southwestern Oklahoma and northwestern Texas to southern California and northwestern Mexico (Figure 1).

Nama stevensii and N. hispidum apparently are closely related. Although they are highly restricted as to soil type, they differ consistently in only one morphological character, the nature of the pubescence (Benenati, 1974; Grummer, 1977). Nama stevensii has appressed hairs whereas N. hispidum has hispid hairs and this difference in pubescence usually is emphasized in taxonomic keys. They exhibit less conspicuous differences in leaf shape and size, and mode of branching. However, Benenati (1974) reported that the two taxa exhibited phenotypic plasticity. She noted that wide leaves and spreading pubescence are characteristic of both taxa growing in soils low in or lacking gypsum. As the gypsum content increases, the leaves become narrower and the hairs on them are more appressed.

Even though these two taxa have been traditionally accepted as species (Hitchcock, 1933b; Waterfall, 1969; Correll and Johnston, 1970), there have been questions as to whether they are distinct. I.M. Johnston (1941) described a gypsophilic variety of N. hispidum from Neuvo Leon, Mexico. Bacon (1974, 1981), however, believed that

this taxon was more like N. stevensii and transferred it to the taxon. Correll and Johnston (1970) suggested that N. stevensii was perhaps only a gypsophilous phase of N. hispidum.

In an attempt to clarify the relationship between the two taxa, biosystematic studies have been ongoing for several years. Data accumulated by Grummer (1977), Erteeb (1983), and Tyrl et al., (1984) indicate that the two taxa should be recognized as distinct species despite their similarities in morphology, reproductive biology, karyology, and flavonoid composition. It is hypothesized (Tyrl et al., 1984) that the widely distributed and variable N. hispidum has given rise to the gypsophilus N. stevensii. Similarities in morphology, phenology, and genetic patterns, and an incomplete barrier to gene exchange indicate a close relationship. N. hispidum is believed to exhibit all of the variability necessary for the origin of N. stevensii. Moreover, the presence of numerous gypsophiles in the genus suggest that such an origin is possible.

Bacon (1974, 1981) has been also studying species relationships within Nama. In 1984, he published (Chance and Bacon, 1984) the results of an investigation of the seed coats of 37 species in the genus. Both N. stevensii and N. hispidum were examined; unfortunately, only N. hispidum was illustrated. Because of the interest in the relationship between the two species (Erteeb, 1983; Tyrl

et al., 1984), it was thought that an additional examination of the seed coats of N. stevensii and N. hispidum via scanning electron microscopy (SEM) would contribute to our understanding of the relationship of the two taxa. The results of this study are presented below.

Materials and Methods

Mature seeds of both species were removed from herbarium specimens deposited in the Oklahoma State University Herbarium (OKLA). Sheets examined included: N. stevensii: U.T. Waterfall (11975); R.J. Tyrl, J.R. Estes & C.B. McDonald (761); C. Wallis (5145); U.T. Waterfall (17281); U.T. Waterfall (7317); F.B. Erteeb (1128); N. hispidum: R.J. Tyrl, P.L. Risk & C.B. McDonald (860); U.T. Waterfall (7286); A.D. Wood (s.n.); G.W. Stevens (1044); S.C. Barber (969). The uniformity of morphology and agreement with the observations of Chance and Bacon (1984) indicated that additional specimens did not need to be examined.

Preparation of the seeds for examination with the scanning electron microscope employed the procedure of Chance and Bacon (1984). The seeds were mounted on aluminium specimen stubs with double-stick tape, coated with gold-palladium for two minutes, and observed with a JEOL JSM 35-U scanning electron microscope at an accelerating voltage of 25 KV. Photographs of the entire

seed and a portion of the coat were taken with Polaroid Type 35 film at magnifications of X 200 and X 540.

Results and Discussion

When viewed with both a dissecting and a scanning electron microscope, the seeds of N. stevensii and N. hispidum are obviously similar (Figure 2). The seeds of both species are small, yellow, ovoid-fusiform, and alveolate (honeycombed) or foveolate (pitted). Size varies somewhat. The seeds of N. stevensii are about 0.3 mm long whereas those of N. hispidum are about 0.5 mm long. These lengths agree with those reported by Hitchcock (1933b).

The alveolate or foveolate pattern exhibited by both species is believed (Chance and Bacon, 1984) to be the result of the thin seed coat (2-5 microns) conforming to the topology of the underlying endosperm. The chambers or pits are not formed because of unequal thickening of the coat. Rather the coat is a dense, melded, acellular layer that is essentially uniform in thickness.

Although seeds of the two species appear to differ slightly as can be seen in Figure 2, they are so similar that Chance and Bacon (1984) placed them and three other species in "Seed Group 2", one of six such groups in the genus that they established on the basis of seed size, shape, and coat characteristics. The seed size, thin acellular coat, and alveolate or foveolate pattern

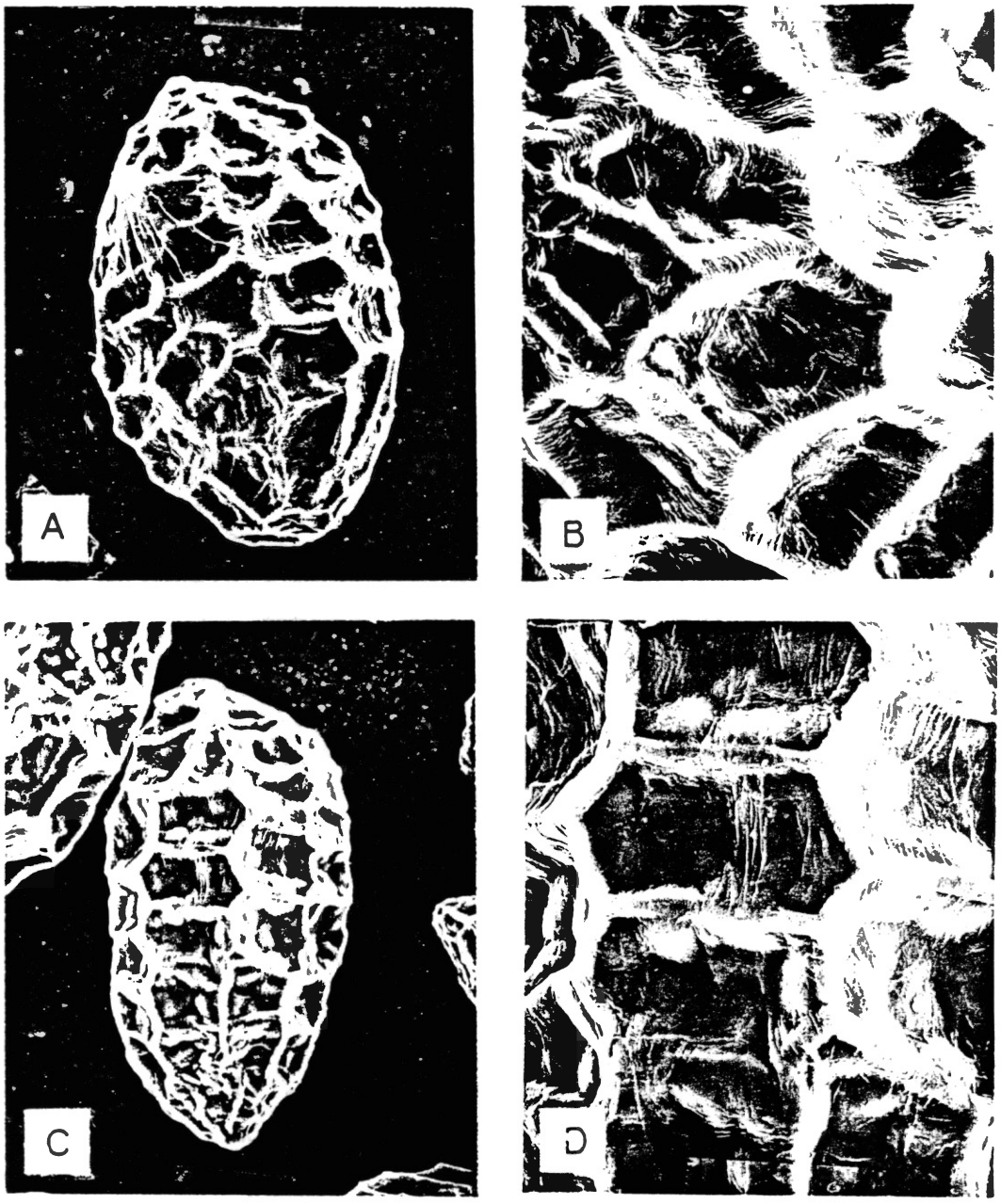

Figure 2. Seeds of Nama stevensii and N. hispidum. A. Seed of N. stevensii X 200. B. Portion of seed coat of N. stevensii X 540. C. Seed of N. hispidum X 200. B. Portion of seed coat of N. hispidum X 540.

circumscribe the group. In contrast, species of "Seed Group 1" have large seeds about 1.4 mm in length and a solid coat 45-60 microns thick which begins as a cellular layer and becomes solid after intracellular deposition of wall material.

"Seed Group 2" comprises five species, N. turneri, N. undulatum, N. sandwicense, N. stevensii, and N. hispidum. Nama turneri is a gypsophile from San Luis Potosi, Mexico. Nama undulatum occurs on gravelly soils from southern Texas to central Mexico. A Hawaiian endemic, N. sandwicense possesses the distinctive coat pattern of the group but differs in seed shape and color. Chance and Bacon consider it distantly related to the other four species which they believe to be closely related. For example, Bacon (1981) when describing N. turneri as a new species stated:

> Yet another marked gypsophile, N. turneri is to be associated with other namas having yellow, ovoid-fusiform seeds, particularly N. hispidum Gray and N. stevensii C.L. Hitch. var. gypsicola (I.M. Johnst.) Bacon. While N. turneri shares a similar edaphic preference and habit with var. gypsicola, it differs from that taxon in its decidedly perennial habit and its broader, apically obtuse leaves. Although lacking the prostrate habit and perennial duration of N. turneri, it is probable that N. hispidum will prove to be the closest relative of this species.

As noted above, data accumulated by Grummer (1977), Erteeb (1983), and Tyrl et al., (1984) indicate that the N. stevensii and N. hispidum are distinct species but closely related. They exhibit similarities in morphology,

reproductive biology, karyology, and flavonoid composition. The similarity in ornamentation of the seed coats agrees with the similarity exhibited in other features.

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PART THREE

TAXONOMIC TREATMENTS OF THE CHENOPODIACEAE AND CRASSULACEAE IN OKLAHOMA

CHAPTER XII

INTRODUCTION TO THE FLORA OF OKLAHOMA PROJECT

The vascular flora -- ferns, fern allies, gymnosperms, flowering plants -- of Oklahoma comprises 152 families, some 824 genera, and approximately 2600 species. It is a complex assemblage of species representative of a number of phytogeographic regions (Kuchler, 1964). Species characteristic of the northeastern oak-hickory forests, the southeastern oak-pine forests, the central prairies/plains, and the southwestern deserts occur within the state. Plants of the Rocky Mountains are also present at the end of the Panhandle. Oklahoma also has a plethora of weedy species, both native and introduced from throughout the world. Some are only adventive and others are naturalized. As has been emphasized by state taxonomists (Flora Oklahoma Inc., 1987) this diverse flora constitutes a major economic resource and thus is studied and manipulated by agronomists, farmers, ranchers, range managers, soil conservationists, wildlife biologists, foresters, recreationalists, ecologists, and botanists. All require a means of identifying native and introduced plants. Identification, for example, is required by

agronomists concerned with the spread and control of weeds in cultivated fields. It is essential to first identify the problem plant in order to decide which control measures are effective. Similarily, range managers and ecologists identify particular plant species to judge the quality of rangeland--its use or misuse. Identification is an unavoidable prerequisite of management. A comprehensive taxonomic treatment, or taxonomic flora, of the vascular plants of Oklahoma is therefore indispensible.

A flora is a means of rapidly identifying plant families, genera, and species. It traditionally contains a series of keys for their identification, technical descriptions of each group's morphology, and brief discussions of the group's habitat, geographical distribution, time of flowering and fruiting, and economic significance. If the plant has been introduced into the state, comments regarding its origin and worldwide distribution are often inserted. Common names, taxonomic comments, and nomenclatural notes are also included. Illustrations which detail the salient features of each taxon may be included. Only two floras for Oklahoma have been written. The first, by G.W. Stevens, was completed in 1916 as a doctoral dissertation submitted to Harvard University; it was never published. Stevens' treatment included keys and generic descriptions, but lacked species descriptions. About 1600 species were cited by Stevens.

In 1937, T.R. Stemen and W.S. Myers treated 640 genera and 1626 species in their Oklahoma Flora. This illustrated manual included abbreviated descriptions of the families, genera, and species. Unfortunately, the authors did not include the graminoids -- the Poaceae (grasses), the Cyperaceae (sedges), and the Juncaceae (rushes). Two other taxonomic treatments of the state's flora are available for state researchers. In 1958, G.J. Goodman published his Keys to the Spring Flora of Central Oklahoma. The fourth edition (1969) of Keys to the Flora of Oklahoma by U.T. Waterfall is the most recent treatment of the state's flora. As the name implies, this publication contains only keys; it lacks descriptions of families, genera and species.

A modern, comprehensive flora for the state is not available. A consortium of state botanists has undertaken the writing and publication of one (Flora Oklahoma Inc., 1987). Beginning their efforts in the fall of 1983, botanists from universities throughout the state established a non-profit corporation, elected a coordinating editor and assistant editor, developed a format for the flora, published a style manual, and solicited taxonomists to write technical treatments of specific plant families. The author of this dissertation was asked to contribute treatments of the Crassulaceae (stonecrops) and Chenopodiaceae (goosefoots), two families with which he was familiar because of his work in Libya.

In the following chapters, a description of how the treatments were prepared and the treatments themselves are presented.

CHAPTER XIII

PREPARATION OF TAXONOMIC TREATMENTS

In order to prepare the treatments of the species and genera of the Crassulaceae and Chenopodiaceae, a series of activities, some sequential and some consecutive, were conducted. Work was initiated with a review of the taxonomic literature for each taxon in order to determine: (1) which species and genera have been reported to occur in Oklahoma, (2) if monographs have been published recently, (3) if biosystematic studies have been published recently, and (4) if changes in nomenclature have occurred. As the literature was reviewed, morphological features used to distinguish one species from another were noted. Possible problems in classification and/or nomenclature also were noted. References of particular interest included: Waterfall (1969), Goodman (1958), Stevens (1916), Stemen and Myers (1937), Correll and Johnston (1970), Great Plains Flora Association (1986), Fernald (1950), Gleason (1952), Kartesz and Kartesz (1980), and U.S.D.A. S.C.S.National List of Scientific Plant Names (1982).

Herbarium specimens of the taxa were then borrowed from state herbaria: East Central Oklahoma State

University (ECSC), Northwestern Oklahoma State University (NWOSU), University of Science and Arts of Oklahoma (OCLA), Southeastern Oklahoma State University (DUR), Central State University (CSU), Cameron University (CU), University of Oklahoma (OKL), Northeastern Oklahoma State University (NOSU), University of Tulsa (TULS), and Southwestern Oklahoma State University (WOH). Specimens were accumulated in order to permit an assessment and description of the range of morphological variation exhibited by each species within the state. Using the herbarium label information, the geographical and ecological distribution of each species also was determined.

The specimens were identified using the available keys and descriptions. In most cases, the identification made by the specimen's collector was confirmed. An annotation label was affixed to each sheet. As the specimens were examined and identified, personal concepts of the circumscription of each taxon were developed and refined.

Observations and measurements of the morphological characters of the accumulated specimens of each species were made. Both vegetative and floral features were examined. Data sheets were developed and used to tabulate measurements. Detailed descriptions of each species based on these observations and measurements were then prepared. The format of the description followed that dictated by

the Flora of Oklahoma Style Manual (Estes, 1984). An attempt was made to ensure that the description reflected precisely the range of variation exhibited by the species in Oklahoma. In addition to summarizing the morphological features, comments regarding the species' habitat, geographical distribution, flowering time, and economic significance were made. Nomenclatural notes and taxonomic comments were also included.

Following completion of the descriptions of the species, a genus description was written which also reflected the pattern of variation exhibited in Oklahoma by the included species. A dichotomous key for the identification of the species of the genus was constructed. In the case of monotypic genera, the species description and the generic description were combined. In turn, a description of the family was prepared and a key for the identification of genera constructed. Again, the formats of the genus and family descriptions were prescribed by the Style Manual.

The completed treatments which are presented in Chapters XV and XVI will be submitted to the Coordinating Editor for review. The editor will review them for stylistic continuity, ease of use, and technical accuracy. It is anticipated that the treatments will be sent to other taxonomists for review.

CHAPTER XIV

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CHAPTER XV

TAXONOMIC TREATMENT OF THE CRASSULACEAE

07-062. CRASSULACEAE DC., Stonecrop Family

SEDUM L., Stonecrop

Annual or perennial herbs, usually succulent. Stems erect or decumbent; branched at base or above; glabrous. Roots fibrous or occasionally a well developed taproot. Leaves simple; alternate or whorled; estipulate; sessile; terete or flat; linear to lanceolate or oblanceolate; venation obscure; glabrous; apex acute or obtuse; margins entire or dentate; base obtuse-slightly auriculate or conspicuously auriculate. Inflorescence comprising terminal, 1-sided cymes; rachises unbranched or branched. Flowers perfect; regular; hypogynous; sessile or subsessile; 4-5 merous. Sepals united at base; yellow or green; ovate to lanceolate; glabrous; fleshy; apex obtuse. Petals free; yellow, white, or pink; linear to lanceolate; apex acute to acuminate. Stamens twice the number of petals, 8 or 10; free; anthers yellow, dark pink, or brown. Pistils 4-5; simple; free or barely united at bases; each with small, nectariferous appendage at base; ovary superior; ovules many. Fruit a follicle with

conspicuous beak. Seeds small, brown, obovate to elliptic.

The Crassulaceae is represented in Oklahoma by a single genus and three species. Penthorum, included in the family by some taxonomists, is positioned in the Saxifragaceae (cf. A. Cronquist. 1981. An Integrated System of Classification of Flowering Plants. Columbia University Press).

1. Leaves alternate; annual; stems erect or ascending
   2. Petals yellow; sepals yellow; mature follicles widely divergent..... 1. S. nuttallianum
   2. Petals white or pink; sepals green; mature follicles ascending or spreading..... 2. S. pulchellum
1. Leaves whorled in 3's; perennial; stems creeping, rooting at nodes.... 3. S. sarmentosum

1. Sedum nuttallianum Raf., Yellow Stonecrop. Annual. Stems erect; branched at base or above, branches erect or ascending. Leaves alternate; oblong to linear-oblong; terete; 4-10 mm long; 1.5-3.5 mm wide; apex obtuse; margins entire; base obtuse or slightly auriculate; upper leaves not crowded; lower leaves readily deciduous. Inflorescence branches 2-5; forked; 1.5-5 cm long; spreading or ascending; the flowers alternating with

small leaves. Flowers sessile or short pedicelled, pedicels 1-1.5 mm in fruit; separated or crowded. Sepals yellow; ovate; 2-3 mm long. Petals yellow; lanceolate; 3.5-4 mm long; apex acute. Anthers yellow at maturity. Pistils 3 mm long; beaked, beaks 0.5-1 mm long. Follicles divergent at maturity. 3-4 mm long; beak 1 mm long. Seeds 0.5 mm long; 0.2 mm long; obovate to elliptic; surface without striations.

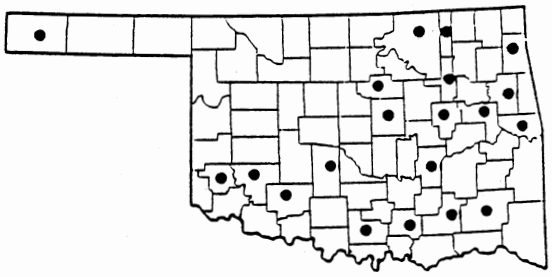
May-July. Eastern 1/2 of state. In thin, rocky soils over granite, limestone, or sandstone; open areas in woods and near creeks.

2. Sedum pulchellum Michx. Annual. Stems erect or ascending, branching at base in soil or solitary. Leaves alternate; linear to linear-spathulate; terete; 7-20 mm long; 1.5 mm wide; apex obtuse; margins entire; base auriculate; upper leaves crowded; lower leaves readily deciduous. Inflorescence branches 2-7; forked; 2-6 cm long; spreading or recurving; the flowers alternating with small leaves. Flowers sessile; crowded. Sepals green; lanceolate; 3 mm long. Petals white or pink; linear to lanceolate; 5-6 mm long; apex acute to acuminate. Anthers dark pink at maturity. Pistils 3.5-4 mm long; beaked, beaks 1.5-2 mm long. Follicles spreading or ascending at maturity; 4-7 mm long; beak 2.5-3 mm long. Seeds 1-1.1 mm long; up to 0.6 mm wide; obovate; surface with numerous dark brown striations. 2n = 22, 44, 66.

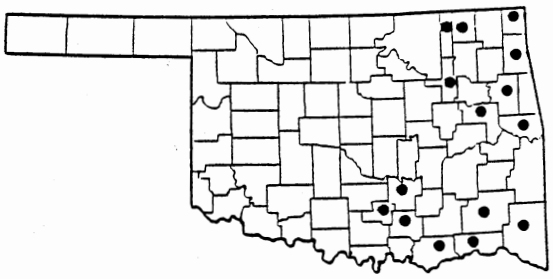
May-July. Eastern 1/2 of state. Thin, rocky soils, particularly on limestone outcrops.

3. Sedum sarmentosum Bunge. Perennial. Stems creeping, rooting at nodes, and sending up flowering stems at nodes; flowering stems 8-16 cm tall. Leaves whorled, in 3's; oblanceolate to oblong-elliptical; thick but flat; 1-23 (30) mm long; (2) 3-5 mm wide; apex acute; margins entire; base auriculate; upper leaves not crowded; lower leaves not readily deciduous. Inflorescence branches 2-4; forked; 2-5 cm long; spreading; the flowers alternating with leaves. Flowers sessile; not crowded. Sepals yellow; narrowly ovate to lanceolate; 4 mm long. Petals yellow; linear-lanceolate; 6-7 mm long; apex acute. Anthers brown at maturity. Pistils 2.5-4 mm long; beak 1.5 mm long. Follicles erect at maturity; 5 mm long; beak 1.5-1.8 mm long. Seeds 0.5 mm long; 0.2 mm wide; surface with 1 purple striation. 2n =72.

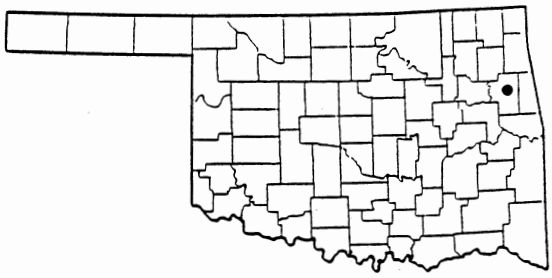
May-July. Native to Asia, S. sarmentosum is cultivated as ornamental, but appears to have escaped and become established in dry, rocky habitats. Collected twice from Cherokee County in 1953 and 1977.



Sedum nuttallianum L.



Sedum pulchellum Michx.



Sedum sarmentosum Bunge

Figure 1. Distribution of Sedum Species in Oklahoma.

CHAPTER XVI

TAXONOMIC TREATMENT OF THE CHENOPODIACEAE

07-030. CHENOPODIACEAE Vent., Goosefoot Family

Annual herbs or perennials woody at the base or throughout (low shrubs). Stems erect, decumbent, or prostrate; branching at base or above; glabrous, pubescent, or farinose, rarely gland-dotted; occasionally conspicuously striate. Roots from a well-developed taproot. Leaves simple; alternate or opposite below; estipulate; sessile or long-petioled; blade shapes numerous, linear to triangular-hastate; glabrous, pubescent, or farinose above and below, a few species gland-dotted; venation netted or inconspicuous; apex apiculate, acute, or obtuse; margins entire, dentate, or lobed basally; base cuneate. Inflorescence comprising glomerules in leaf axils or terminal congested spikes, the arrangement sometimes difficult to interpret; flowers subtended by 1 or 2 bracts or ebracteate. Flowers small, inconspicuous; greenish; perfect or imperfect and plants monoecious or dioecious; apetalous; sessile or short-pedicelled. Perianth segments 1-5, absent in pistillate flowers of Ceratoides; free or fused to near

apex; transverse wing present or absent; glabrous or farinose, rarely gland-dotted. Stamens 1-5, typically as many as perianth segments and opposite them. Pistil 1; compound; ovary superior, with 1 ovule; styles 2 (3 or 5), long or short, free or fused at base. Fruit a utricle; typically enclosed within perianth at maturity; pericarp free or adherent to seed, indehiscent or irregularly dehiscent. Seed oriented vertically or horizontally within utricle; embryo conspicuous, encircling endosperm or spiral and endosperm scanty.

The family is represented in Oklahoma by 10 genera and 27 species, many of which are weeds.

1. Leaves conspicuously and stoutly spinulose or cuspidate-bristle tipped
    2. Leaves spinulose; flowers subtended by 2 lateral bracts in addition to the leafy bract; utricle obovoid and not winged..... 8. Salsola
    2. Leaves bristle tipped; flowers subtended by only the leafy bract; utricle oval and winged..... 4. Corispermum
1. Leaves not spinulose nor bristle tipped
    3. Flowers typically imperfect; pistillate flowers lacking perianth but having 2 conduplicate bracts enclosing utricle
        4. Stems and leaves conspicuously and densely stellate pubescent; fruiting bracts villous..... 2. Ceratoides
        4. Stems and leaves glabrous or farinose; fruiting bracts not villous
            5. Stems erect or ascending; leaves linear-spathulate, triangular or lanceolate-hastate; staminate flowers with 5 perianth segments..... 1. Atriplex
            5. Stems prostrate to ascending; leaves rhombic-ovate to orbicular; staminate flowers with 3-4 perianth segments..... 10. Suckleya

3. Flowers perfect, or rarely imperfect or a few pistillate; all flowers possess perianth of 1 or 5 segments

6. Perianth consisting of 1 scale-like segment; stamen 1 ..... 7. Monolepis

6. Perianth consisting of 3-5 segments; stamens 3-5

7. Leaf blades pilose-hirsute, hairs dense at margins; bracts of inflorescence covered with white silvery or rusty hairs, hairs to 6 cm long; fruiting perianth with interrupted wing..... 6. Kochia

7. Leaf blades glabrous or farinose or sparsely pubescent, but not pilose-hirsute; bracts of inflorescence glabrous or farinose; fruiting perianth wingless or with continous wing

8. Utricle densely tomentulose; fruiting perianth segments with wings forming a continuous ring..... 5. Cycloloma

8. Utricle glabrous; fruiting perianth segments not winged

9. Plants typically of saline or alkaline habitats; leaves succulent, linear or terete; each flower subtended by 2 membranous bracteoles 1-3 mm long..... 9. Suaeda

9. Plants typically of disturbed sites and barren soils; leaves not succulent, typically oblong to ovate to rhombic, if linear plants found on rocky hillsides; each flower not subtended by 2 bracteoles..... 3. Chenopodium

1. ATRIPLEX L., Saltbush

Herbaceous annuals or woody perennial. Stems erect; branching at base or above; 30-100 cm tall; glabrous to strongly farinose. Leaves alternate or alternate above and opposite below; sessile or petiolate; linear-spathulate to ovate-lanceolate or broadly triangular-hastate to ovate-round; glabrous to sparsely farinose above and below; midnerve conspicuous; apex obtuse, acute, or mucronate; margins entire; base cuneate; persistent. Inflorescence comprising glomerules in leaf axils or terminal spikes; staminate flowers not subtended by bracts; pistillate flowers subtended by two bracts; conspicuously farinose. Flowers imperfect; plants monoecious or dioecious; sessile or pedicelled.

Staminate flowers ebracteate; Perianth segments 5, fused or free at base; oblong to obovate, apex obtuse. Stamens 3-5; opposite perianth segments.

Pistillate flowers enclosed within 2 bracts. Bracts fused near base or to apex; fleshy-membranous to indurate; margins entire. Perianth segments absent. Ovary ovoid or depressed globose; styles 2, fused at base. Utricle enclosed in bracts; pericarp free from seed. Seed vertical; brown or black.

Three species occur in Oklahoma and are usually found in alkaline or saline soils of open flats, waste places, or river beds.

1. Perennial shrub..... 2. *A. canescens*

1. Annual herb

    2. Leaves hastate-triangular with lobes to 15 mm long or ovate-lanceolate; bracts of pistillate flowers united only at base, margins denticulate..... 3. *A. patula*

    2. Leaves triangular-ovate to rounded-ovate, subhastate with lobes less than 5 mm long; bracts of pistillate flowers fused to middle or above, margins laciniate..... 1. *A. argentea*

1. *Atriplex argentea* Nutt., Silverscale Saltbush. Herbaceous annual, plants monoecious. *Stems* erect; branching at base, first 2-4 branches opposite, branches spreading or ascending; 30-60 cm tall; glabrous, but farinose when young; stout; angled. *Leaves* subsessile or short petioled; triangular-ovate to rounded-ovate, slightly hastate, lobes less than 5 mm long; 1.4-4(5) cm long; 1-3 cm wide; apex obtuse or mucronate; base broadly cuneate to truncate. *Flowers* sessile. *Staminate Flowers* in upper leaf axils or mixed with pistillate in middle axils. *Stamens* 5. *Bracts of pistillate flowers* fused to middle or above almost to apex; obovate to suborbicular; indurate

in center; apex rounded; margins laciniate. Seed brown; 1.5-3 mm in diameter.

Jun-Aug.

2. Atriplex canescens (Pursh) Nutt., Four-wing Saltbush. Woody perennial, plants dioecious or rarely monoecious. Stems erect; loosely to densely branched, sometimes spinose; 40-100 cm tall; farinose, gray; stout. Leaves sessile or subsessile; linear-spathulate to nearly oblong; somewhat thickened; 1.5-5 cm long; 0.2-0.8 cm wide; farinose but becoming glabrous; apex obtuse; margins entire; base cuneate. Staminate flowers borne in short spikes in axils of upper leaves; perianth segments free at base. Pistillate flowers clustered in leaf axils; pedicelled, pedicels 1-3 mm long. Bracts of pistillate flowers fused almost to apex; 4-winged; faces smooth or with small appendages 4-10 mm long. Seed brown; 1.5-2.5 mm in diameter. 2n =36.

May-Aug.

This species is considered to be a valuable browse species of the desert although it can be toxic when forage is limited.

3. Atriplex patula L. var. hastata (L.) Gray. Herbaceous annual, plants monoecious. Stems erect; usually branched above base, lower branches opposite, branches spreading ascending to ascending; 30-90 cm. tall, sparsely farinose when young, often glabrous; angular. Leaves alternate above, opposite below;

petiolate, petioles 8-20 mm long; hastate-triangular with lobes to 15 mm long or ovate-lanceolate; 2.5-9 cm long; 1-2 cm wide; pale green, more or less succulent; glabrous or sparsely farinose above; densely farinose below; apex acute; margins entire with two spreading basal lobes to 15 mm long; base cuneate. Inflorescence consisting of loose or dense clusters of spikes at ends of branches or in leaf axils. Staminate flowers intermixed with pistillate; perianth fused at base; stamens 5. Pistillate flowers sessile. Bracts of pistillate flowers fused only at cuneate base; triangular to ovate-triangular; margins entire or denticulate. Seed of two types; brown and more or less circular, 1.5-2.5 mm in diameter; black and slightly obovate to oval, 1.3-2 mm wide. 2n = 18.

Jun-Aug.

A. subspicata (S. Wats.) Rydb. in Flora of the Great Plains; A. hastata L. in N. Amer. Flora.

2. CERATOIDES Gagnebin, Winter Fat

Ceratoides lanata (Pursh) J.T. Howell. Perennial shrub, but woody only at base. Stems erect or ascending; branched at base; 20-80 cm tall; pubescence white or brownish, stellate hairs mixed with slender long hairs. Roots from a woody taproot. Leaves alternate; sessile or short petioled; linear to lanceolate; 1-4.5 cm long; 2-3.5 mm wide; pubescence white or brownish, stellate hairs mixed with slender long hairs; midnerve conspicuous; apex rounded; margins entire, revolute; base broadly acute or

cuneate; persistent as plant matures; small leaves of short secondary branches fascicled in axils of primary leaves. Inflorescence consisting of glomerules in leaf axils of leaves or short axillary spikes, branches bearing glomerules or spikes 1/3 -2/3 of their length; staminate flowers not subtended by bracts; pistillate flowers subtended by two bracts. Flowers imperfect, plants staminate or pistillate, but a few flowers of other sex may be present; sessile.

Staminate flowers 1.7-2 mm in diameter; deciduous after anthesis. Perianth segments 4; fused 1/2 length; pubescence white or brownish, stellate hairs mixed with slender long hairs; ovate-elliptic; wing absent; 0.7-1 mm long; apex rounded. Stamens 4; anthers 0.5-0.7 mm long.

Pistillate flowers 2-2.2 mm wide; enclosed within 2 bracts. Bracts densely villous-hirsute, hairs long and silvery-rusty brown; fused almost to apex, tips free and divergent; 4-6 mm long. Perianth segments absent. Ovary ovate to obovate, compressed; tomentose; styles 2, 3-4 mm long, free at base. Utricle enclosed in bracts; obovate; 3 mm long; pericarp free from seed. Seed vertical; flattened; reddish brown.

Eurotia lanata (Pursh) Moq., long used for this species, cannot be used (Howell, J.T. 1971. A new name for "winter fat". Wassmann J. Biol. 29:105).

Apr-Sept. Cimarron County.

Also known as white sage and winter sage. C. lanata provides browse for sheep in winter as common names indicate.

3. CHENOPODIUM L., Goosefoot

Herbaceous annuals (C. ambrosioides sometimes perennial). Stems erect or prostrate to decumbent; solitary or branched at base or above; usually farinose, glabrous or puberulent or gland-dotted. Leaves alternate; usually petiolate; linear, oblong, lanceolate, ovate, rhombic, or hastate-rhombic; glabrous to farinose or puberulent or gland dotted; lanceolate or ovate to oblong; apex apiculate to cuspidate or acute; margins entire to sinuate-dentate or lobed; base cuneate (round or truncate in C. gigantospermum). Inflorescence comprising glomerules in spikes (open cyme in C. incisum); spikes terminal or borne in leaf axils, bracteate or ebracteate. Flowers perfect; sessile or aborted ones pedicelled; not subtended by bracts. Perianth segments 5; fused 1/3 length; wing absent; glabrous to farinose or puberulent or gland-dotted; flat or keeled. Stamens 5 (1 in C. pumilio). Ovary depressed globose or plano-convex; styles 2-3 (4-5). Utricle enclosed by perianth at maturity or free; pericarp membranous; free or adherent to seed. Seed vertical or horizontal; black or reddish brown; smooth or roughened or alveolate.

References: Aellen, P. and T. Just. 1943. Key and synopsis of the American species of the genus Chenopodium

L. Amer. Mid. Nat. 30:47-76.

Basset, I.J. and C. W. Crompton. 1982. The genus Chenopodium in Canada. Can. J. Bot. 60:586-610.

Wilson, H.D. 1980. Artificial hybridization among species of Chenopodium sect. Chenopodium. Syst. Bot. 5:253-263.

Species of the genus are difficult to identify because many of their characters are variable and there is considerable intergradation among them. Specimens need to be collected in both flower and fruit. Twelve species are recognized as occurring in Oklahoma.

1. Foliage glandular; definitely aromatic or strong scented

    2. Seed oriented vertically in utricle; stamen 1;
    plants prostrate to decumbent..... 11. C. pumilio

    2. Seed oriented horizontally in utricle; stamens 5;
    plants erect or ascending

        3. Flowers in glomerules in dense or somewhat
        interrupted spikes; flowers sessile, all
        fertile..... 2. C. ambrosioides

        3. Flowers solitary in forks of dichotomously
        branched cymes at ends of lateral branches;
        flowers sessile and fertile or pedicelled
        and aborted..... 7. C. incisum

1. Foliage not glandular nor strongly aromatic

    4. Leaves large, 3-15 cm long and 2-12 cm wide,
    broadly ovate; utricles 2-2.6 mm in diameter..... 4. C. gigantospermum

    4. Leaves smaller, 0.5-9 cm long and 0.1-3.5 cm wide,
    linear to ovate; utricles less than 2 mm in diameter

5. Pericarp free from seed, readily separated

6. Plants prostrate, decumbent or ascending to erect, low, usually less than 30 cm tall; branched at base

7. Leaves broadly ovate, oblong to oblong-ovate; margins sinuate-dentate or entire, without basal lobes, apex obtuse; stems and perianth glabrous..... 5. C. glaucum

7. Leaves trullate-ovate; margins entire with only 1-2 lobes at base of each side, apex apiculate; stems and perianth farinose..... 6. C. incanum

6. Plants erect, usually more than 30 cm tall; branched above, stem solitary at ground

8. Utricles 0.9-1.3 mm in diameter; stems farinose above, glabrous below; blades densely farinose below..... 10. C. pratericola

8. Utricles 1.2-1.6 mm in diameter; stems glabrous above and below; blades sparse to moderately farinose below..... 12. *C. standleyanum*

5. Pericarp adherent to seed, not readily separated

9. Leaves linear; 1-nerved..... 9. *C. pallescens*

9. Leaves ovate or trullate or elliptic; 3-nerved

10. Pericarp conspicuously alveolate..... 3. *C. berlandieri*

10. Pericarp smooth or roughened, but not alveolate

11. Branches flexuous at maturity; nodes and inflorescence conspicuously tinged with pink; utricles 1-1.2 mm in diameter..... 8. *C. missouriensis*

11. Branches stiff at maturity; nodes and inflorescence not conspicuously tinged with pink; utricles 1.1-1.5 mm in diameter..... 1. *C. album*

1. Chenopodium album L., Lamb's Quarters. Stems erect; branched above, branches well developed and ascending; 40-100 (200) cm tall; glabrous or sparsely to moderately farinose. Leaves petiolate, petioles 0.5-5 cm long; ovate-trullate, elliptic, ovate, or ovate-lanceolate to lanceolate; 0.5-5 cm long; 0.5-2.5 cm wide; moderately farinose or glabrous above, densely farinose below; apex apiculate; margins of lower leaves with 4-6 teeth on each side, two larger than others; margins of upper leaves entire. Spikes in axils of leaves and at ends of branches; lower bracteate, upper ebracteate. Perianth segments fused 1/2 length; ovate; conspicuously farinose; apex obtuse to acute; margins entire; flat to slightly or moderately keeled. Utricle enclosed within perianth but exposed when mature; depressed globose; 1.1-1.5 mm in diameter; pericarp slightly roughened, not alveolate; tightly adherent to seed. Seed horizontal; black; surface roughened. 2n = 54.

Jun-Sept. Weed of barren soil throughout the state. An extremely variable taxon to which plants of other species are identified especially if immature. Its circumscription has been altered considerably by various taxonomists; a more strict interpretation is applied here.

2. Chenopodium ambrosioides L., Mexican Tea. Foliage and flowers densely yellow gland-dotted to glabrous and foul smelling. Stems erect or ascending; branched at base or solitary; 30-85 (100) cm tall. Leaves

sessile or short petioled, 0.4-0.9 (1.5) cm long; oblong to elliptic or upper lanceolate; 3.8-9 (12) cm long; 1-2.5 cm wide; sparsely glandular above, densely glandular below; apex acute, upper leaves somewhat cuspidate; margins sinuate-dentate. Spikes both axillary and terminal; dense or interrupted, slender or thick; bracteate. Perianth segments fused 1/3 to 1/2 length; orbicular-ovate; glandular and villous or glabrous; apex mucronate or acute; margins entire; flat, not keeled. Utricle enclosed within perianth; compressed globose or obovate; 0.7-1 mm in diameter; pericarp glandular; free from seed. Seed horizontal or vertical; reddish brown. 2n = 32.

Jul-Oct. Weed of disturbed areas and shaded sites primarily in northeastern 1/4 of state.

Variety anthelminticum (L.) Gray is differentiated from the typical form on the basis of the inflorescence and lower leaves. However, all of the characters vary to such a degree that consistent recgonition is tenuous.

3. Chenopodium berlandieri Moq., Pitseed Goosefot. Stems erect; profusely branched above base, branches spreading or ascending; glabrous. Leaves petiolate, petioles 0.7-2.5 cm long; rhombic-ovate to ovate, oval, elliptic, or oblong; 1.4-4.5 cm long; 0.9-3 cm wide; sparsely farinose above, densely farinose below; apex rouned or acute; margins sinuate-dentate, upper leaves entire. Spikes both axillary and terminal; bracteate.

Perianth segments fused 1/3 - 1/2 length; ovate to oval; moderately to densely farinose; apex obtuse; margins entire; strongly keeled, flower star-shaped in fruit. Utricle initially enclosed by perianth but exposed when mature; depressed globose; 1.2-1.5 mm in diameter; pericarp roughened and alveolate at least along edges; rusty brown or yellow; adherent to seed. Seed horizontal; shiny black; roughened. 2n = 36. C. album var. berlandieri (Moq.) Mack. & Bush. Included are C. dacoticum Standl. and C. petiolare H.B.K.

Jul-Oct. Throughout the state as a weed in disturbed open habitats; dry limestone outcrops, playas, and waste sites.

4. Chenopodium gigantospermum Aellen., Maple-leaf Goosefoot. Stems erect; branched above base, branches well developed, spreading to ascending; 40-85 (120) cm tall; glabrous. Leaves petiolate, petioles 1-5 cm long; broadly ovate; 3.5-15 cm long; 3-12.5 cm wide; glabrous or sparsely farinose above and below; apex cuspidate; margins dentate-sinuate; base round or truncate. Spikes borne in conspicuous panicles at ends of branches; ebracteate. Perianth segments fused at base; oblong or oblanceolate; glabrous or sparsely farinose; apex acute; margins entire; slightly keeled. Utricle not completely enclosed by perianth at maturity, partially exposed; slightly plano-convex or flattish; 2-2.6 mm in diameter; pericarp reticulated; adherent to seed. Seed horizontal; black,

shiny. 2n = 18. C. hybridum L. var. gigantospermum (Allen) Rouleau in Waterfall.

Jun-Aug. Primarily northern 1/2 of state in shade of wooded creek banks, under bridges, and in waste areas.

This distinctive species appears to be native to North America; it is morphologically and cytologically distinct from the C. hybridum complex of Eurasia.

5. Chenopodium glaucum L., Oak-leaf Goosefoot. Stems prostrate or ascending to erect; profusely branched at base; 10-70 cm long; glabrous. Leaves petiolate, petioles 0.2- 1.2 cm long; oblong or ovate-oblong to broadly ovate; 0.5-4 cm long; 0.4-2 cm wide; glabrous above, densely farinose below; apex obtuse; margins sinuate-dentate or entire to few tooth; Spikes axillary, rarely terminal; ebracteate. Perianth segments free; obovate or oval; glabrous; apex acute; margins entire. Utricle enclosed by perianth; depressed globose; 0.6-1 mm in diameter; pericarp grayish-green; free from seed. Seed vertical or horizontal; reddish brown. 2n = 18.

Jul-Sept. Collected once from Texas County, the species is weed of alkaline habitats elsewhere.

6. Chenopodium incanum (S. Wats.) A. Heller. Stems decumbent or erect; branched at base, branches spreading to ascending; 10-30 cm tall; glabrous or sparsely farinose below, densely farinose above. Leaves petiolate, petioles 0.4-1.4 cm long; triangular to rhombic or oval; 0.6-1.4 cm long; 0.3-1.2 cm wide; sparsely to moderately farinose

above, densely farinose below; apex acuminate or cuspidate; margins entire with 1 lobe on each side just below middle. Spikes both axillary and terminal; ebracteate. Perianth segments fused 1/4 - 1/3 length; ovate to triangular; densely farinose; apex acute; margins entire. Utricle enclosed by perianth; plano-convex; 1-1.1 mm in diameter; pericarp smooth; free from seed. Seed horizontal; black, shiny. 2n = 18.

Jun-Jul. Cimarron County and southwest corner of state as weed in wheat fields, disturbed areas, and abandoned fields.

7. Chenopodium incisum Poir., Rag-leaf Goosefoot. Foliage strongly scented. Stems erect; branched above or rarely at base, branches ascending; 20-60 cm tall; glabrous or sparsely puberulent. Leaves petiolate, petioles 4-19 mm long; ovate, lanceolate, or oblong, conspicuously dissected; 2-6.5 cm long; 1.5-3 cm wide; glabrous to minutely viscid-villous above, densely yellow gland-dotted below; apex acute; margins sinuate-pinnatifid. Inflorescence comprising solitary flowers borne in forks of dichotomously branched panicles (cymes) arising from leaf axils; flowers fertile and sessile or abortive and short pedicelled; ebracteate. Perianth segments fused only at base; ovate, oval to oblong; covered with sessile yellow glands; apex acuminate; margins entire; keeled near the summit. Utricle not completely enclosed within perianth, partially exposed;

depressed globose; 0.5-0.8 mm in diameter; pericarp smooth, adherent to seed. Seed horizontal; reddish brown. 2n = 32. C. graveolens Willd. of Aellen and Just.

Jun-Sept. A species of the southwest and Central America, it is represented in Oklahoma herbaria by a single specimen from Cimarron County.

8. Chenopodium missouriensis Aellen., Stems erect; branched above base, branches spreading or ascending, flexuous at maturity; typically glabrous or sparsely farinose above. Leaves petiolate, petiole 0.5-3 cm long; ovate-trullate, elliptic, or lanceolate; 1.9-5.5 cm long; 0.3-3.5 cm wide; sparsely farinose to glabrous above, sparsely to moderately farinose below; apex acute to apiculate; margins with 3-4 teeth on each side. Spikes terminal in well developed panicles; ebracteate. Perianth segments fused 1/3 length; ovate to oblong; farinose; apex acute or obtuse; margins entire; slightly keeled. Utricle not enclosed by perianth at maturity, fully exposed; depressed globose; 1-1.2 mm in diameter; pericarp slightly roughened; adherent to seed. Seed horizontal; black. 2n = 54.

Sept-Oct. Scattered throughout state in disturbed sites.

The species is very similar to C. album in which it has been positioned as a variety, but differs in looser habit and smaller utricles.

9. Chenopodium pallescens Standl., Stems erect; branched above base, branches ascending; 11-35 (50) cm tall; glabrous or sparsely farinose above. Leaves sessile or short-petioled; linear; (1.2) 2-2.5 cm long; 0.1-0.3 mm wide; glabrous above; sparsely to moderately farinose below; apex acute; margins entire. Spikes borne in axils of upper leaves, a few terminal; ebracteate. Perianth segments fused only at base; broadly ovate to orbicular; farinose; apex acute or obtuse; margins entire; moderately to strongly keeled. Utricle enclosed by perianth at maturity; depressed globose; 1.4-1.6 mm in diameter; pericarp smooth; adherent to seed. Seed horizontal; black, shiny. 2n = 18.

Jun-Aug. Represented in Oklahoma herbarium by two specimens from Kay and Major counties; perhaps more common but mistaken for C. pratericola.

10. Chenopodium pratericola Rydb., Stems erect; branched above base, branches ascending; 24-80 cm tall; farinose above and glabrous below. Leaves petiolate, petioles 0.3-1.5 cm long; linear, lanceolate, or oblanceolate; 1.2-4.5 cm long; 0.3-1.2 cm wide; glabrous or sparsely farinose above, densely farinose below; apex acute or cuspidate; margins entire or lower leaves with 2 lateral lobes. Spikes in axils of upper leaves or terminal; ebracteate. Perianth segments free; ovate or oval; densely farinose; apex acute; margins entire; keeled. Utricle enclosed by perianth or exposed at

maturity; plano-convex; 0.9-1.3 mm in diameter; pericarp smooth; rusty brown; free from seed. Seed horizontal; black, shiny. 2n = 18. C. dessicatum A. Nels. var. leptophylloides Murr in Flora of Texas.

Jun-Oct. Common weed in disturbed sites throughout state.

All specimens of this species in Oklahoma herbaria were identified previously as C. leptophyllum (Nutt. ex Moq.) S. Wats. or C dessicatum A. Nels. These taxa do not occur in the state and the names have been misapplied. Plants of C. leptophyllum possess 1-nerved leaves and a utricle in which the pericarp is adherent to the seed, in contrast to the 3-nerved leaves and free seed in C. pratericola. C. dessicatum branches at the base and has spreading branches in contrast to the ascending branches arising above the base in C. pratericola. Biosystematic studies indicate that the three taxa are distinct species.

11. Chenopodium pumilo R. Br., Ridged Goosefoot. Stems prostrate to decumbent or weakly ascending; branched at base; 20-55 cm long; puberulent and glandular. Leaves petiolate, petioles 0.4-1.5 cm long; ovate, oblong, or ovate-oblong; 0.9-1.8 (2.3) cm long; 0.3-0.9 (1.1) cm wide; puberulent to glabrous above, a few glands may be present; densely glandular below, glands sessile; apex obtuse to barely acute; margins dentate to sinuate-dentate, 2-3 teeth per side. Spikes axillary; ebracteate. Perianth segments free; oblong; puberulent and glandular;

apex acute; margins entire. Stamen 1. Utricle not enclosed by perianth at maturity; oval; 0.8 mm long; 0.6 mm wide; pericarp smooth, adherent to seed. Seed vertical; reddish brown. 2n = 18. C. carinatum auth. non R. Br.

May-Oct. A native of Australia, it occurs as a weed primarily in southeastern 1/4 of state along creek banks and pond edges as well as disturbed sites.

12. Chenopodium standleyanum Aellen., Stems erect or arching; slender; branched above base, branches ascending; 30-90 (150) tall; glabrous. Leaves petiolate, petioles 0.2-2.5 (3) cm long; lanceolate to ovate; 1.5-5.5 cm long; 0.2 (0.5)-1.2. (2.2) cm wide; glabrous or sparsely farinose above, sparse to moderately farinose below; apex acute; margins entire or rarely lower leaves dentate. Spikes both axillary and terminal; ebracteate. Perianth segments free; ovate or oval; farinose; apex acute to obtuse; margins entire. Utricle enclosed by perianth at maturity; plano-convex; 1.2-1.6 mm in diameter; pericarp brown or sometimes reddish-brown, free from seed. Seed horizontal; black, shiny. 2n = 18. Synonym is C.boscianum Moq.

Jul-Oct. Common in moist woods primarily in northeastern 1/4 of state.

4. CORISPERMUM L., Tickseed

Herbaceous annuals. Stems erect; profusely branched at base, branches spreading to ascending; 15-50 cm

tall; glabrous or stellate-villous; striate, often tinged with red when mature. Roots from well developed taproot. Leaves alternate; sessile; linear to linear-lanceolate; glabrous or stellate-villous; apex cuspidate; margins entire; deciduous as plant matures. Inflorescence comprising dense or loose spikes, spikes terminal or axillary; flowers solitary in axils of conspicuous leafy bracts. Flowers perfect; sessile. Perianth segments 1; between ovary and axis, papery-membranous, erose, segments. Stamens 1-3 (5). Ovary oval to orbicular; strongly compressed with conspicuous wing to 1 mm wide; styles 2. Utricle wider or narrower than subtending bract; apiculate; shiny, stramineous-brown; glabrous; pericarp adherent to seed. Seed vertical.

Reference: Maihle, N.J. and W.H. Blackwell, Jr. 1977. A synopsis of North American Corispermum (Chenopodiaceae). Sida 7:382-391.

1. Mature utricles as wide as bracts and hidden by them; spike short and congested; utricle wing 0.2-0.5 mm wide..... 1. C. hyssopifolium

1. Mature utricles wider than bracts and exposed; spike elongate and loose; utricle wing 0.5-1 mm wide..... 2. C. nitidum

1. Corispermum hyssopifolium L. Hyssopleaf Tickseed. Stems 15-50 cm tall. Leaves linear or linear-lanceolate; 1-4.5 cm long; 1-2 mm wide. Inflorescence of dense spikes borne on short peduncles arising in leaf axils; bracteate, bracts overlapping and covering rachis. Stamens 5; 0.6-1 mm long. Utricle as wide as or narrower than bract; 3-4 mm long; 1.5-2.5 mm wide; wing 0.2-0.5 mm wide. 2n = 18.

Aug-Oct. Center of state on sandy soils of floodplains, railroad rights-of-way, and waste sites.

2. Corispermum nitidum Kit. Bugseed. Stems 30-50 cm tall. Leaves linear; 0.5-4.5 cm long; 0.5-2 mm wide; Inflorescence of loose spikes borne at ends of branches; bracts slightly or not overlapping and exposing rachis. Stamens 3; 0.5 mm long. Utricle wider than bract; 2.5-4 mm long; 2 mm wide; wing 0.5-1 mm wide. 2n = 18.

Aug-Oct. Northwest 1/4 of state on sandy soils of floodplains and prairies.

5. CYCLOLOMA Moq., Winged Pigweed

Cycloloma atriplicifolium (Spreng.) Coult. Herbaceous annual. Stems erect; profusely branched, branches ascending and incurved giving plant globose appearance; 17-80 cm tall and as much in diameter; young stems canescent-tomentose but becoming glabrous; striate. Roots from a well developed taproot, slightly woody. Leaves alternate; petiolate; narrowly elliptic-oblong to oblanceolate; 1-6 (7) cm long; 1-16 (20) mm wide; glabrous

or canescent above and/or below; apex apiculate; margins sinuate-dentate; teeth conspicuously apiculate; base cuneate; deciduous as plant matures. Inflorescence composed of terminal spikes; flowers widely spaced; without subtending bracts. Flowers perfect, a few imperfect; sessile; 3-5 mm in diameter including perianth wing. Perianth segments 5; fused 1/2 length; keeled; winged, wing forming continuous ring, membranous, irregularly toothed, purplish brown at maturity. Stamens 5; anthers 0.3-0.4 mm long. Ovary densely tomentulose; styles 3, occasionally 2; 0.6-0.8 mm long; slightly fused at base. Utricle enclosed within perianth; plano-convex; pericarp rusty brown; with scattered fine white hairs and sessile yellow glands; free from seed. Seed horizontal; black, shiny; slightly roughened. 2n = 36.

May-Oct. Throughout the state as weed primarily in sandy soils. Also known as tumble ringwing.

6. KOCHIA Roth, Kochia

Kochia scoparia (L.) Schrader. Herbaceous annual. Stems erect; branched from base; branches spreading to ascending, plant becoming hemispherical or pyramidal, yellowish green, at first streaked with red and then red-purple at maturity; 30-150 (200) cm tall; glabrous to puberulent or sometimes villose. Roots from well developed taproot. Leaves alternate; petiolate to sessile; elliptic to oblanceolate or linear; 2-5 (6) cm long; 2-4 mm wide; glabrous or sparsely pilose-hirsute;

apex acute; margins entire, often conspicuously pilose-hirsute; not readily deciduous as plant matures. Inflorescence spike-like, up to 10 cm long, comprising paired or solitary flowers borne in axils of foliose bracts at ends of branches; bracts 1-2 (3) mm long, covered with white-silvery or rusty hairs. Flowers perfect or a few pistillate; sessile; 3-5 mm wide; subtended by tuft of rusty villous hairs. Perianth segments 5; fused 2/3 of length; winged, wing flat and membranous or tuberculate. Stamens 5; anthers 1 mm long; Ovary globose; styles 2 (3), 1-1.2 mm long, fused or free at base. Utricle partially exposed within perianth; depressed globose; 4 mm in diameter; pericarp brown, membranous, free from seed. Seed horizontal; dull black; ovate, 1.8-2 mm long and 1-1.5 mm wide. 2n = 18.

Jul-Oct. Throughout the state as weed in disturbed sites.

Also known as summer-cypress and fireweed, K. scoparia is native to Eurasia. Although accumulating nitrates and oxalates and causing photosensitization problems, its use for grazing, hay and silage is increasing. Plants vary considerably in pubescence, color, and appearance of the inflorescence.

Reference: Blackwell, W.H.Jr., M.D. Baechle, and G. Williamson. 1977. Synopsis of Kochia (Chenopodiaceae) in North America. Sida 7:248-254.

7. MONOLEPIS Schred.

Monolepis nuttalliana (R. & S.) Greene. Povertyweed. Herbaceous annual. Stems prostrate to decumbent or ascending; freely branched at the base; 5-27 (30) cm long; slightly succulent; sparsely mealy to glabrous. Roots from a slender taproot. Leaves alternate; basal leaves petiolate, upper leaves short petiolate or sessile; lanceolate to ovate or trullate or hastate, sometimes with a few teeth above the lower divergent pair of lobes; 1-6 cm long; apex rounded to acute; margins entire; base cuneate; persistent. Inflorescence consisting of many-flowered glomerules in leaf axils; flowers not subtended by bracts. Flowers perfect, a few pistillate; sessile; 0.3-0.5 mm in diameter. Perianth segment 1; green, bract-like; oblanceolate; wing absent; apex rounded. Stamen 1 in perfect flowers; anthers 0.2-0.3 mm long. Ovary ovoid, glaucous; styles 2, short, fused at base. Utricle subtended by perianth segment; ovoid, compressed pericarp finely pitted at maturity; adherent to seed when dry, separable when wet. Seed vertical; flattened; dark brown or black; 1-1.3 mm in diameter. 2n = 18.

Apr-Sept. Throughout the state as weed in dry or moist soils; waste areas, cultivated fields, roadsides, and ravines.

8. SALSOLA L., Russian Thistle

Herbaceous annuals. Stems erect; profusely branched at base, branches spreading and/or ascending, plant becoming

hemispherical or spherical; glabrous to sparsely hispidulous, young branches sometimes densely hispidulous; striate, green and purple-red lines; branches rigid as plant matures. Roots from a well developed taproot. Leaves alternate; sessile; filiform; glabrous or hispidulous; apex spinulose; margins entire; base dilated; persistent as plant matures; somewhat succulent when young. Inflorescence comprising solitary flowers and short spikes in leaf axils; flowers subtended by 2 bracteoles. Flowers perfect; sessile. Perianth segments 5; free; membranous in flower but becoming ridged or winged in fruit; ovate below protuberance and oblong or triangular above; apex mucronate to apiculate. Stamens 5. Ovary ovoid; styles 2, short. Utricle enclosed within perianth, obovoid or barrel-shaped; pericarp adherent to seed. Seed horizontal.

References: Beatley, J.C. 1973. Russian-thistle (Salsola) species in western United States. J. Range Manag. 225-226. Schapaugh, W. 1958. Salsola collina Pall., new to Iowa. Proc. Iowa Acad. Sci. 65:118-121.

A characteristic of Salsola is the tumbleweed habit. At maturity, abscission of the primary stem occurs at ground level and the spherical plant breaks free and rolls before the wind. The genus comprising approximately 150 species is represented in Oklahoma by two Eurasian introductions which occur as troublesome weeds in cultivated fields, waste areas, and other disturbed sites.

1. Spikes long and slender,
   15-40 cm long; bracts appressed
   or only tips slightly recurved..... 1. S. collina
1. Spikes short and stout, 3-10 (14)
   cm long; bracts spreading..... 2. S. iberica

1. Salsola collina Pall. Tumbleweed. Stems 40-100 cm tall. Leaves 1-3 (6) cm long; 0.5-1 mm wide; dilated at base, to 2 mm wide. Spikes long, slender, 15-40 cm long. Bracts appressed; lanceolate to ovate; apex long acuminate, scabrous-hispidulous, spinulose; margins scarious-membranous. Perianth segments 2-3 mm long; white membranous and oblong above inconspicuous protuberance, light green and ovate below; apex mucronate to apiculate. Anthers 0.4-1.5 mm long. Ovary globose to obovoid; styles 2.5 mm long. 2n = 18.

Aug-Oct. The species is represented in Oklahoma herbaria by single specimen from Cimarron County. It is probably more common but mistaken for the variable S. iberica.

2. Salsola iberica Senn. & Pau. Russian Thistle. Stems 25-100 (120) cm tall. Leaves 2-4.5 (8) cm long; 0.5-1 mm wide; dilated at base, to 2 mm wide. Spikes short, stout, 3-10 (14) cm long; single flowers in leaf axils also present. Bracts spreading; ovate; apex long acuminate, glabrous, spinulose; margins scarious-membranous. Perianth segments 1.5-2.7 mm long; white membranous and triangular-oblong above conspicuous

protuberance or ridge, slightly green and ovate below; apex apiculate. Anthers 1-1.5 mm long. Ovary depressed ovoid; styles 2-3 mm long. 2n = 18.

Aug-Oct. Throughout the state, but more common in the western 1/2. Introduced from Eurasia, it is naturalized and a noxious weed in raw soils. Salsola kali L. long used for this species apparently has been misapplied by American taxonomists.

9. SUAEDA Forsk. ex Scop., Seepweed

Annual herb or suffrutescent perennial. Stems erect or prostrate to ascending; branched at base; glabrous or tomentose; often somewhat fleshy; strongly striate and angled. Roots from a well developed taproot which is woody in S. suffrutescens. Leaves alternate; sessile; linear to narrowly lanceolate, often terete; fleshy; glabrous or tomentose; apex acute to apiculate; margins entire; reduced upwards; persistent. Inflorescences spike-like, comprising glomerules of 3-7 flowers borne in axils of foliose bracts at ends of branches. Flowers perfect or perfect and imperfect mixed together; sessile; each associated with 2 membranous bracteoles 1-3 mm long. Perianth segments 5; fused 1/4 1/3 length; oval, somewhat cucullate; round or keeled, keel corniculate at maturity; apex acute. Stamens 5; anthers 0.2 mm long. Ovary depressed globose; styles 2. Utricle enclosed by the perianth; pericarp free from seed. Seed horizontal or vertical; shiny, black; smooth.

Reference: Hopkins, C.O. and W.H. Blackwell, Jr. 1977. Synopsis of Suaeda (Chenopodiaceae) in North America. Sida 7:147-173.

1. Herbaceous annual; stems and leaves glabrous; seed oriented horizontally within utricle.....1. S. depressa

1. Suffrutescent perennial, stems and leaves tomentose; seed oriented vertically in utricle.....2. S. suffrutescens

1. Suaeda depressa (Pursh) S.Wats. Sea Blite. Herbaceous annual. Stems erect or prostrate; 3-8 cm tall; glabrous; often somewhat fleshy. Leaves linear or narrowly lanceolate; 17-24 mm long; 1.8-2 mm wide; glabrous. Inflorescence 1.5-7.5 cm long. Perianth segments fused 1/2 length; somewhat unequal in length; glabrous; keeled and slightly corniculate. Seed horizontal. 2n = 36.

Jul-Oct. Western 1/2 of state; usually in saline or alkaline soils.

2. Suaeda suffrutescens S. Wats. Desert Seepweed. Suffrutescent perennial from woody taproot and base. Stems erect: 3-9 (10) cm tall; tomentose throughout. Leaves terete or linear; 4-12 mm long; 1-1.2 mm wide; tomentose. Inflorescence 4-11 cm long. Perianth segments fused 1/4 to 1/3 length; equal in length; tomentose; rounded. Seed vertical.

Apr-Sept. Rare in western third of state in saline or alkaline soils.

10. SUCKLEYA Gray

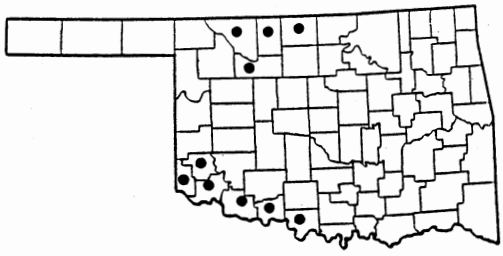
Suckleya suckleyana (Torr.) Rydb. Poison suckleya. Monoecious annual herb. Stems prostrate to ascending; branched at base; 10-40 (50) cm long; glabrous or sparsely mealy; terete. Roots from slender taproot. Leaves alternate; long petiolate, petioles 1-4 cm long; blades rhombic-ovate to orbicular, 1-2.5 cm long, 1-2.4 cm wide, sparsely mealy when young, glabrous with age, apex rounded, margins repand-dentate, teeth acute or obtuse, base cuneate. Inflorescence consisting of glomerules in leaf axils; staminate flowers in upper axils, not subtended by bracts; pistillate flowers in lower axils, subtended by two bracts. Flowers imperfect; sessile.

Staminate flowers 0.9-1.1 mm in diameter. Perianth segments 3-4, 2 sometimes larger than others; fused at base; obovate to lanceolate; cucullate; wing absent; 0.7-0.8 mm long; membranous, translucent; apex rounded. Stamens 3-4, anthers 0.2-0.4 mm long.

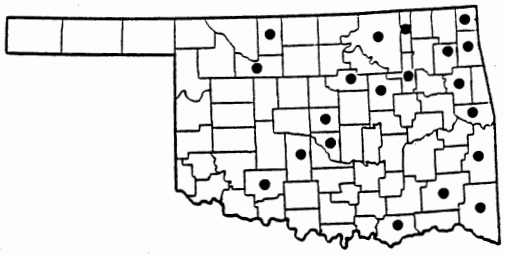
Pistillate flowers 2.5-3.5 mm in diameter; enclosed within 2 bracts; bracts conduplicate, ovate-rhombic, subhastate; glaucous; narrow-winged; apex terminating in 2 short beaks. Ovary ovoid, compressed; styles 2, short, filiform. Utricle enclosed by bracts; 3 mm long; pericarp free from seed, membranous. Seed vertical; reddish

brown; smooth. 2n = 18.

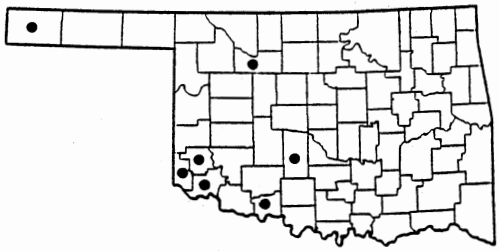
May-Aug. Cimarron and Texas counties; edges of streams and ponds.



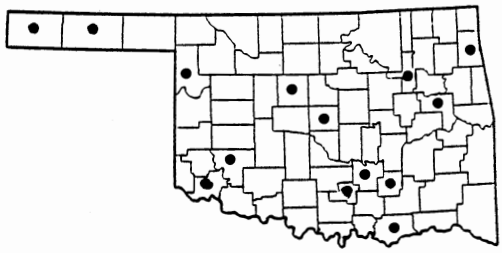
Atriplex argentea Nutt.



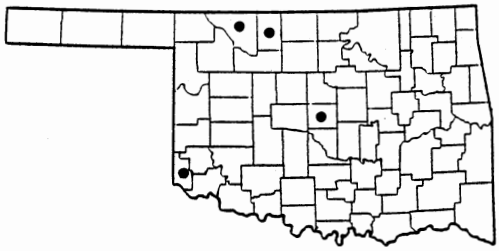
Chenopodium ambrosioides L.



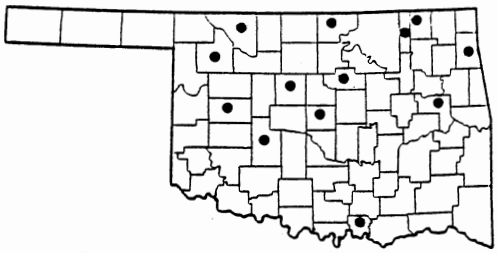
Atriplex canescens (Pursh)Nutt.



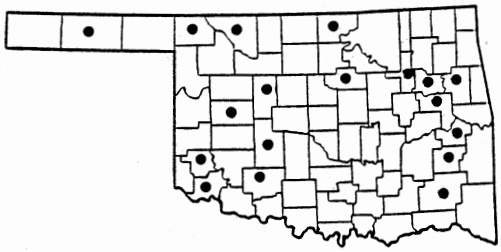
Chenopodium berlandieri Moq.



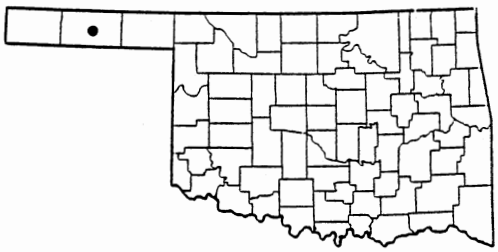
Atriplex patula L. var. hastata (L.)Gray



Chenopodium gigantospermum Aellen

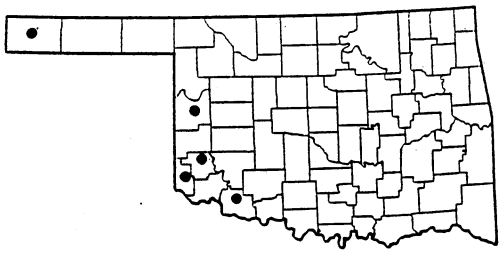


Chenopodium album L.

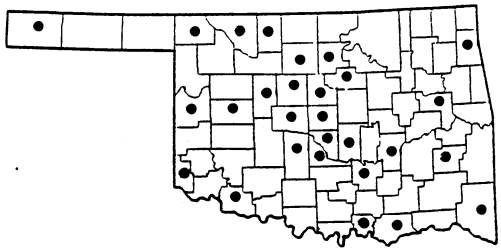


Chenopodium glaucum L.

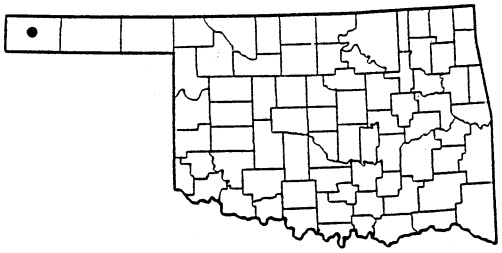
Figure 2. Distribution of the Species of the Chenopodiaceae in Oklahoma.



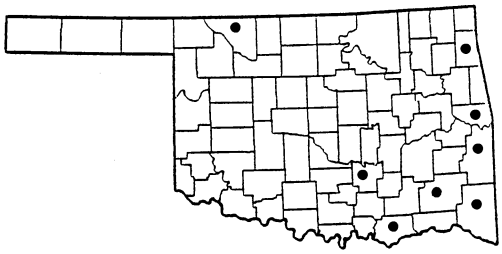
Chenopodium incanum (S.Wats.)Heller



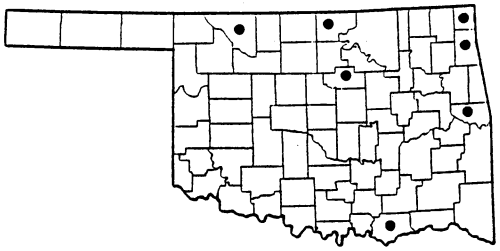
Chenopodium pratericola Rydb.



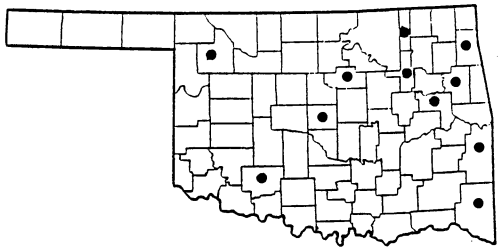
Chenopodium incisum Poir.



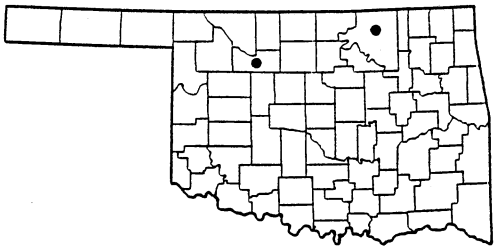
Chenopodium pumilio R.Br.



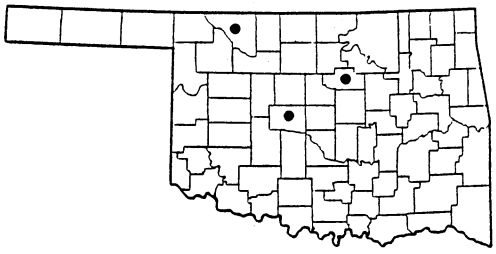
Chenopodium missouriense Aellen



Chenopodium standleyanum Aellen

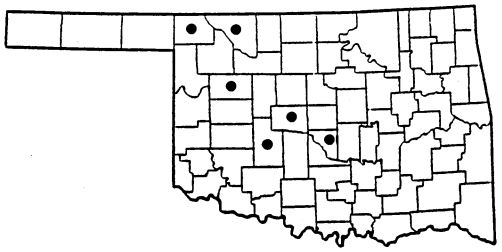


Chenopodium pallescens Standley

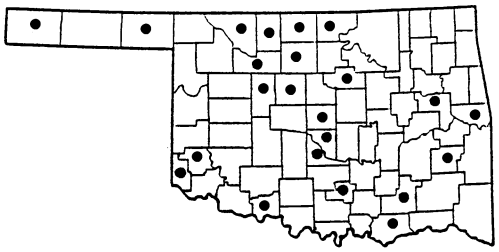


Corispermum hyssopifolium L.

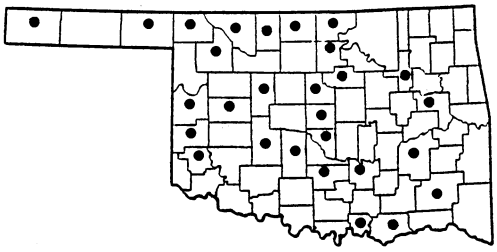
Figure 2. Distribution of the Species of the Chenopodiaceae in Oklahoma (continued).



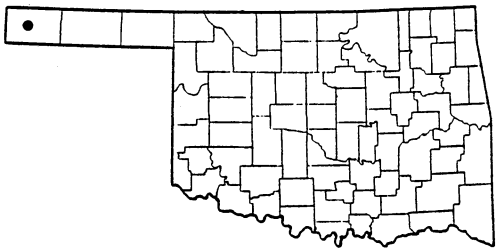
Corispermum nitidum Kit.



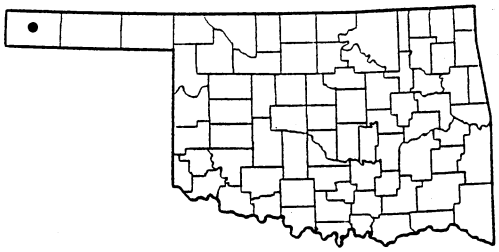
Monolepis nuttalliana (R&S)Greene



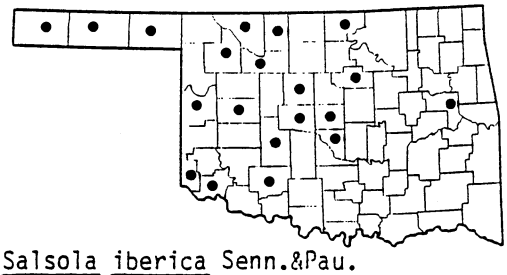
Cycloloma atriplicifolium (Spreng.)Coult.



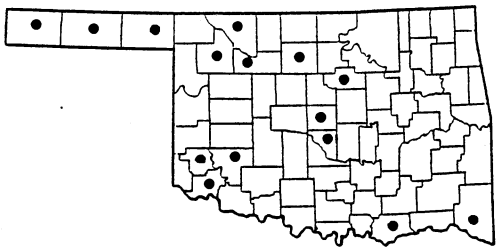
Salsola collina Pall.



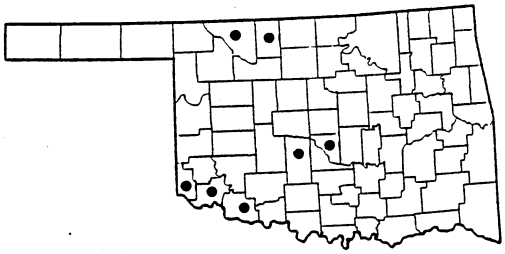
Ceratoides lanata (Pursh) J.T. Howell



Salsola iberica Senn.&Pau.



Kochia scoparia (L.)Schrad.



Suaeda depressa (Pursh)S.Watts.

Figure 2. Distribution of the Species of the Chenopodiaceae in Oklahoma (continued).

Suckleya suckleyana (Torr.)Rydb.

Suaeda suffrutescens S. Watts.

Figure 2. Distribution of the Species of the Chenopodiaceae in Oklahoma (continued).

VITA

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Doctor of Philosophy

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Major Field: Botany

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