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

Cover photo: *Gymnosporagnium juniperi-virginianae* (Cedar-apple rust) on *Juniperus virginiana* (Eastern red cedar) by L.B. Stabler

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Forward

Several years ago a small group of members of the Oklahoma Native Plant Society, interested in fungi, initiated its Mycological Chapter. The debate which accompanied the chapter's formation naturally centered on the fact that fungi are just not plants, even if they had historically been studied by botanists. In the end most realized that if we did not give the fledgling group a place in the Society, mycological studies in Oklahoma might forever continue to be inadequately addressed in the natural sciences.

For the past several years Dr. Clark Ovrebo has served as chair of the Mycological Chapter and has contributed articles regarding fungi, including one in this volume as well. *The Oklahoma Native Plant Record* is proud to deliver these articles to those who would study fungi in Oklahoma and to those whose interests in fungi might be stimulated toward further investigation.

In another effort to spawn more interest in these under-studied taxa, we present in this volume the first, and until recently the only, major study of lichen distribution in Oklahoma. Lichens, being a dual organism of a fungal base with algal and/or bacterial photobionts, offer the biologist a unique perspective on ecosystem dynamics and evolution. Lichens deserve a more thorough study and this seminal article is the requisite for their study in Oklahoma.

The author of *The Lichens of North Central Oklahoma*, Darvin Wendell Keck was born at Willis, Oklahoma in 1926. After serving in the Army from 1944 to 1946 and before receiving his Ph.D., he taught four years in secondary schools and eight years in higher education. He received his Bachelor of Science, Master of Science and Ph.D. degrees from Oklahoma State University. After receiving his doctorate he accepted a teaching position at Oklahoma Christian University where he was the first inductee of the Science and Engineering Hall of Honor and was awarded many other honors including the Gaylord Chair of Distinguished Teaching and the Master Teacher Award. He was the Chairman of the Division of Science for 15 years before retiring in 1989.

Keck became interested in Oklahoma lichens while taking a course in lichenology at the University of Michigan Biological Station in the summer of 1958. The teacher, Dr. Howard Crum, pointed out that very little work had been done in Oklahoma and in most of the surrounding states, and encouraged him to pursue a study of this type. The primary purpose of his study was to collect and identify lichens in an 11-county area of North Central Oklahoma. Secondary aims were to analyze ecological relationships and to establish a record of species distribution for each county. Difficulties encountered included the lack of sufficient up-to-date literature, particularly family and generic monographs, and the lack of herbarium specimens for reference. Since no herbarium specimens were available at OSU, the author sent most of the foliose specimens to Mason E. Hale, Jr. at the Smithsonian Institution for verification. He also spent several days at the University of Colorado studying with Sam Shushan and William Weber, while making use of the excellent herbarium facilities there.

National Science Foundation provided the research grant. Dr. John E. Thomas served as thesis adviser and Chairman of the Graduate Committee, and Drs. Walter W. Hansen, George Moore, Glenn Todd, and U.T.Waterfall were members.

Darvin Keck is retired and currently resides in Oklahoma City, Oklahoma.

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THE LICHENS OF NORTH CENTRAL OKLAHOMA

By DARVIN WENDELL KECK

Submitted to the Faculty of the Graduate School of Oklahoma State University in partial fullfillment of the requirements for the degree of DOCTOR OF PHILOSOPHY
August, 1961

Over 1,000 specimens of lichens were collected at 78 collecting stations in 11 counties of North Central Oklahoma during 1959 and 1960. The objectives were to identify lichens collected in the area; to establish a record of lichen distribution for each county in the area; and to analyze the ecological relationships.

One hundred eleven species and varieties were identified, representing 34 genera and 20 familiies. Species occurring in each county were *Candelaria fibrosa, Parmelia bolliana, Physcia syncolla, Teloschistes chrysophthalomus, and Xanthoria candelaria*. Only ten other species occurred in eight or more counties, while 64 species were found in three counties or less and 30 of these were found in only one county each. The number of species per county varied from a low of 19 in Kingfisher County to a high of 77 in Osage County. The variation was very closely correlated to the two physiographic regions of the area. The five counties largely contained in the Sandstone Hills varied between 41 and 77 species with an average of 50. The six counties in the Redbeds Plains had between 19 and 33 species with an average of 26.

This variation between regions is correlated to rainfall which averages near 40 inches per year at the eastern boundary of the Sandstone Hills, but only 30 inches at the western boundary of the Redbeds Plains. Other factors, conditioned by rainfall, and also having an influence on lichen growth are the presence of trees, the kinds of rock, and the acidity of the soil.

Keck, D.W.
https://doi.org/10.22488/okstate.17.100044

INTRODUCTION

Historical Background

The term "lichen" was used by Theophrastus (371-287 B.C.), in his *History of Plants,* to signify a superficial growth on the bark of trees. It referred to hepatics of the *Marchantia* type rather than to the lichens as they are currently understood. He did, however, describe a species of *Roccella*, and another of *Usnea* or *Alectoria*, which is perhaps the earliest known reference to lichens.

Lichens were alluded to by only a few writers during the next 2000 years. This reflected not only the small amount of study in natural history, but also the relative lack of economic worth of lichens (28).

Schneider (27) in 1897 wrote a history of lichenology, recognizing the following periods:

> *I. From the earliest times to the end of the seventeenth century.*
>
> *II. From 1694, when Tournefort, the first to separate lichens taxonomically from the bryophytes, arranged plants into classes called genera, to 1729.*
>
> *III. From 1729, when Micheli divided lichens into different orders, to 1779.*
>
> *IV. From 1779, when Weber established definite and reasoned lichen genera based on the structure of thallus and fruits, to 1825.*
>
> *V. From 1825, when Wallroth and Meyer each published works dealing with detailed morphological, ecological, and biochemical observations, to 1868.*
>
> *VI. From 1868, when Schwendener discovered the dual nature of lichens, to 1894.*

Other notable milestones could include the arrangement of all known lichens under their respective genera by Acharius in 1803, and the use of spore characters in classification by De Notaris in 1846.

The discovery of the dual nature of lichens by Schwendener, in 1868, is often considered to be the beginning of modern lichenology. This discovery led to a wide variety of ideas about classification. This was demonstrated in a report by Fink (8) who conducted a survey of leading botanists and lichenologists throughout the world in an attempt to analyze ideas regarding the relationship of lichen components. Ideas expressed included the following: lichens are a distinct group of organisms and should be separated from fungi; lichens should be classified in the fungus genera that they closely resemble; and, lichens have a definite relationship to fungi, but for convenience should be kept separated from the fungi.

Fink (9) gave his own idea in the following statement: "The lichen is a fungus which lives all or a part of its life in *parasitic* relation with an algal host and also sustains a relation with an organic or an inorganic substratum." This idea has not been widely accepted, and, despite Fink's

insisting that a lichen was a fungus, he never attempted to place lichens in existing fungus genera. Perhaps a more widely accepted idea was given by Imshaug (22) who defined a lichen as "an entity capable of reproducing itself, and consisting of two organisms, an alga and a fungus, living together in a state of *symbiosis*, as is manifested by some change in the anatomy, morphology, or physiology of at least one of its components."

Ideas in regard to the relationship of lichen components, which in turn have influenced taxonomic ideas, have been further complicated by the observance of some lichens that are apparently parasitic on other plants, and even on other lichens.

While the relationship between lichens and fungi has long been recognized, no serious attempt has been made to place lichens in recognized fungus genera.

Other problems are related to growth form and to chemistry. Some workers make no distinction on growth form, but a more common approach is to separate groups purely on that basis (i.e.,"foliose", "fruticose", "squamulose").

Lichens are also known to contain a great many unique chemicals, and in recent times considerable emphasis has been placed on the chemistry of lichen substances as an aid to lichen taxonomy. This is well illustrated by the work of Asahina (1), and by the use of chemical tests in almost all keys identifying lichens.

It is not, however, been accepted without opposition, as indicated by the following statement by Nearing (25):

> *Chemical dyes determine nothing, and in most cases differentiate species only from certain artificial "Species" invented for the purpose of being thus differentiated. In certain cases chemicals may be suggestive and helpful, but the naming of hundreds of "species" on the basis of chemical reactions alone, is in itself sufficient proof that the reactions do not coincide with evident relationships, that all determinations should rest on botanical characters, or else all on chemical, which last, of course, would be absurd, but no more absurd than the present mixing of the two methods.*

This likely represents an extreme view, but does illustrate the diversity of ideas relating to the classification of lichens.

Because of the uniqueness of lichens, it is understandable that serious problems still exist in lichen taxonomy; much work remains to be done before they can be satisfactorily solved.

In the United States, lichen studies have been confined mostly to the east, north, and Pacific Coast areas with the southwest largely being bypassed. Oklahoma has barely 100 species reported from about one fourth of its 77

counties, and no one has attempted to do a complete floristic work for even one county. Kansas had less than 40 species reported until Fearing (7) collected 163 taxa including about 140 species. He suggested that this was perhaps only one third of the total lichens in the state. Arkansas and Texas each has had only a few species reported. This compares with 245 species reported from Ohio by Wolfe (34), and 335 species reported from Washington by Howard (21), although neither suggested the work was complete in those states.

It has always been customary to report the substrate from which a particular lichen was collected. While the finer details of environment were not included, this has at least served as a beginning for ecological studies. In recent times specific observations have been made about light, temperature, humidity, and other factors in regard to various lichen species, although little work has been done on the microenvironment.

Because of the limited literature on lichens in the southwest, and more especially in Oklahoma, the need for this present work was seen.

REVIEW OF LITERATURE

Previous studies involving the lichens of Oklahoma have been very limited. Only two earlier studies have been made wherein appreciable numbers of lichens from Oklahoma were collected and identified.

The first of these was by Hedrick (20), who identified specimens that Prof. Robert Stratton from Oklahoma State University collected from Cimarron, Delaware, Harmon, Johnston, Kay, Mayes, McCurtain, Murray, Osage, Payne, and Roger Mills counties. These counties are widespread throughout the state and represent a great diversity of habitats; however, no attempt was made to collect all the species occurring in any area or county. This study included 59 species. A majority of these were crustose forms occurring on rocks, with *Lecidea, Caloplaca, Buellia,* and *Lecanora* being the genera most frequently represented.

The second work was by Hale (16) who collected during 1955-1956 in six contiguous counties in eastern Oklahoma as part of a study of lichens in the Ozarks. These counties were Adair, Cherokee, LeFlore, McCurtain, Pushmataha, and Sequoyah. This study involved “Macro-corticolous” lichens and included 47 species,

primarily from the genera: *Parmelia, Physica, Usnea, Anaptychia, Leptogium,* and *Pannaria.*

Since the latter study dealt exclusively with foliose and fruticose lichens growing on trees, and the previous study dealt largely with crustose forms, there was little duplication of species collected. Only seven species were common to both lists, and collectively these two efforts totaled 99 species.

In addition to these two reports, a few additional specimens representing eight other species and involving the additional counties of Comanche, Noble, and Carter have been reported in monographs by Berry (2), Imshaug (22), and Thomason (31), and in other articles by Hale (11, 14, 15, 18). This gives a total of 107 species reported from Oklahoma and involves 19 of the 77 counties where at least some collecting is known to have been done.

Specimens reported by Hedrick are in the herbarium at the University of Michigan, and those collected by Hale are at the Smithsonian Institution. Other Oklahoma specimens are preserved in herbaria of the Missouri Botanical Garden, New York Botanical Garden, University of Wisconsin, and the private herbarium of C. W. Dodge at St. Louis.

THE STUDY AREA

Location and Size

The area involved in this study includes the following 11 counties: Creek, Garfield, Grant, Kay, Kingfisher, Lincoln, Logan, Noble, Osage, Pawnee, and Payne. It is situated in North Central Oklahoma (Fig. 1). It is near-rectangular in shape, and is about 115 miles long (east to west), and averages 95 miles wide with the greatest width being about 105 miles. It covers almost 11,000 square miles which is between one sixth and one seventh of the total area of Oklahoma.

The area of each county, in square miles, as computed from General Highway County Maps prepared by the Oklahoma Department of Highways is as follows:

County	Total Area (Sq. Mi.)
Creek	988
Garfield	1068
Grant	1008
Kay	938
Kingfisher	910
Lincoln	967
Logan	771
Noble	750
Osage	2393
Pawnee	597
Payne	696

Physiographic Regions

Bruner (3) divided the area into two physiographic regions: the Sandstone Hill region which occupies

approximately the eastern 40 per cent of the area (Fig. 2), and the Redbeds Plains. These regions are not sharply delimited; therefore, a wide zone characterized by features of both regions is noticeable.

The Sandstone Hills region is composed largely of weathered Pennsylvanian shales, with rough low hills of the more resistant sandstone remaining. Maximum height of these hills is 300 to 400 feet, although the average is much less. Large sandstone blocks cover the tops and slopes of hills. The broader flat-topped ridges have soil of sufficient depth to support good plant growth.

The Redbeds Plains are composed of soft red Permian clays and shales, with some thin sandstones which are usually so soft that they do not prduce escarpments. This region is primarily one of the rolling plains where hills seldom exceed 100 feet in height. The slightly rolling plain to the west is in contrast to the greater relief near and in the Sandstone Hills region.

Climate and Vegetation

North Central Oklahoma has a continental type of weather which is characterized by a pronounced seasonal range in temperature. It has a mean January temperature of 34^{o}-39^{o}F and a mean July temperature of 80^{o} – 82^{o} F. Extremes in temperature vary from several degrees below 0^{o}F to somewhat over 100^{o}F. There is an average of 200-220 frost-free days throughout the area (32).

Rainfall averages vary from about 30 inches per year in the west to 40 in the east, with considerable year-to-year variation.
There is also an accompanying small increase in relative humidity toward the east.

The Sandstone Hills region is covered with a transitional oak forest interspersed with grass areas, while the Redbeds Plains region is primarily grassland, with trees usually confined to the flood plains of streams (3). A vegetation map of the area taken from an Oklahoma Game and Fish Department map (Fig. 3).

Higher rainfall and humidity favor the development of most lichens, at least within the limits of conditions found in the study area. Most of the effect is apparently direct since there is a definite change in each category of the lichen flora (terricolous, saxicolous, corticolous) with a change in rainfall. Some of the effect is perhaps related only to tree growth since a few corticolous species are considered to be specific in regard to substrate.

There is also a correlation between rainfall and pH, with

the eastern part of the study area where the rainfall is greater being primarily acidic and the western part being near neutral to slightly basic. Considerable influence is also exerted on the lichen flora by the pH (17), although this is more related to the micro-environment than to the pH condition of the general area.

All of these conditions are interrelated and therefore difficult to evalulate individually, but there is a pronounced change in the lichen flora between the eastern and western limits of the study area.

PROCEDURES

Collecting stations were selected in each county, with desirability as a collecting site being given primary consideration. General County Highway Maps were used to determine the general collecting areas; then a survey of each of these was made to determine a collecting station. This normally consisted of the area immediately around a stream or draw so that collecting could be done from trees, rocks, and partially shaded soil since nearly all lichens grow best on one of these sugbstrates. Less frequently, areas were collected from where rock was the predominant substrate. Observations were also made repeatedly on exposed soil and fence posts, ordinarily near the general collecting areas, but only a very limited number of lichens were found and collected under these conditions.

Consideration was also given to the size of counties so that collecting stations varied in number from four in Pawnee County to 15 in Osage County. This is double the minimum of two collecting stations for any county by Hale (16). An attempt was made to properly distribute these stations within counties and between adjacent counties.

Over 1,000 specimens were collected and are being deposited with the lichen collection in the Department of Botany and Plant Pathology of Oklahoma State University, with duplicates of most of these being kept in the author’s private collection.

The seasonal aspect is important primarily because some lichens have mature spores only during certain seasons of the year (28). Collecting was done at three different times: (1) from late May to early Auugust, 1959; (2) November, 1959; and (3) April 1960.

Seventy-four collecting stations were visited including at least four stations for each county during the summer. After the degree of repetition was determined to be unusually

high among neighboring stations used in the summer, it was decided that a considerably smaller number of stations would sufficie during subsequent collection periods. Twenty-one stations were visited during the fall. This included one new station in Kingfisher County, and two stations previously visited in each of the other counties. Eighteen stations including three new areas were visited in the spring. This included at least one in each county.

The 78 collecting areas are shown in Fig. 4. Their descriptions, locations, and dates visited are as follows:

1. A wooded hillside near highway 99, two miles northeast of Cleveland, in Osage County, May 25, 1959; November 21, 1959.

2. Along a small stream, three miles south of Wild Horse store in Osage County, May 25, 1959.

3. A wooded hillside with limestone outcrops near highway 20, five miles west of Skiatook, in Osage County, May 25, 1959; April 12, 1960.

4. A blackjack thicket near highway 23, two miles north of Barnsdall in Osage County, May, 25, 1959.

5. Postoak woods, one mile west of Hula Dam near highway 10 in Osage County, May 26, 1959.

6. A wooded ravine near a county road west of highway 99, 12 miles north of Pawhuska in Osage County, May 26, 1959; November 21, 1959’ April 13, 1960

7. Along a creek in Osage Hills State Park, two miles south of highway 60 in Osage County, May 26, 1959; April 14, 1960.

8. Sandstone bluffs near highway 99, four miles southeast of Pawhuska in Osage County, May 27, 1959.

9. Sandstone outcrops near highway 20, 12 miles west of Pawhuska in Osage County, May 27, 1959.

10. Along Bird Creek, four miles east of Foraker in Osage County, May 25, 1959.

11. Along a small stream, three miles north and two miles west of Webb City, In Kay County, May 27, 1959.

12. Around Phillips Lake, two miles south of Shidler in Osage County, May 27, 1959.

13. Along the Salt Fork River, two miles south of Lamont in Grant County, May 28, 1959; November 26, 1959.

14. Along Deer Creek, 13 miles north of Lamont in Grant County, May 28, 1959.

15. Along Crooked Creek, three miles west of Wakita in Grant County, May 28, 1959.

16. Along a wooded draw near highway 81, one mile south

of Medford in Grant County, May 28, 1959.

17. Along the Salt Fork River, two miles north of Pond Creek in Grant County, May 28, 1959; November 26, 1959.

18. Along the Salt Fork River, three miles north of Nash in Grant County, May 29, 1959.

19. A wooded ravine, three miles southeast of

Hillsdale in Garfield County, May 19, 1959.

20. Along Turkey Creek, three miles north of Drummond in Garfield County, May 29, 1959.

21. Along Turkey Creek, eight miles southeast of Drummond in Garfield County, May 29, 1959; November 26, 1959.

22. Along Wolf Creek, three miles southeast of Douglas in Garfield County, May 29, 1959.

23. Open woods near Breckenridge, eight miles northeast of Enid in Garfield County, May 29, 1959.

24. Along Red Rock Creek, eight miles north of Garber in Garfield County, May 29, 1959.

25. A rocky ravine near highway 64, three miles southeast of Covington in Garfield County, May 29, 1959; April 15, 1960.

26. Postoak woods near highway 33, one mile north of Coyle in Payne County, June 1, 1959.

27. Along Cottonwood Creek, three miles south and one-half mile west of Guthrie in Logan County, June 1, 1959.

28. Along Bear Creek, one-fourth mile west of Meridian in Logan County, June 1, 1959; November 28, 1959.

29. A wooded draw, one-half mile south of highway 105 - 40 junction, three miles west of Tryon in Lincoln County, June 2, 1959; November 28, 1959.

30. Sandstone outcrops near highway 40, one mile north of Warwick in Lincoln County, June 2, 1959.

31. Along Quapaw Creek north of highway 62, six miles west of Meeker in Lincoln County, June 2, 1959.

32. Postoak woods near highway 18, three miles south of Chandler in Lincoln County, June 2, 1959; November 12, 1959.

33. A persimmon grove, three miles south and one-half mile west of Avery in Lincoln County, June 5, 1959.

34. Postoak woods near highway 27, three and one-half miles east of Shamrock in Creek County, June 5, 1959; November 24, 1959.

35. A rocky ravine near the Cimarron River, eight miles

northeast of Cushing in Payne County, June 5, 1959.

36. A wooded ravine, one mile west of highway 99 near Arlington in Lincoln County, June 6, 1959; April 11, 1960.

37. Postoak woods, three miles south and nine miles east of Stroud, in Creek County, June 6, 1959.

38. Postoak woods, five miles south and three miles east of Bristow in Creek County, June 6, 1959.

39. A wooded ravine near highway 66, eight miles northeast of Bristow in Creek County, June 6, 1959.

40. Postoak woods, two miles west of Sapulpa and one-half mile south of highway 66 in Creek County, June 6, 1959.

41. Along Bridge Creek near highway 51, 21 miles east of Hennessey, in Logan County, June 8, 1959; November 28, 1959.

42. Along Skeleton Creek, seven miles east and two miles south of Hennessey in Kingfisher County, June 8, 1959; November 26, 1959.

43. Along Turkey Creek, two miles west of Kingfisher in Kingfisher County, June 8, 1959; November 26, 1959.

44. Postoak woods, two miles southeast of Dover in Kingfisher County, June 8, 1959.

45. Along Cooper Creek, one-half mile south of Loyal in Kingfisher County, June 9, 1959.

46. A wooded draw, two and one-half miles south of highway 33, ten miles west of Kingfisher in Kingfisher County, June 9, 1959.

47. A wooded ravine between highway 33 and the Cimarron River, 15 miles east of Kingfisher in Kingfisher County, June 9, 1959; April 16, 1960.

48. A rocky draw, one mile south of highway 74 – 33 junction, ten miles west of Guthrie in Logan County, June 9, 1959.

49. Postoak woods, two miles north of Crescent in Logan County, June 9, 1959; April 16, 1960.

50. Sandstone bluffs near highway 77, eight miles north of Guthrie in Logan Countyk, June 9, 1959.

51. Along Black Bear Creek, one mile north of Morrison in Noble County, June 14, 1959.

52. Along the Arkansas River, ten miles south and three miles east of Ponca City in Noble County, June 13, 1959.

53. A wooded draw, six miles east and three miles south of Billings in Noble County, June 13, 1959; November 26, 1959.

54. A rocky ravine, near highway 64, five miles west

of Perry in Noble County, June 13, 1959; April 15, 1960.

55. A wooded draw, near highway 64, five miles east of Perry in Noble County, June 13, 1959; April 15, 1960.

56. A wooded ravine, four miles northeast of Ripley in Payne County, June 26, 1959; November 24, 1959; April 11, 1960.

57. A rocky draw near highway 108, four miles south of Glencoe in Payne County, July 7, 1959.

58. A wooded draw, two miles north of Maramec in Pawnee County, July 7, 1959; November 21, 1959.

59. Wooded draw and hillside near highway 64, six miles southeast of Cleveland in Pawnee County, July 7, 1959; April 12, 1960.

60. A wooded ravine near the Arkansas River, one mile north of Blackburn in Pawnee County, July 7, 1959.

61. Sandstone bluffs, along highway 15, eight miles north of Morrison, in Pawnee County, July 7, 1959; November 21, 1959.

62. Along the Arkansas River, five miles southeast of Oilton, in Creek County, August 6, 1959; November 24, 1959.

63. Sandstone bluffs near highway 51, two miles west of Mannford in Creek County, August 6, 1959, April 12, 1960.

64. A wooded hillside, one mile west of highway 99 and four miles north of Hominy in Osage County, August 6, 1959.

65. Along Gray Horse Creek, seven miles east of Fairfax in Osage County, August 6, 1959.

66. Rocky bluffs near the Arkansas River, five miles west of Fairfax in Osage County, August, 6, 1959.

67. Along the Arkansas River near highway 60, nine miles east of Ponca City in Osage County, August 6, 1959.

68. Along the Salt Fork River near highway 77, five miles northeast of Marland in Kay County, August 8, 1959.

69. Along the Salt Fork River, two miles southwest of Tonkawa in Kay County, August 8, 1959.

70. A wooded draw near highway 11, three miles west of Blackwell in Kay County, August 8, 1959.

71. Along the Chikaskia River, two miles west of Braman in Kay County, August 8;, 1959.

72. Along Deer Creek, four miles northeast of Newkirk in Kay County, August 8, 1959.

73. Along the Arkansas River, six miles south and six miles east of Newkirk in Kay

County, August 8, 1959; November 21, 1959; April 13, 1960.

74. A wooded ravine, four miles west and one mile south of Stillwater in Payne County, August 8, 1959; October 9, 1959.

75. A wooded draw near highway 81, seven miles north of Enid in Garfield County, November 26, 1959.

76. Along a rocky wooded draw, one-fourth mile southwest of Tuskegee in Creek County, April 11, 1960.

77. Along the side and top of a tall rocky hill, one mile west of Mounds in Creek County, April 11, 1960.

78. Along a rocky draw, six miles northwest of Renfrow in Grant County, April 15, 1960.

ECOLOGY

The area studied has many variations in habitat. These include timberland and grassland, a considerable range in average rainfall, different types of rocks such as limestone, sandstone, and loosely compacted silty clay, with shaded and exposed soil, and each having at least some species restricted to that particular environment.

As a consequence of this diversity, few lichen species are widespread in the study area. Only *Candelaria fibrosa, Parmelia bolliana, Physcia syncolla, Teloschistes chrysophthalmus, and Xanthoria candelaria* were collected in each county. Others which are widely distributed, occurring in at least eight counties, are *Acarospora citrina, Caloplaca aurantiaca, Candelaria concolor* (two varieties), *Lecanora muralis, Parmelia reticulate, Physcia aipolia, P. ciliata, P. orbicularis, P. Tribacoides,* and *P. stellaris.*

A total of 64 species were found in three counties or less, and 30 of these were collected in only one county each. Table I lists all species found and their occurrence by counties.

Corticolous Species

Growth Forms

Foliose

The foliose forms occurring primarily on trees, but occasionally on rocks, are *Anaptychia granulifera, A. heterochroa, A. hypoleuca, A. speciosa, Candelaria concolor* var. *concolor, C. concolor* var. *effuse, C. fibrosa, Collema conglomeratum, c. subfurvum, Dermatocarpon tuckermani, Leptogium chloromelum, L. cyanescens, Parmelia bolliana, P. caperata, P. haitiensis, P. reticulate, P. rudecta, Physcia aipolia, P. ciliate, P. elaeina, P. grisea, P. millegrana, P. orgicularis,*

P. tribacoides, P. stellaris, P. syncolla, Pyxine caesiopruinosa, Teloschistes chrysophthalmus (fruticose), and *Xanthoria candelaria.*

Candelaria concolor, C. fibrosa, Parmelia bolliana, P. reticulate, Physcia aipolia, P. orbicularis, P. tribacoides, P. stellaris, P. syncolla, Teloschistes chrysophthalmus, and Xanthoria candelaria occur generally throughout the area with *Parmelia bolliana and P. reticulate* being more abundant in the east (the Sandstone Hills region) than elsewhere, and *Physcia aipolia, P. syncolla,* and *Xanthoria candelaria* more abundant in the west (the Redbeds Plains area). Extreme east refers to one or more of Creek, Pawnee, and Osage counties. Westernmost refers to one or more of Grant, Garfield, and Kingfisher counties.

Those occurring only in the extreme east include *Anapptychia granulifera, A. hypoleuca, Dermatocarpon tuckermani, Physcia millegrana,* and *Pyxine caesiopruinosa.*

Other occurring over a wider area, but not found in the west are *Anaptychia heterochroa, Collema conglomeratum, C. subfurvum, Leptogium chloromelum, L. cyanescens, Parmelia caperata, P. haitiensis, P. rudecta,* and *Physcia grisea.*

The 29 “macro-corticolous” lichens indicate the gradual change from a more luxuriant lichen flora in the Ozarks where Hale (16) collected 63 species, which included all but three of the above group. He found 47 of these in six eastern Oklahoma counties. Only 11 of the 29 occur in Grant, Garfield, and Kingfisher counties.

Crustose

Crustose lichens found on trees include *Allarthonia caesia, Buellia punctata, B. schaereri, Caloplaca aurantiaca, C. cerina, C. chrysophthalma, C. microphylina, C. ulmorum, Candelariella xanthostigma, Crocynia membranacea, Lecanora hageni, L. piniperda, L. subfusca, L. varia, Lepraria chlorine, Graphis scripta, Pertusaria leioplaca, P. multipuncta,* and *P. pustulata.*

Only *Caloplaca aurantiaca* was found in some abundance throughout the area, while *C. chrysophthalma, C. microphylina, Lecanora hageni, L. varia, Pertusaria leioplaca, P. multipuncta,* and *P. pustulata* also occurred scattered in several counties. *Caloplaca microphylina* occurred only in the west while the others occurred primarily in the east.

Other species were collected infrequently but indicated the following distributional pattern: *Allarthonia caesia, Crocynia membranacea, Lecanora*

piniperda, L. subfusca, Lepraria chlorine, Graphis scripta, Pertusaria leioplaca, P. multipuncta, and *P. pustulata* occurred only in the east, and *Candelariella xanthostigma* only in the west.

Microhabitat

Most of the foliose forms were found on rough bark of various woody species although *Teloschistes chrysophthalmus* and *Xanthoria candelaria* were often found on dead twigs or bark of dead trees.

Crustose forms were divided into three categories: *Caloplaca microphylina, Buellia punctata,* and *B. schaereri* which were found n decaying fence posts or old stumps; *Allarthonia caesia, Lecanora hageni, L. piniperda, L. subfusca, Graphis scripta, Pertusaria leioplaca, and P. pustulata* which were found on smooth bark such as the younger parts of hickory (*Carya* sp.), hackberry (*Celtis laevigata*), redbud (*Cercis canadensis*), and red oak (*Quercus* sp.); and *Caloplaca aurantiaca, c. cerina, c. ulmorum,* and *Pertusaria multipuncta* which were found on rough bark such as post oak (*Quercus stellata)*, blackjack *(Q. marilandica*), cottonwood (*Populus deltoids)*, and elm (*Ulmus Americana).*

Saxicolous Species

Growth Forms

Foliose

Lichen species growing on rocks about equal the number growing on trees, but there is a greater proportion of crustose species. There are only a few that can properly be termed foliose; however, several others which approach this form are called “squamulose” or “near-foliose”. The first term applies to small bits of thallus that have the same morphology as a foliose lichen except that it is much smaller in diameter. The latter term applies to those forms that have a poorly developed thallus in the center but are thicker and lobed at the margins.

Lichens growing on rocks in the above categories are *Dermatocarpon miniatum, Endocarpon pusillum, Heppia hassei, Lecanora muralis, L. rubina, Lecidea rufonigra, L. russellii, Parmelia conspersa, P. isidiata, P. obsessa, P. stenophylla, Physcia halei, P. subtilis, P. teretiuscula,* and *Rinodina oreina.*

Lecanora muralis is the only species that occurs throughout the area. There are only a few species in the west but this likely reflects the extreme scarcity of rocks in the three westernmost counties. None of the species occurs primarily in the west, but *Lecidea rufonigra, L. russellii, Endocarpon*

pusillum, and *Heppia hassei* are rather intermediate while the other species are found exclusively in the east.

According to Weaver and Clements (33), foliose forms normally follow crustose forms in a xerosere, but Oosting and Anderson (26) indicate that crustose forms sometimes decay a rock in such a way that this succession is not followed. Both conditions were found in the study area.

Crustose

The crustose rock forms include the following species: *Acarospora citrine, A. fuscata, A. smaragdula, Bacidia granosa, B. umbrina, Buellia alboatra, B. novomexicana, B. retrovertens, B. spuria, B. stigmaea, B. vilis, Caloplaca arizonica, C. decipiens, C. flavovirencens, C. lobulata, C. murorum, Candelariella vitellina, Diploschistes actinostomus, d. scruposus,* var. *scruposus, Lecania californica, L. perproxima, Lecanora atra, L. calcarea, L. dispersa, L. melaena, Lecidea tesselina, Pertusaria pertusa, P. velata, Placynthium nigrum, Sarcogyne clavus, S. pruinosa, S. simplex, Verrucaria calsiceda,* and *V. nigrescens.*

Acarospora citrine, Candelariella vitellina, Diploschistes actinostomus, and Sarcogyne clavus are relatively widespread, but somewhat more abundant in the east. *Lecanora calcarea* is also widespread, but more frequent in the west. Others occurring less frequently but still not confined to a small area are *Acarospora fuscata, Caloplaca flavovirescens,* and *Lecanora dispersa.*

The other species were collected only a few times each, or in a small area, with the following distribution pattern: *Acarospora smaragdula, Bacidia granosa, Buellia novomexicana, B. spuria, B. stigmaea, Lecania californica, Lecanora atra, L. melanea, Pertusaria pertusa,* and *Verrucaria calciseda* are found only in the east, while *Buellia alboatra* and *B. vilis* are found only in the west. Many in this group occupy an intermediate to somewhat easterly position.

Types of Rock

Another important consideration is the type of rock. Those species found on limestone are *Bacidia granosa, Buellia alboatra, B. vilis, Dermatocarpon miniatum, Heppia hassei, Lecania californica, L. perproxima, Lecanora calcarea,* and *Verrucaria calsiceda.*

Those found on both sandstone and limestone are *Acaropsora fuscata, Caloplaca murorum, Endocarpon pusillum,*

Lecanora muralis, Lecidea russellii, Placynthium nigrum, and *Sarcogyne pruinosa,* while the remaining 35 species in this group are confined to sandstone.

There was a slight north to south variation since most of the limestone was found in the north.

Terricolous Species

The remaining species of lichens grow on soil or loosely compacted silty clay, sometimes being closely associated with rocks but not attached directly to them.

Included are *Cladonia apodocarpa, C. capitata, C. chlorophaea, C. fimbriata, C. subcariosa, C. subtenuis, C. uncialis, Coccocarpia cronia, Dermatocarpon hepaticum, Diploschistes scruposus,* var. *bryophila, Lecidea decipiens, Peltigera canina, Staurothele diffreactella,* and *S. umbrina.*

The Cladonia species occur primarily on thin, moist, shaded soil overlying sandstone. *Cladonia capitata* and *C. chlorophaea* are readily found in the east with *C. subcariosa* being restricted to a smaller area and also of less frequent occurrence. The other species are very infrequent and occur only in the extreme west. No *Cladonia* species were found in westernmost counties, although sterile, unidentifiable specimens were found only a few miles away in adjacent counties.

Coccocarpia cronia, which also occurs on tree bases, and *Diploschistes scruposus* var*. bryophila* occur only in the east and grow among mosses over sandstone.

Staurothele diffractella, s. umbrina, Dermatocarpon hepaticum, and *Lecidea decipiens* were found on exposed soil, and occur only in the west.

SUMMARY

Over 1000 specimens of lichens were collected in an 11-county area of North Central Oklahoma during 1959-60. this included 111 species and varieties representing 34 genera and 20 families. Their identificfation involved the use of 24 monographic studies and other taxonomic literature. Keys to various taxa and a list of all species are included. The order of listing families follows Fink (10) with nomenclature following Hale and Culberson (13). Families having the greatest number of species and varieties are Physciaceae 17, Lecanoraceae 14, Parmeliaceae 12, Caloplacaceae 10, and Buelliaceae 9. These five families contain 56 per cent of all species found. Table I shows the distribution by counties for each taxon. A

tablular view of families is shown in Table II.

The specimens are being deposited with the lichen collection of the Department of Botany and Plant Pathology at Oklahoma State University, and duplicates of most of these are in the author's private collection. Only five species were collected in each county, while ten othrs were collected in at least eight counties. Sixty-four species were collected in three counties or less and 30 of these were collected in only one county each. There was a much more luxuriant lichen flora in the east than in the west, with little north to south variation. Ecological relationships are discussed and remarks on location and habitat are given for each species in the "List of Species and Habitats".

Fifty-nine additions were made to the lichen flora of Oklahoma. These are given special reference in the keys.

LIST OF SPECIES AND HABITATS

[Ed. note: Nomenclature updated in 2006 by Douglas M. Ladd is in brackets]

The order of listing families follows Fink (10) while nomenclature follows Hale and Culberson (13). Each number is a collecting number for a specimen. These are referred to only for species which represent additions to the lichen flora of Oklahoma. When more than one specimen is cited for a species, each substrate is cited only once, and specimens without the substrate immediately following the collecting number have the same substrate as the one previously listed. Taxa preceded by an asterisk have not been previously reported as components of the Oklahoma lichen flora. Those species among this group not followed by special literature citations were not included in other literature pertinent to Oklahoma lichens. (11, 14, 15, 16, 18, 20).

Pyrenulales

Verrucariaceae

***Verrucaria calsiceda* DC.[= V. calciseda DC.]** is represented by Keck 68 on limestone, five miles west of Skiatook, in Osage County.

***Verrucaria nigrescens* Pers.** is represented by Keck 36 on sandstone, two miles northeast of Cleveland, in Osage County, and by Keck 1075 on limestone, six miles northwest of Renfrow in Grant County.

***Staurothele diffractella* (Nyl.)** Tuck. is represented by Keck 519 on poorly cemented silty clay, 15 miles east of Kingfisher in Kingfisher County.

***Staurothele umbrina* (Ach.) Tuck.** **[= S. fissa (Taylor) Zwackh];** on poorly cemented silty clay; Kingfisher County.

Dermatocarpaceae

***Dermatocarpon hepaticum* (Ach.) Th. Fr.** **[= Catapyrenium cinereum (Pers.) Körber, but these reports probably refer, at least in part, to *Placidium squamulosum* (Ach.) Breuss]** is represented by Keck 995 on exposed soil, two miles west of Kingfisher in Kingfisher County.

***Dermatocarpon miniatum* (L.) Mann.** **[reports on calcareous substrates probably refer to *D. muhlenbergii* (Ach.) Műll. Arg.]** is represented by Keck 76 on limestone, five miles west of Skiatook, in Osage County, and Keck 1056, six miles south and six miles east of Newkirk, in Kay County.

***Dermatocarpon tuckermani* (Rav.) Zahl.** **[= *Placidium arboretum* (Michener) Lendemer];** on post oak, in Osage County.

***Endocarpon pusillum* Hedw.** **[local reports probably refer to *E. pallidulum* (Nyl.) Nyl.]** is represented by Keck 374 on sandstone, one mile north of Warwick in Lincoln County, and by Keck 762 on limestone, four miles northeast of Newkirk in Kay County.

Hysteriales

Arthoniaceae

***Allarthonia caesia* Fw.** **[= *Arthonia caesia* (Flotow) Körber]** is represented by Keck 915 on persimmon (*Diospyros virginiana*), five miles southeast of Oilton, in Creek County; by Keck 57 on willow (*Salix nigra*), three miles south of Wild Horse store, and Keck 849 on redbud, 12 miles north of Pawhuska, both in Osage County.

Graphidaceae

***Graphis scripta* (L.)Ach.** is represented by Keck 678 on hackberry, one mile northwest of Blackburn in Pawnee County, and by Keck 939 on red oak, four miles northeast of Ripley in Payne County.

Lecanorales

Diploschistaceae

***Diploschistes actinostomus* (Pers.)Zahl.** **[(Ach.) Zahlbr.]** is represented by Keck 16 on sandstone, two miles east of Cleveland, in Osage County, and by Keck 440, 361, 536, 584, and 672 in Creek, Lincoln, Logan, Noble, and Pawnee counties, respectively.

Diploschistes scruposus* (Schreb.) Norm., var. *scruposus; on sandstone; Lincoln, Logan, Osage, and Payne counties.

***Diploschistes scruposus* (Schreb.) Norm., var. *bryophila* (Ehrh.) Ach.** **[= *D. muscorum* (Scop.) R. Sant.]** is represented by Keck 792 over mosses, five miles southwest of Stillwater in Payne County, and by Keck 345 over *Cladonia* sp. three and one-half miles southwest of Tryon in Lincoln County.

Collemaceae (5)

Collema conglomeratum Hoffm.: on post oak; Lincoln,

Pawnee, Lincoln, Pawnee, and Payne counties.

***Collema subfurvum* (Mull. Arg.) Degel.** **[= *C. subflaccidum* Degl.]**; on post oak and red cedar (*Juniperus virginiana);* Creek, Lincoln, Osage, and Payne counties.

****Leptogium chloromelum* (Sw.) Nyl.** **[occurs rarely in midcontinental North America; *L. millegranum* Sierk is more common]** is represented by Keck 614 on cedar, four miles northeast of Ripley in Payne County, and by Keck 796 on post oak, three miles south of Chandler in Lincoln County.

***Leptogium cyanescens* (Ach.) Khr.** **[(Rabenh.) Körber]**; on post oak; Lincoln County.

Heppiaceae

****Heppia hassei* Zahl.** **[= *Peltula* obscurans Nyl. var. hassei (Zahlbr.) Wetmore]** is represented by Keck 1067 on limestone, six miles northwest of Renfrow in Grant County, and by Keck 78 and 268 from Osage and Garfield counties, respectively.

Pannariaceae

****Placynthium nigrum* (Huds.) S. Gray** is represented by Keck 1075B on limestone, six miles northwest of Renfrow in Grant County, and by Keck 1081 on loosely compacted silty clay, 15 miles east of Kingfisher in Kingfisher County.

****Coccocarpia cronia* Tuck.** **[= *C. palmicola* (Sprengel) Arv. & D.J. Galloway]**; on moss-covered sandstone; Creek County.

Peltigeraceae (31)

***Peltigera canina* (L.) Willd.;** **[probably *P. praetextata* (Flörke ex Sommerf.) Zopf]**; on shaded mossy banks, usually overlying sandstone; Creek, Pawnee, and Payne counties.

Lecideaceae

***Lecidea decipens* (Ehrh.) Ach.** [= *Psora decipiens* (Hedw.) Hoffm.]; on open soil over *Dermatocarpon hepaticum;* Grant, Kingfisher, and Noble counties.

***Lecidea rufonigra* (Tuck.)Nyl.** **[= Psorula rufonigra (Tuck.) Gotth. Schneid.]** is represented by Keck 1010 on sandstone, one-half mile southwest of Tuskegee in Creek County.

***Lecidea russellii* Tuck.** **[= *Psora russellii* (Tuck.) A. Schneid., a terricolous species – these reports of saxicolous populations refer to *Psora pseudorussellii* Timdal]**; on sandstone and limestone; Lincoln, Logan, and Osage counties.

****Lecidea tesselina* Tuck.** **[= *Lecanora oreinoides* (Körber) Hertel & Rambold]** is represented by Keck 10 on sandstone, two miles east of Cleveland, in Osage County, and by Keck 113, 143, 871, and 880 at other locations in Osage County.

****Bacidia granosa* (Tuck.) Zahl.** **[= Bacidia coprodes (Körber) Lettau]** is represented by Keck 75 on limestone, five miles west of Skiatook, in Osage County.

***Bacidia umbrina* (Ach.) Bausch [= *Scoliciosporum umbrinum*) Ach.) Arnold]** is represented by Keck 586 on sandstone, seven miles west of Perry in Noble County.

Cladoniaceae (16, 24)

***Cladonia apodocarpa* Robbins** is represented by Keck 1053 on shaded soil, 12 miles north of Pawhuska in Osage County, and by Keck 1046, one mile west of Mounds in Creek County.

***Cladonia capitata* (Michx.) Spreng. [= *C. peziziformis* (With.) J.R. Laundon]** is represented by Keck 784 on shaded soil, five miles southwest of Stillwater in Payne County and by Keck 100, 663, 998, and 1037 in Osage, Pawnee, Logan, and Lincoln counties, respectively.

***Cladonia chlorophaea* (Fik.) Spreng. [possibly including or consisting of this species and/or *C. cryptochlorophaea* Asahina and *C. grayi* G. Merr.];** on thin soil over sandstone; Creek, Lincoln, Osage, Pawnee, and Payne counties.

***Cladonia fimbriata* (L.) Fr. [possibly, but not known from Oklahoma; these reports more likely refer to the *C. chlorophaea* complex (see previous entry]** is represented by Keck 388 on thin soil over sandstone, three miles south of Chandler in Lincoln County.

***Cladonia subcariosa* Nyl. [= *C. polycarpoides* Nyl.]** is represented by Keck 26 on shaded soil, two miles east of Cleveland, in Osage County, and by Keck 392C and 663B in Lincoln and Pawnee counties, respectively.

***Cladonia subtenuis* (des Abbayes) Evans [(Abbayes) Mattick]** is represented by Keck 847 on slightly shaded soil, 12 miles north of Pawhuska in Osage County.

***Cladonia uncialis* (L.) Web. [(L.) F.H.Wigg.]** is represented by Keck 1054 on slightly shaded soil, 12 miles north of Pawhuska in Osage County.

Acarosporaceae

***Sarcogyne clavus* (Ram.) Krmph.** is represented by Keck 29 on sandstone, two miles east of Cleveland, in Osage County, and by Keck 465, 289, 359, 540, 595, and 674 in Creek, Garfield, Lincoln, Logan, Noble, and Pawnee counties, respectively.

***Sarcogyne pruinosa* (Sm.) Kbr. [=*S. regularis* Körber.]** is represented by Keck 725 on sandstone, seven miles east of Fairfax in Osage county, and by Keck 271 and 1073 on limestone, in Garfield and Grant counties, respectively.

***Sarcogyne simplex* (Dav.) Nyl. [= *Polysporina simplex* Davies) Vězda];** on sandstone; Logan County.

***Acarospora citrina* (Tayl.) Zahl.;** on sandstone; Creek, Garfield, Lincoln, Logan, Noble, Osage, Pawnee, and Payne counties.

***Acarospora fuscata* (Nyl.) Arn.** **[(Schrader) Arnold]** is represented by Keck 82 on limestone, five miles west of Skiatook, and Keck 2 on sandstone, two miles east of Cleveland, both in Osage County, and Keck 1033, 659, and 642 in Lincoln, Pawnee, and Payne counties respectively.

***Acarospora smaragdula* (Wh.) Th. Fr.** is represented by Keck 40 on sandstone, two miles east of Cleveland, in Osage County, and by Keck 368 and 653 in Lincoln and Pawnee counties, respectively.

Pertusariaceae

***Pertusaria leioplaca* (Ach.)DC.** **[DC.; this report may include or consist of *P. paratuberculifera* Dibben, which is locally common on hardwoods in the eastern portion of the study area]** is represented by Keck 13 on blackjack oak, two miles east of Cleveland, in Osage County, and by Keck 464, 382, 573, and 611 on various woody species in Creek, Lincoln, Noble, and Payne counties, respectively.

***Pertusaria multipuncta* (Turn.) Nyl.;** **[= *P. multipunctoides* Diben]** on blackjack oak, post oak, and hickory; Creek, Lincoln, Osage, and Payne counties.

***Pertusaria pertusa* (L.) Tuck.** **[North American reports of this taxon are based on misidentifications; several pre-1980 Missouri specimens determined as this species are actually *P. plittiana* Erichsen, and the sandstone substrate cited here indicates a similar possibility];** on sandstone; Creek and Payne counties.

***Pertusaria pustulata* (Ach.) Duby** is represented by Keck 415 on post oak, three and one-half miles east of Shamrock in Creek County, and by Keck 368, 128, 669, and 269 on various woody species in Lincoln, Osage, Pawnee, and Payne counties respectively.

***Pertusaria velata* (Turn.) Nyl.** is represented by Keck 1028 on sandstone, one mile northwest of Ripley in Payne County.

Lecanoraceae

***Lecanora atra* (Huds.) Ach.** **[= *Tephromela atra* (Huds.) Hafellner];** on sandstone; Creek County.

***Lecanora calcarea* (L.)Smrft.** **[=*Aspicilia calcarea* (L.) Mudd; local reports may include or consist of *A. contorta* (Hoffm.) Kremp.)** is represented by Keck 66 on limestone, five miles west of Skiatook, in Osage County, and by Keck 270, 1070, 531, 558, and 905 in Garfield, Grant, Logan, Noble, and Pawnee counties, respectively.

***Lecanora dispersa* (Pers.) Rohl.** **[= (Pers.) Sommerf.]** is represented by Keck 240 on cement, three miles southwest of Hillsdale in Garfield County, and by Keck 538, 582, and 728 on sandstone, in Logan, Noble, and Osage counties respectively.

***Lecanora hageni* Ach.; [= *L. hagenii* (Ach.) Ach.]** on hickory, hackberry, persimmon, pecan (*Carya illinoensis)*, red cedar, and various oaks; Creek, Kay, Lincoln, Noble, and Payne counties.

****Lecanora melaena* (Hedl.) Fink** is represented by Keck 38 on sandstone, two miles east of Cleveland, in Osage county.

***Lecanora muralis* (Schreb.) Rabh.;** on sandstone and limestone; Creek, Garfield, Kay, Logan, Noble, Osage, Pawnee, and Payne counties.

****Lecanora piniperda* Kbr. [Brodo et al. (2001) restrict the range of this taxon to boreal North America and the Rocky mountains]** is represented by Keck 414 on post oak, three and one-half miles southwest of Avery in Lincoln County, and by Keck 853 on redbud, 12 miles north of Pawhuska in Osage County.

****Lecanora rubina* (Vill.) Ach. [= *Rhizoplaca chrysoleuca* (Sm.) Zopf]** is represented by Keck 117 on sandstone, 12 miles north of Pawhuska in Osage County, and by Keck 948 and 686 in Noble and Pawnee counties, respectively.

***Lecanora subfusca* (L.) Ach. [= *L. allophana* Nyl., but probably refers to *L. hybocarpa* (Tuck.) Brodo];** on hackberry, persimmon, red oak, hickory, redbud, ash *(Fraxinus americana*), and red cedar; Creek, Kay, Lincoln, Osage, Pawnee, and Payne counties.

***Lecanora varia* (Ehrh.) Ach. [(Hoffm.) Ach.; almost certainly refers to *L. strobilina* (Sprengel.) Keiffer];** on hickory, persimmon, post oak, plum (*Prunus* sp.), birch *(Betula nigra*), redbud, ash, and cedar; Creek, Kay, Lincoln, Osage, Pawnee, and Payne counties.

****Lecania californica* (Zahl.) Fink** is represented by Keck 71 on limestone, five miles west of Skiatook, in Osage County.

****Lecania perproxima* (Nyl.)Zahl.** is represented by Keck 1015 on sandstone, one-half mile west of Meridian in Logan County.

****Candelariella vitellina* (Ehrh.) Mull Arg. [(Hoffm.) Műll. Arg.];** on sandstone; Creek, Garfield, Lincoln, Logan, Noble, Osage, Pawnee, and Payne counties.

****Candelariella xanthostigma* (Pers.) Lett. [(Ach.) Lettau]** is represented by Keck 188 over *Physcia* sp. on cottonwood, two miles south of Lamont in Grant County.

Parmeliaceae

***Candelaria concolor* (Dicks.) [(Dicks.) Stein.] Arn. Var. *concolor*;** on elm, soapberry, (*Sapindus drummondii*), red cedar, hackberry, willow, birch, mulberry *(Morus rubra*), post oak, and blackjack oak; Creek, Garfield, Grant, Kingfisher, Logan, Noble, and Osage counties.

***Candelaria concolor* (Dicks.) Arn. var. *effuse* (Tuck.) Merr. & Burnh.** is represented by Keck 982 on Willow, three miles southeast of Hillsdale in Garfield County, and by Keck 323 on elm and 899 on bois-d'Arc in Logan and Pawnee counties, respectively.

***Candelaria fibrosa* (Fr.) Mull. Arg.;** on most woody species and on sandstone; Creek, Garfield, Grant, Kay, Kingfisher, Lincoln, Logan, Noble, Osage, Pawnee, and Payne counties.

***Parmelia bolliana* Mull. Arg.; [= *Punctelia bolliana* (Műll. Arg.) Krog and/or *Punctelia graminicola* (de Lesd.) Egan];** on most woody species and on sandstone; Creek, Garfield, Grant, Kay, Kingfisher, Lincoln, Logan, Noble, Osage, Pawnee, and Payne counties.

***Parmelia caperata* (L.) Ach.; [= *Flavoparmelia caperata* (L.) Hale and/or *F. baltimorensis* (Gyeln. & Foŕiss.) Hale;** blackjack oak, sandstone, and thin soil overlying sandstone; Creek, Lincoln, Osage, and Payne counties.

***Parmelia conspersa* (Ehrh.)Ach. [= *Xanthoparmelia conspersa* (Ach.) Hale; may refer to other isidiate taxa of *Xanthoparmelia, with a dark lower cortex, such as X. mexicana* (Gyeln.) Hale];** on sandstone; Creek and Osage counties.

****Parmelia haitiensis* (Hale)[= *Parmotrema hatiense* (Hale) Hale]** is represented by Keck 944 on sandstone, four miles northeast of Ripley in Payne County, and by Keck 418, 348, and 841 on post oak or black jack in Creek, Lincoln, and Osage counties, respectively.

***Parmelia isidiata* (Anzi) Gyel.;** on sandstone; Logan, Noble, and Pawnee counties.

***Parmelia obsessa* (Ach.); [= *Myelochroa obsessa* (Ach.) Elix & Hale];** on sandstone; Creek County.

***Parmelia reticulate* (Tayl.)[= *Parmotrema reticulatum* (Taylor) M. Choisy];** on blackjack oak, post oak, redbud, elm, red cedar, and sandstone; Creek, Kay, Kingfisher, Lincoln, Logan, Noble, Osage, Pawnee, and Payne counties.

***Parmelia rudecta* Ach. [*Punctelia rudecta* (Ach.) Krog; may also include *Punctelia missouriensis* G. Wilh. & Ladd];** on blackjack oak and sandstone; Lincoln, Osage, and Payne counties.

***Parmelia stenophylla* (Achl.) Heug. [= *Xanthoparmelia viriduloumbrina* (Gyeln.) Lendemer];** on sandstone; Osage County.

Caloplacaceae

****Caloplaca arizonica* Rudolph non Magn. [possibly *C. subsoluta* (Nyl.) Zahlbr.]** is represented by Keck 94 on sandstone, two miles north of Barnsdall in Osage county, and by Keck 1007 and 813 in Logan and Pawnee counties, respectively.

***Caloplaca aurantiaca* (Lightf.) Th. Fr.[= *C. flavorubescens* (Huds.) J.R. Laundon];** on most woody species; Creek, Garfield, Grant, Kay,

Kingfisher, Lincoln, Logan, Noble, Osage, and Payne counties.

***Caloplaca cerina* (Ehrh.) Th. Fr.;** on elm and cottonwood; Garfield and Grant counties.

****Caloplaca chrysophthalma* Degel. [while this taxon is frequent in the region, it is a corticolous species]** is represented by Keck 462, 748,835,689, and 308 on various woody species in Creek, Kay, Osage, Pawnee, and Payne counties, respectively.

****Caloplaca dicipiens* (Arn.)Jatta. [(Arnold) Blomb. & Forss.]** is represented by Keck 583 and 597 on sandstone, seven miles west of Perry in Noble County.

****Caloplaca flavovirescens* (Wulf.) D.T. & S.** is represented by Keck 4 on sandstone, two miles east of Cleveland, in Osage County, and by Keck 432, 1012, and 568 from Creek, Lincoln, and Noble counties, respectively.

****Caloplaca lobulata* (Floerke) Hellb. [(Flörke) de Lesd.]**is represented by Keck 92 on sandstone, two miles north of Barnsdall in Osage County, and by Keck 376, 527, and 814 from Lincoln, Logan, and Pawnee counties, respectively.

****Caloplaca microphylina* (Tuck.) Hasse** is represented by Keck 278 on mulberry, eight miles north of Garber in Garfield County, and by Keck 220, 757, 510, 410, and 576, primarily on fence posts and dead wood, in Grant, Kay, Kingfisher, Lincoln, and Noble counties, respectively.

***Caloplaca murorum* (Hoffm.) Th. Fr.; [= *C. saxicola* (Hoffm.) Nordin (may represent misidentification)]** on sandstone and limestone; Garfield, Osage, and Payne counties.

****Caloplaca ulmorum* Fink [(Fink) Fink]** is represented by Keck 233 on cottonwood, three miles southeast of Hillsdale in Garfield County, and by Keck 178, 746, 521, 417, and 155 on elm, cottonwood, and dead wood in Grant, Kay Kingfisher, Logan, and Osage counties, respectively.

Teloschistaceae (30)

***Teloschistes chrysophthalmus* (L.) Th. Fr.;** on various woody species especially dead twigs; Creek, Garfield, Grant, Kay, Kingfisher, Lincoln, Logan, Noble, Osage, Pawnee, and Payne counties.

***Xanthoria candelaria* (L.) Arn. [possibly *Xanthomendoza fulva* (Hoffm.) Søchting or *Xanthomendoza fallax* (Hepp) Søchting];** on various woody species, especially bark of dead trees; Creek, Garfield, Grant, Kay, Kingfisher, Lincoln, Logan, Noble, Osage, Pawnee, and Payne counties.

Buelliaceae (22)

***Buellia alboatra* (Hoffm.) Th. Fr.** **[= *Diplotomma alboatrum* (Hoffm.) Flotow, possibly including or consisting of *D. venustum* (Körber) Körber]** is represented by Keck 1079 on limestone, six miles northwest of Renfrow in Grant County, and by Keck 1065 in Garfield County. Imshaug (22) lists this species as occurring in several northeastern and midwestern states extending no farther south than Colorado.

****Buellia novomexicana* B. de Lesd.** **[= *B. tyrolensis* Körber]** is represented by Keck 2 on sandstone, two miles east of Cleveland, in Osage County, and by Keck 593 on sandstone and 86 on limestone in Noble and Osage counties, respectively.

***Buellia punctata* (Hoffm.) Mass.** **[= *Amandinea punctata* (Hoffm.) Coppins & Scheid.];** on sandstone and dead wood; Garfield, Grant, Osage, Pawnee, and Payne counties.

****Buellia retrovertens* Tuck.** is represented by Keck 581 on sandstone, seven miles west of Perry in Noble County, and by Keck 675 from Pawnee County. Imshaug (22) lists this species as occurring from Texas, New Mexico, and Colorado westward to the coast.

****Buellia schaereri* Dnot.** **[may represent misidentifications; this is a boreal taxon that is restricted to coniferous substrates (possibly *Amandinea sp.?)]*** is represented by Keck 509 and 513 on dead wood, one-half mile south of Loyal, in Kingfisher County. Imshaug (22) lists this species as boreal, and reported only from states bordering Canada.

***Buellia spuria* (Schaer.) Anzi**; on sandstone; Osage County.

****Buellia stigmaea* Tuck.** **[= *B. maculate* Bungartz?]** Is represented by Keck 882 on sandstone, two miles east of Cleveland, in Osage County, and by Keck 439 and 711 in Creek County. Imshaug (22) lists this species from several southern states but not farther west than Missouri.

****Buellia vilis* Th.Fr.** is represented by Keck 67 on limestone, five miles west of Skiatook, in Osage County. Imshaug (22) lists this species only from North Dakota and Colorado.

***Rinodina oreina* (Ach.) Mass.** **[=*Dimelaena oreina* (Ach.) Norman]**; on sandstone; Osage and Pawnee counties.

Physciaceae (23)

****Pyxine caesiopruinosa* (Tuck.) Imshaug** **[possibly *P. subcinerea* Stirton]** is represented by Keck 702 on red oak, five miles southeast of Oilton, in Creek County. Imshaug (23) lists this species as occurring only from several Gulf Coast states.

***Physcia aipolia* (Ehrh.) Hampe [(Ehrh. Ex Humb.) Fűrnr.];** on various woody species; Garfield, Grant, Kay, Kingfisher, Lincoln, Logan, Noble, Osage, Pawnee, and Payne counties.

***Physcia ciliata* (Hoffm.) DR.[= *Phaeophyscia ciliata* (Hoffm.) Moberg];** on soapberry, elm, cottonwood, post oak, and ash; Garfield, Grant, Kay, Lincoln, Noble, Osage, Pawnee, and Payne counties.

***Physcia elaeina* (Sm.) A. L. Sm. [= *Hyperphyscia adglutinata* (Flörke) H. Mayrhofer & Poelt];** on cottonwood and hickory; Garfield, Grant, and Osage counties

***Physcia grisea* (Lam.) Zahl. [probably *Physconia leucoleiptes* (Tuck.) Essl.];** on blackjack oak, post oak, hickory, and elm; Creek, Lincoln, Noble, and Osage counties.

****Physcia halei* Thomson** is represented by Keck 816 on sandstone, eight miles north of Morrison, in Pawnee County, and by Keck 115, 134, and 875 from Osage County.

***Physcia millegrana* Degel.;** on birch; Osage County.

***Physcia orbicularis* (Neck.) Poetsch. [= *Phaeophyscia orbicularis* (Necker) Moberg, but probably other sorediate species including *P. adiastola* (Essl.) Essl, *P. insignis*) Mereschk.) Moberg, *P. pusilloides* (Zahlbr.) Essl. or *P. rubropulchra* (Degel.) Essl.];** on various woody species and limestone; Creek, Garfield, Kay, Kingfisher, Logan, Noble, Osage, and Payne counties.

***Physcia stellaris* (L.) Nyl.;** on various woody species and sandstone; Creek, Garfield, Kay, Kingfisher, Lincoln, Logan, Noble, Osage, Pawnee, and Payne counties.

****Physcia syncolla* Tuck. [= *Hyperphyscia syncolla* (Tuck ex Nyl.) Kalb]** is represented by Keck 1041 on hackberry, one mile west of Mounds in Creek County, and by Keck 197, 737, 480, 383, 319, 556, 156, 645, and 635 on various woody species from Garfield, Grant, Kay, Kingfisher, Lincoln, Logan, Noble, Osage, Pawnee, and Payne counties, respectively.

***Physcia teretiuscula* (Ach.) Lynge [= *P. dubia* (Hoffm.) Lettau; possibly *Speerschneidera euploca* (Tuck.) Trevisan or *Physcia subtilis* Degel.];** on sandstone; Creek County.

***Physcia tribacoides* Nyl.; [possibly *P. americana* G. Merr.]** on post oak, blackjack oak, elm, hackberry, persimmon, red cedar, and sandstone; Creek, Grant, Kay, Lincoln, Logan, Osage, and Payne counties.

***Anaptychia granulifera* (Ach.) Mass.;** [**= *Heterodermia* granulifera (Ach.) W.L. Culb.]** on post oak; Osage County.

***Anaptychia heterochroa* Vain.[= *Heterodermia obscurata* (Nyl.) Trevisan];** on various oaks, hickory, and sandstone; Creek, Lincoln, Osage, Pawnee, and Payne counties.

***Anaptychia hypoleuca* (Muhl.) Vain.** **[= *Heterodermia hypoleuca* (Muhl.) trevisan];** on post oak and red oak; Creek and Osage counties.

***Anaptychia speciosa* (Wulf.) Mass.** **[= *Heterodermia speciosa* (Wulfen) Trevisan];** on sandstone; Payne County.

Lichenes Imperfecti

Leprariaceae

****Lepraria chlorina* Ach.** **[= *Chrysothrix chlorina* (Ach.) J.R. Laundon, but probably *Chrysothrix candelaris* (L.) J.R. Laundon]** is represented by Keck 1052 on birch, in Osage Hills State Park in Osage County.

****Crocynia membranacea* (Dicks.) Zahl.** **[probably *Lepraria lobificans* Nyl.]** is represented by Keck 307 on post oak, one mile north of Coyle in Payne County, and by Keck 422, 353, 315, 562, and 140 on various oaks or sandstones from Creek, Lincoln, Logan, Noble, and Osage counties, respectively.

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TABLE I SPECIES OCCURRENCY BY COUNTIES

	Creek	Garfield	Grant	Kay	Kingfisher	Lincoln	Logan	Noble	Osage	Pawnee	Payne
Acarospora citrine	X	X				X	X	X	X	X	X
A. fuscata		X				X			X	X	X
A.smaragdula						X			X	X	
Allarthonia caesia	X								X		
Anaptychia granulifera									X		
A. heterochroa	X					X			X	X	X
A. hypoleuca	X									X	
A. speciosa											X
Bacidia granosa									X		
B. umbrina								X			
Buellia alboatra		X	X								
B. novomexicana								X	X	X	
B. punctata		X	X						X	X	X
B. retrovertens								X		X	
B. schaereri					X						
B. spuria									X		
B. stigmaea	X								X		
	C	G	G	K	K	L	L	N	O	P	P

B. vilis									X		
Caloplaca arizonica							X		X	X	
C. aurantiaca	X	X	X	X	X	X	X	X	X		X
C. cerina		X	X								
C. chrysophthalma	X			X		X			X	X	X
C. decipiens								X			
C. flavovirescens	X					X		X	X		
C. lobulata						X	X		X	X	
C. microphylina		X	X	X	X	X		X			
C. murorum		X							X		X
C. ulmorum		X	X	X	X		X		X		
Candelaria concolor var. *concolor*	X	X	X		X		X	X	X		
C. concolor var. effusa		X					X			X	
C. fibrosa	X	X	X	X	X	X	X	X	X	X	X
Candelariella vitellina	X	X				X	X	X	X		X
C. xanthostigma			X								
Cladonia apodocarpa	X								X		
	C	G	G	K	K	L	L	N	O	P	P

C. capitata						X	X		X	X	X
C. chlorophaea	X					X			X	X	X
C. fimbriata						X					
C. subcariosa						X			X	X	
C. subtenuis									X		
C. uncialis									X		
Coccocarpia cronia	X										
Collema conglomeratum						X			X	X	X
C. subfurvum	X					X			X		X
Crocynia membranacea	X					X	X	X	X		X
Dermatocarpon hepaticum			X		X			X			
D. miniatum				X					X		
D. tuckermani									X		
Diploschistes actinostomus	X	X				X	X	X	X	X	
D. scruposus var. *scruposus*						X	X		X		X
D. scruposus var. *bryophila*						X					X
Endocarpon pusillum				X		X					
Graphis scripta										X	X
	C	G	G	K	K	L	L	N	O	P	P

Heppia hassei		X	X						X		
Lecania californica									X		
L. perproxima							X				
Lecanora atra	X										
L. calcarea		X	X	X			X	X	X	X	
L. dispersa		X					X	X	X	X	
L. hageni	X			X		X		X			X
L. melaena									X		
L. muralis	X	X		X			X	X	X	X	X
L. piniperda	X								X		
L. rubina								X	X	X	
L. subfusca	X					X			X		X
L. varia	X			X		X			X	X	X
Lecidea decipiens			X		X			X			
L. rufonigra	X						X				
L. russellii						X	X		X		
L. tesselina									X		

	Creek	Garfield	Grant	Kay	Kingfisher	Lincoln	Logan	Noble	Osage	Pawnee	Payne
Lepraria chlorine									X		
Leptogium chloromelum						X					X
L. cyanescens						X					
Parmelia bolliana	X	X	X	X	X	X	X	X	X	X	X
P. caperata	X					X			X		X
P. conspersa	X								X		
P. haitiensis	X					X			X		X
P. isidiata							X	X		X	
P. obsessa									X		
P. reticulata	X			X	X	X	X	X	X	X	X
P. rudecta						X			X		X
P. stenophylla									X		
Peltigera canine	X									X	X
Pertusaria leioplaca	X					X		X	X	X	X
P. multipuncta	X					X			X		X
P. pertusa	X										X
P. pustulata	X					X			X	X	X
P. velata											X
	C	G	G	K	K	L	L	N	O	P	P

Physcia aipolia		X	X	X	X	X	X	X	X	X	X
P. ciliata		X	X	X		X		X	X	X	X
P. elaeina		X	X						X		
P. grisea	X					X		X	X		
P. halei									X	X	
P. millegrana									X		
P. orbicularis	X	X		X	X		X	X	X		X
P. stellaris	X	X		X	X	X	X	X	X	X	X
P. subtilis									X	X	
P. syncolla	X	X	X	X	X	X	X	X	X	X	X
P. teretiuscula										X	
P. tribacoides	X		X	X		X	X		X		X
Placynthium nigrum			X		X		X				
Pyxine caesiopruinosa	X										
Rinodina oreina									X	X	
Sarcogyne clavus	X	X				X	X	X	X	X	
S. pruinosa		X	X						X		
	Cre	**Gar**	**Gra**	**Kay**	**Kin**	**Lin**	**Log**	**Nob**	**Osa**	**Paw**	**Pay**

S. simplex							X				
Staurothele diffractella					X						
S. umbrina					X						
Teloschistes chrysophthalmus	X	X	X	X	X	X	X	X	X	X	X
Verrucaria calsiceda									X		
V. nigrescens			X						X		
Xanthoria candelaria	X	X	X	X	X	X	X	X	X	X	X
Total species	44	29	24	21	19	45	32	33	77	41	42

TABLE II TABULAR VIEW OF THE FAMILIES

Families		**Genera**	**Species and subordinate taxa**
Verrucariaceae		2	4
Dermatocarpaceae		2	4
Arthoniaceae		1	1
Graphidaceae		1	1
Diploschistaceae		1	3
Collemaceae		2	4
Heppiaceae		1	1
Pannariaceae		2	2
Peltigeraceae		1	1
Lecideaceae		2	6
Cladoniaceae		1	7
Acarosporaceae		2	6
Pertusariaceae		1	5
Lecanoraceae		3	14
Parmeliaceae		2	12
Caloplacaceae		1	10
Teloschistaceae		2	2
Buelliaceae		2	9
Physciaceae		3	17
Leprariaceae		2	2
TOTALS	20	34	111

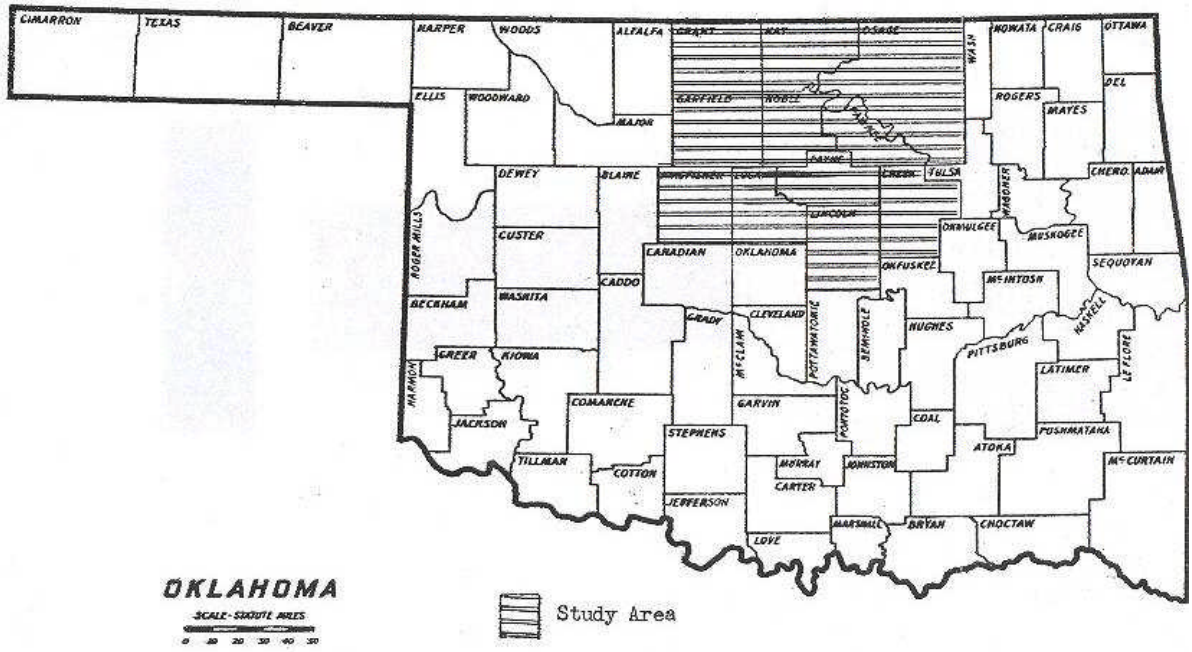

Fig. 1. Map of Oklahoma Showing the Study Area

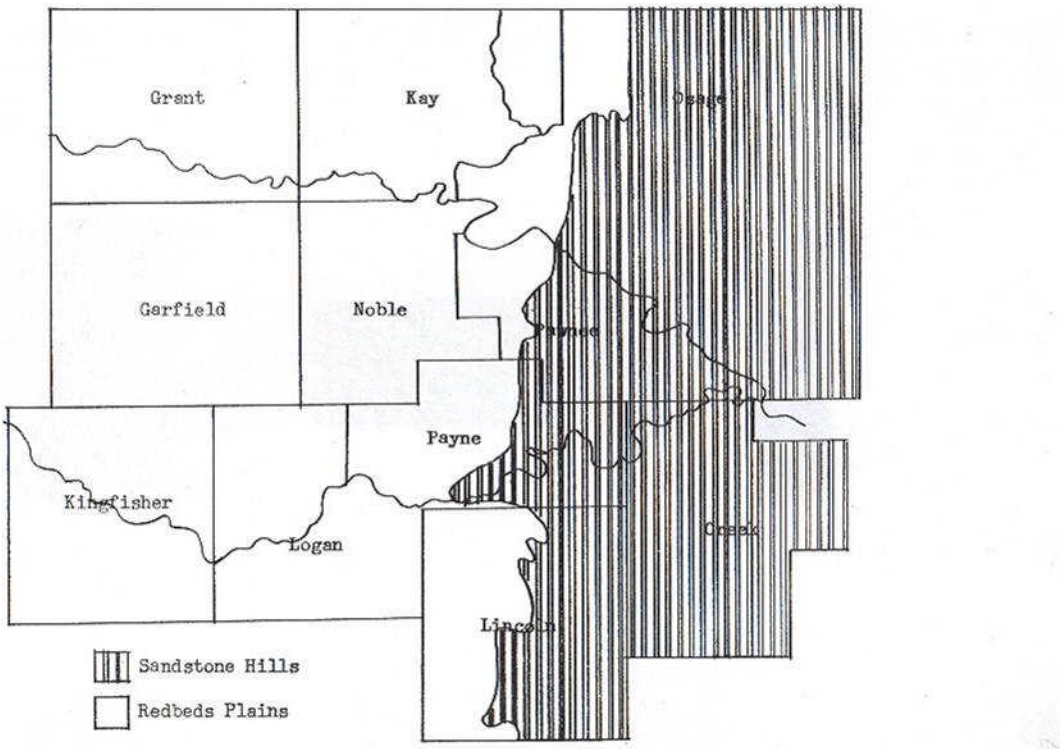

Fig. 2. Physiographic Regions of the Study Area

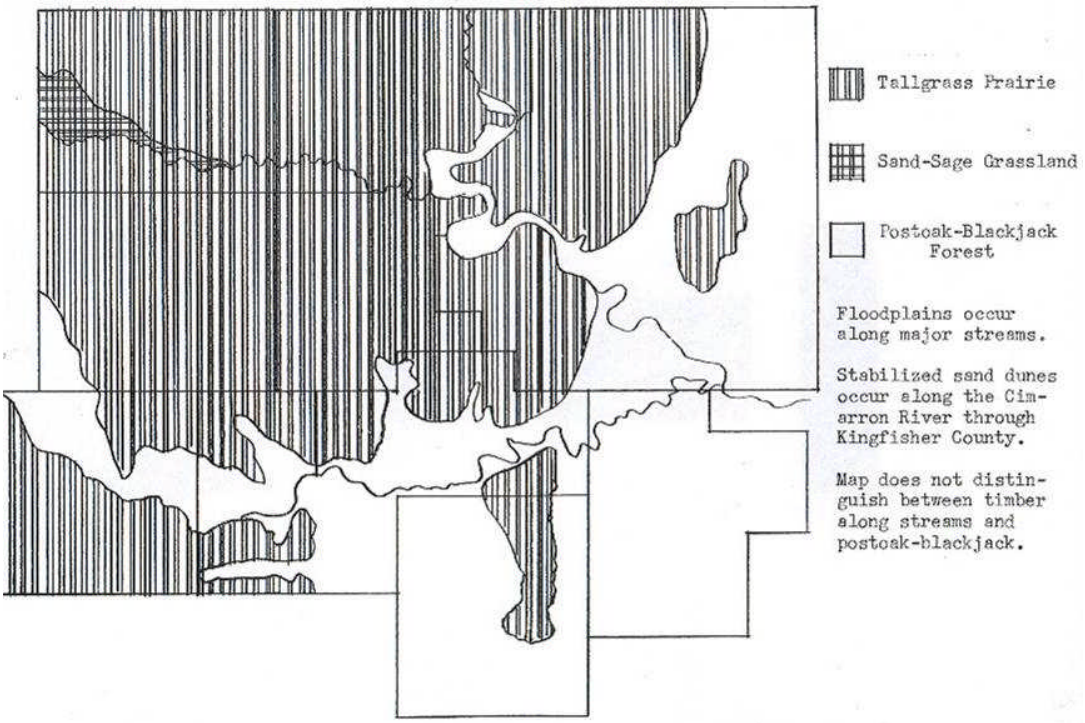

Fig. 3. A Vegetation Map of North Central Oklahoma

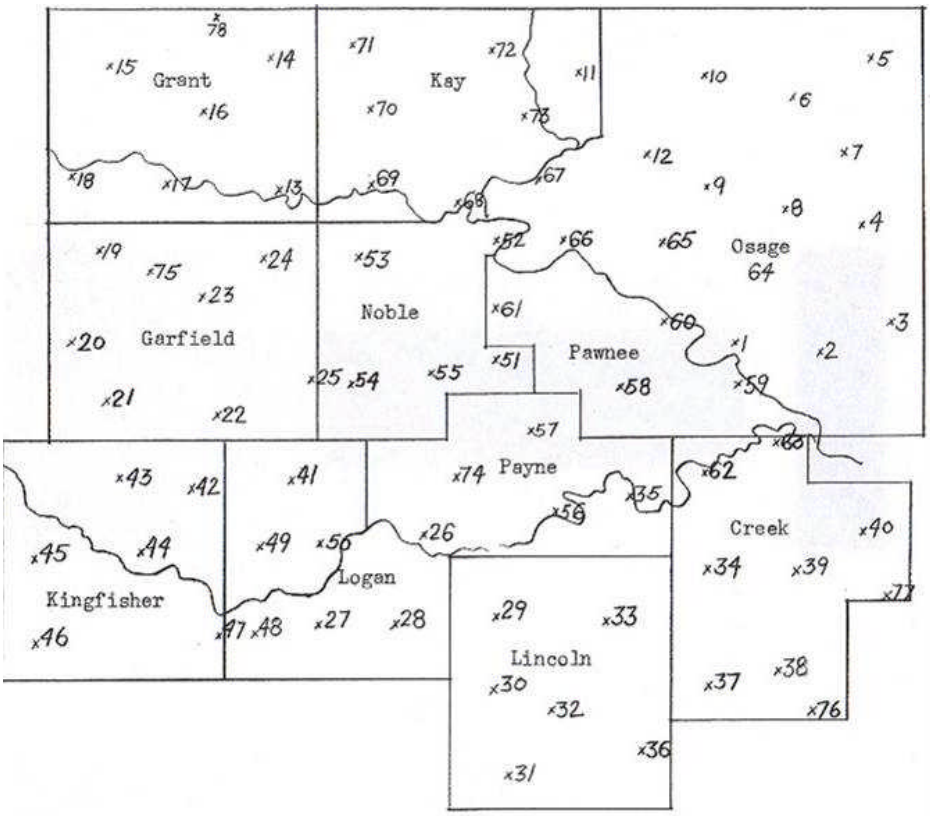

Fig. 4. Location of Collecting Sites

TAXONOMIC TREATMENT

Keys to Various Taxa

Key to Classes, Orders, and Families

1. Thallus of more or less definite form, usually with ascocarps. Ascolichenes
1. Thallus of entangled hyphae, without ascocarps . . . . . Lichenes Imperfecti

Ascolichenes

1. Hymenium produced in a perithecium . . . . . .Pyrenulales
1. Hymenium produced in an apothecium
   2. Thallus rudimentary; apothecia irregular, linear or oblong. . . . . Hysteriales
   2. Thallus commonly well developed; apothecia more or less round or cuplike . . . . . Lecanorales

Pyrenulales

1. Thallus crustose . . . . . Verrucariaceae
1. thallus squamulose or foliose. . . . . Dermatocarpaceae

Hysteriales

1. Apothecia without an exciple . . . . . .Arthonicaceae
1. Apothecia with an exciple. . . . . Graphidaceae

Lecanorales

1. Phycobiont a species of Myxophyceae
   2. Thallus squamulose to foliose, taking its form from that of the phycobiont . . . . . .Collemaceae
   2. Thallus foliose to granulose; not taking its form from the phycobiont
      3. Thallus large, plainly foliose . . . . . Peltigeraceae
      3. Thallus smaller, somewhat foliose to granulose
         4. Spores many per ascus . . . . . Heppiaceae
         4. spores 8 per ascus . . . . . Pannariaceae
1. Phycobiont a species of Chlorophyceae
   5. Apothecia with both thalloid and proper exciples. . . . Diploschistaceae
   5. Apothecia with either thalloid or proper exciple, but not with both
      6. Thallus two-fold, having both squamules and podetia. . Cladoniaceae
      6. Thallus otherwise
         7. Spores brown
            8. Thallus crustose to scaly . . . . . Buelliaceae
            8. Thallus foliose . . . . . Physciaceae
         7. Spores hyaline
            9. Spores very large, commonly up to 200 microns

long . . . . . Pertusariaceae
9. spores smaller
10. Thallus plainly foliose to fruticose
11. Thallus generally small, yellowish in color Teloschistaceae
11. Thallus larger, not yellowish. Parmeliaceae
10. Thallus crustose to squamulose, or near foliose
12. Spores minute, many per ascus . . . . . Acarosporaceae
12. Spores larger, usually eight per ascus
13. Apothecia with proper exciple . . . . . Lecideaceae
13. Apothecia with thalloid exciple
14. Apothecia usually yellowish, spores usually one-septate with cells polar Caloplacaceae
14. Apothecia rarely yellowish, spores non-septate, septate, or muriform, but not polar . . . . . Lecanoraceae

Lichenes Imperfecti

The only family representing this group is Leprariaceae.

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Volume 6, Number 1, December 2006

KEY TO GENERA AND SPECIES

Pyrenulales

Verrucariaceae

1. Spores non-septate . . . . . 1. Verrucaria
1. Spores muriform. . . . . 2. Staurothele

1. Verrucaria

1. Thallus grayish-white . . . . . *V. calciseda*
1. Thallus brownish or greenish to black . . . . *V. nigrescens*

2. Staurothele

1. Spores two per ascus . . . . . *S. umbrina*
1. Spores eight per ascus . . . . . .*S. diffractella*

Dermatocarpaceae

1. Spores non-septate . . . . . 1. Dermatocarpon
1. Spores muriform. . . . . 2. Endocarpon

1. Dermatocarpon

1. Thallus umbilicate, foliose . . . . . *D. miniatum*
1. Thallus adnate, squamulose
   2. Squamules round with elevated margins, not contiguous *D. hepaticum*
   2. Squamules lobed and *overlapping. . . . . D. tuckermani*

2. Endocarpon

The only species representing this genus is *E. pusillum.*

Hysteriales

Arthoniaceae

The only genus representing this family is Allarthonia and the only species is *A. caesia.*

Graphidaceae

The only genus representing this family is Graphis and the only species is *G. scripta*.

Lecanorales

Collemaceae

1. Cortex of interwoven hyphae. . . . . 1. Collema
2. Cortex plectenchymatous. . . . . 2. Leptogium

1. Collema

1. Thallus isidiate . . . . . *C. subfurvum*
2. Thallus without isidia . . . . . *C. conglomeratum*

2. Leptogium

1. Thallus brown to black, lobes crenate. . . . *L. chloromelum*
2. Thallus bluish-slate colored, lobes entire . .*L. cyanescens*

Heppiaceae

The only genus representing this family is Heppia and the only species is *H. hassei.*

Pannariaceae

1. Thallus with lower cortex wanting. . . . . 1. Placynthium
1. Thallus with lower cortex. . . . . 2. Coccocarpia

1. Placynthium

The only species representing this genus is *P. nigrum.*

2. Coccocarpia

The only species representing this genus is *C. cronia.*

Peltigeraceae

The only genus representing this family is Peltigera and the only species is *P. canina.*

Diploschistaceae

The only genus representing this family is Diploschistes.

1. Proper exciple thick, radiately striate. . .*D. actinostomus*
1. Proper exciple thin, minutely toothed
   2. Apothecia often 1 mm across, on soil and rocks. . . . . *D. scruposus* var. *scuposus*
   2. Apothecia usually 0.3 mm or less, on moss and *Cladonia* sp. . . . . *D. scruposus* var. *bryophila*

Lecideaceae

1. Spores non-septate . . . . . 1. Lecidea
1. Spores septate . . . . . 2. Bacidia

1. Lecidea

1. Thallus crustose . . . . . *L. tesselina*
1. Thallus squamulose
   2. Squamules brownish to green on the edge . . *L. rufonigra*
   2. Squamules whitish on the edge
      3. Apothecia blackish. . . . . *L. decipiens*
      3. Apothecia reddish-brown . . . . . L. russellii

2. Bacidia

1. Spores acicular. . . . . *B. umbrina*
1. Spores fusiform . . . . . *B. granosa*

Cladoniaceae

The only genus representing this family is Cladonia.

1. Podetia extremely short or absent. . . . . *C. apodocarpa*
1. Podetia longer
   2. Podetia repeatedly branched, squamules evanescent
      3. Podetia dichotomously branched. . . . . *C. subtenuis*
      3. Podetia variously branched, but not dichotomous. . . . *C. uncialis*

2. Podetia little branched, squamules persistent.
  4. Podetia cup-shaped or trumpet-shaped
    5. Podetia granular. . . . . *C. Chlorophaea*
    5. Podetia with fine, dusty soredia . . . *C. fimbriata*
  4. Podetia not forming cups
    6. Fruits at least twice as broad as the podetia. . . *C. capitata*
    6. Fruits barely broader than the podetia . . . . . *C. subcariosa*

Acarosporaceae

1. Apothecia with thalloid exciple . . . . . 1. Acarospora
1. Apothecia with proper exciple . . . . . 2. Sarcogyne

1. Acarospora

1. Thallus whitish-yellow to green. . . . . *A. citrina*
1. Thallus brown
  2. Aeroles lobed, margins elevated . . . . . *A. fuscata*
  2. Aeroles entire, margins depressed . . . . *A. smaragdula*

2. Sarcogyne

1. Apothecia pruinose . . . . . *S. pruinosa*
1. Apothecia not pruinose
  2. Apothecia 0.2-1.0 mm. across, red when wet. . *S. simplex*
  2. Apothecia 0.7-2.0 mm. across, not red when wet *S. clavus*

Pertusariaceae

The only genus representing this family is Pertusaria.

1. Spores four per ascus. . . . . *P. leioplaca*
1. Spores one or two per ascus
  2. Fruiting knobs sorediate . . . . . .*P. multipuncta*
  2. Fruiting knobs esorediate
    3. Fruiting knobs postulate, some finally opening into a disk. . . . . *P. pustulata*
    3. Fruiting knobs not postulate, or if postulate, then not opening into a disk
      4. Spores one per ascus. . . . . *P. velata*
      4. Spores two per ascus. . . . . *P. pertusa*

Lecanoraceae

1. Thallus yellow . . . . . 1. Candelariella
1. Thallus not yellow
  2. Spores aseptate. . . . . 2. Lecanora
  2. Spores septate . . . . . 3. Lecania

1. Candelariella

1. Thallus persistent; on rocks. . . . . *C. vitellina*
1. Thallus evanescent; on trees. . . . . *C. xanthostigma*

2. Lecanora

1. Epithecia intensely black . . . . . *L. atra*
1. Epithecia variously colored, but not black
  2. Thallus aerolate to squamulose. . . . . .*L. rubina*
  2. Thallus crustose or near-foliose
    3. Thallus near-foliose. . . . . *L. muralis*
    3. Thallus crustose
      4. Apothecia 0.1-0.25 mm. across. . . . . *L. piniperda*
      4. Apothecia somewhat larger to much larger
        5. Apothecia pruinose
          6. Spores subglobose, 9-15 microns wide . . . . . *L. calcarea*
          6. Spores ellipsoid, 406 microns wide . . . . . L. hageni
5. Apothecia not pruinose
  7. Apothecia yellowish to greenish . . . . . *L. varia*
  7. Apothecia light brown or darker
    8. Thallus evanescent . . . . . *L. dispersa*
    8. Thallus persistent
      9. Apothecia light brown, exciples persistent. . . . . *L. subfusca*
      9. Apothecia dark brown to blackish, exciples often disappearing. . . . . *L. melaena*

3. Lecania

1. Apothecia pruinose . . . . . *L. californica*
1. Apothecia not pruinose . . . . . *L. perproxima*

Parmeliaceae

1. Thallus and apothecia yellow; spores many per ascus. . . . 1. Candelaria
1. Thallus and apothecia rarely yellow; spores eight per ascus 2. Parmelia

1. Candelaria

1. Exciple fibrillose below. . . . . .*C. fibrosa*
1. Exciple not fibrillose
  2. Thallus reduced to granulose squamules, or passing into a powdery crust . . . . . *C. concolor* var. *effusa*
2. Thallus granulose on margins only . . . . . *C. concolor* var. *concolor*

2. Parmelia

1. Soredia present
  2. Medulla yellowish . . . . . *P. obsessa*
  2. Medulla white
    3. Soredia on upper surface . . . . . *P. caperata*
    3. Soredia marginal . . . . . *P. reticulata*

1. Soredia absent
   4. Isidia present
      5. Thallus yellowish-green. . . . . *P. isidiata*
      5. Thallus bluish or gray
         6. Upper surface with white dots . . . . . *P. rudecta*
         6. Upper surface without white dots. . . *P. haitiensis*
   4. Isidia absent
      7. Thallus yellowish-green
         8. Thallus tightly adnate . . . . . *P. conspersa*
         8. Thallus loosely attached . . . . . *P. stenophylla*
      7. Thallus bluish to gray. . . . . *P. borreri*

Caloplacaceae

The only genus representing this family is Caloplaca.

1. Thallus sorediate
   2. Soredia dull orange to blackish. . . . . *C. microphylina*
   2. Soredia yellow
      3. Thallus smooth and continuous . . . *C. chrysophthalma*
      3. Thallus distinctly aerolate . . . . . *C. decipiens*
1. Thallus esorediate
   4. Thallus lobed at the margins
      5. Exciple moderately thick and somewhat elevated. . . . *C. murorum*
      5. Exciple thin and not elevated. . . . . *C. lobulata*
   4. Thallus not lobed at the margins
      6. Apothecia yellow, exciples whitish . . . . *C. ulmorum*
      6. Apothecia orange, exciple dull gray to yellow-green or orange
         7. Exciple distinctly yellowish-green. . *C. aurantiaca*
         7. Exciple gray or orange
            8. Exciple gray, thallus well developed, areolate. . *C. arizonica*
            8. Exciple orange, thallus scanty
               9. Apothecia crowded, angular, spores slightly curved. . . . . *C. flavovirescens*
               9. Apothecia scattered, circular, spores not curved. . . . . *C. cerina*

Teloschistaceae

1. Thallus fruticose. . . . . 1. Teloschistes
1. Thallus foliose. . . . . 2. Xanthoria

1. Teloschistes

The only species representing this genus is *T.chrysophthalmus.*

2. Xanthoria

The only species representing this genus is *X. candelaria.*

Buelliaceae

1. Apothecia with proper exciples . . . . . 1. Buellia
1. Apothecia with thalloid exciples . . . . . 2. Rinodina

1. Buellia

1. Spores three-septate . . . . . *B. alboatra*
1. Spores one-septate
  2. Thallus of well-developed areoles
    3. Areoles olive-brown. . . . . .*B. novomexicana*
    3. Areoles greenish-gray to ashy
      4. Hypothallus scanty or obsolete. . . *B. retrovertens*
      4. Hypothallus black, prominent
        5. Exciple white initially, then turning darker. . . *B. stigmaea*
        5. Exciple black. . . . . .*B. spuria*
  2. Thallus not areolate
    6. Hypothecium colorless. . . . . *B. vilis*
    6. Hypothecium brownish
      7. Hymenium colorless throughout. . . . . *B. schaereri*
      7. Hymenium brown above. . . . . *B. punctata*

2. Rinodina

The only species representing this genus is *R. oreina.*

Physciaceae

1. Medulla yellow to salmon-colored. . . . . .Pyxine
1. Medulla white
  2. Lower cortex well developed. . . . . Physcia
  2. Lower cortex poorly developed or wanting. . . Anaptychia

1. Pyxine

The only species representing this genus is *P. caesiopruinosa.*

2. Physcia

1. Thallus esorediate
  2. Thallus tightly adnate throughout. . . . . *P. syncolla*
  2. Thallus loosely adnate
    3. Lobe tips thin and somewhat elevated . . *P. aipolia*
    3. Lobe tips thickened and turned down
      4. Whitish to gray, apothecia usually pruinose, on trees. . . . . *P. stellaris*
      4. Dark gray to blackish, apothecia not pruinose, on rocks. . . . . *P. halei*
1. Thallus sorediate
  5. Soredia in capitate patches on the upper surface
    6. Thallus under two cm. across, brownish, appearing crustose. . . . . *P. elaeina*
    6. Thallus up to five cm. across, grayish, definitely foliose
      7. Soredia white to pale blue . . . . . *P. tribacoides*
      7. Soredia grayish-green. . . . . *P. orbicularis*

5. Soredia along margins, and sometimes on the upper surface, but not in capitate patches
8. Thallus pruinose . . . . . *P. grisea*
8. Thallus not pruinose
9. Lobes thin, flat, and often raised at the margins *P. millegrana*
9. Lobes more or less rounded over the top with tips touching the substrate . . . . . *P. subtilis*

3. Anaptychia

1. Thallus sorediate
2. Hypothallus distinctly yellow. . . . . *A. heterochroa*
2. Hypothallus gray to blackish . . . . . *A. speciosa*
1. Thallus esorediate
3. Thallus isidiate . . . . . *A. granulifera*
3. Thallus without isidia. . . . . *A. hypoleuca*

Lichenes Imperfecti

Leprariaceae

1. Thallus often zonate, grayish-green . . . . . 1. Crocynia
1. Thallus never zonate, bright yellow . . . . . 2. Lepraria

1. Crocynia

The only species representing this genus is *C. membranacea.*

2. Lepraria

The only species representing this genus is *L. chlorine.*

Annotated Nomenclatural Update to Keck (1961)

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Darwin Keck's pioneering work was one of the first detailed accounts of the lichen biota of a region in the Great Plains. This area of Oklahoma is especially interesting, since it includes several important ecoregions, including both cross timbers and Osage Plains/Flint Hills tallgrass prairie. The eastern portions of the study area have strong Ozarkian biogeographic influence. Keck's work is important from a biogeographic perspective, since it elucidates details regarding the western ranges of several species traditionally thought to be associated with eastern woodlands, while simultaneously documenting the presence of several lichen taxa more commonly associated with western and southwestern North America.

Purpose for the update

A major problem facing contemporary users of this work is the massive transition in lichen taxonomic concepts and nomenclature that have occurred since Keck's work. Additionally, extensive additional survey and research have provided a better understanding of patterns of lichen occurrence in midcontintal North America. To make Keck's work more useable to contemporary readers, I have added annotations to appropriate portions of Keck's species accounts. These annotations update the nomenclature and add comments to the extent possible without study of the actual specimens, largely following the latest North American lichen list (Esslinger 2006). Comments appear within relevant species accounts in the main checklist, directly after the name used by Keck. My comments are within brackets, rendered in a different font. These comments fall roughly into one of four categories:

1. Nomenclatural updates for names that have been changed. In some instances names used by Keck are now interpreted to include multiple taxa. In these cases, all such taxa potentially occurring in the region are included, sometimes with relative abundance information based on my field experience (see below).
2. Probable identification for cited taxa that are obviously erroneous — typically in these cases the name cited by Keck is a valid name, but more recent research has revealed that the species is restricted to regions remote from the Great Plains. Where possible, the probable actual identification is provided, based on a decade of sporadic lichen field work in the eastern portion of Keck's study area (e.g. Ladd 1997) and extensive field experience with lichens in the Ozark region just east of the study area (e.g. Ladd 1996, 2002). A good source for general North American

Ladd, D.M.
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range information is Brodo et al. (2001).

3. Revised author citations where more recent taxonomic work has resulted in different accepted authorities for names used by Keck. These are provided not to be niggling, but because correct authorities are essential for accessing the taxonomic literature and to aid in tracking future changes in nomenclature and species concepts.
4. In a few cases, species names reported by Keck are almost certainly erroneous in modern concepts, but without examination of the specimens it is not possible to determine what the actual identification might be — these are pointed out to prevent perpetuation of errors and inaccurate range data.

Looking back 45 years, Darwin Keck's work was a rather astounding undertaking – working in a region where almost nothing was known of the lichen biota, in an era with few North American lichenologists and the concept of lichen floristic studies in its infancy, he was able to effectively produce an initial delineation of the region's lichens. This will serve as a sound foundation for continuing efforts to better understand ecological and distributional patterns of lichens and their interrelationships with other components of Oklahoma's natural heritage.

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Vascular Flora of a Red Sandstone Hills Site Canadian County, Oklahoma

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This article reports the results of an inventory of the vascular plants from a site in central Oklahoma. Three hundred thirty-four species of vascular plants in 237 genera and 76 families were collected. The most species were collected from the families Poaceae (56) and Asteraceae (54). The genera with the most species were *Euphorbia* and *Eragrostis*, both with six species. One hundred six species were annuals, 227 perennials, and 1 biennial. Forty-nine species of woody plants were present. Forty-one species, or 12.3% of the flora, were exotic to Oklahoma. No species listed as threatened or endangered by the U.S. Fish and Wildlife Service were encountered, but two species (*Escobaria vivipara* and *Muhlenbergia bushii*) are tracked by the Oklahoma Natural Heritage Inventory.

INTRODUCTION

Canadian County has been the focus of botanical research for several decades. The first plant collections from the county were made by Shultz and Sawyer on January 10, 1917, when they collected *Helianthus maximiliani, Oenothera rhombipetala, Salsola iberica,* and *Senecio riddellii.* There was no further collecting until 1926, but in the 1930s botanical studies began in ernst. Botanical collections in Canadian County have focused on the "Caddo Canyons" in the western third of the county. Of the 1,121 species recorded in the Oklahoma Vascular Plants database (Hoagland et al. 2006) for Canadian County, 964 are from canyons such as Devil's / Methodist, Grocket, Waters, and Widow-maker. On 29 May 1933, J. C. Shirley collected 38 specimens from Devil's Canyon. Elbert Little collected 87 species from Devil's Canyon in September, 1936. Several collectors visited Devils Canyon in 1937, but the most prolific was Milton Hopkins, who collected 145 in April and September of 1937 (Hoagland et al. 2006). Although collecting continued in Devil's Canyon, emphasis shifted to nearby Water Canyon when Connie Taylor gathered 321 specimens (see Taylor [1961] for a complete species list). Botanical collections outside the canyons have not focused on a particular locale in the county. Although 1,121 taxa of vascular plants have been reported from Canadian County, it is fewer than the taxa reported from adjacent Oklahoma (1,399) and Cleveland (1,426) counties. The current project was initiated on the assumption that focused collection effort at a given site would yield additional county records. It will also provide land managers with a working species list to help guide their activities.

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STUDY AREA

The study area encompasses 64.7 ha in Canadian County (Figure) along the Canadian River. Latitudinal extent ranges from 35.34°N to 35.36°N and longitudinal extent from 97.67°W to 97.68°W. The study area is located within the subtropical humid (Cf) climate zone (Trewartha 1968). Summers are

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warm (mean July temperature = 27.8°C) and humid, whereas winters are relatively short and mild (mean January temperature = 1.78°C). Mean annual precipitation is 87.6 cm, with periodic severe droughts (Oklahoma Climatological Survey 2006).
Physiographically, the study area is located within the Osage Plains section of the Central Lowlands province (Hunt 1974) and the Central Redbed Plains province of Oklahoma (Curtis and Ham 1979). The surface geology is primarily Permian red sandstone and shale with Quaternary silt, sand, and clay along the Canadian River floodplain (Branson and Johnson 1979). Elevation ranges from 411.5 m to 358.7 m. The predominant potential vegetation types are Tallgrass Prairie *and* Bottomland vegetation (Duck and Fletcher 1943).

METHODS

Collections were made monthly from March to June during the 2005 and 2006 growing seasons. The predominant vegetation association at the site were ascribed according to Hoagland (2000) and attributed to each collection. Vouchers for species exotic to North America were made from naturalized populations only, thus excluding cultivated and ornamental plants. Specimens were processed at the Robert Bebb Herbarium of the University of Oklahoma (OKL) following standard procedures. Manuals used for specimen identification included Waterfall (1969), Barkley (1986), and Diggs et al. (1999). Origin, either native or introduced, was determined by using Taylor and Taylor (1991) and US Department of Agriculture-Natural Resources Conservation Service (USDA-NRCS 2006). Nomenclature follows the USDA-NRCS (2006). Voucher specimens were deposited at OKL.

RESULTS AND DISCUSSION

Three hundred thirty-four species of vascular plants in 237 genera and 76 families were collected (appendix 1). The greatest numbers of species were from the Asteraceae (56) and Poaceae (54). The largest genera were *Euphorbia* and *Eragrostis* each with 6 species. There were three species of ferns, two gymnosperm, 78 monocots, and 252 dicots (Table). One hundred and six species were annuals, 227 perennials, and one biennial. Forty-nine species of woody plants were present. The absence of *Q. stellata* at the site is noteworthy. This study contributed an additional 84 species to the flora of Canadian County for a total of 1,205 species.

Forty-one species or 12.3% of the flora was non-native to North America. The Poaceae and Fabaceae had the greatest number of exotic species, 12 and 7 respectively. There were three exotic species in the genus *Bromus* and two in *Ulmus*. These values are consistent with other floristic studies from Oklahoma, in which exotic species constitute 9% - 15% of the flora (Hoagland and Buthod 2003, Hoagland and Buthod 2004, Hoagland and Johnson 2001, Hoagland and Johnson 2004a, Hoagland and Johnson 2004b, Hoagland et al. 2004a, Hoagland et al. 2004b, Hoagland and Wallick 2003,). An exception is Red Slough and Grassy Slough, where exotic species constituted 6.6% (Hoagland and Johnson, 2004b).

No species listed as threatened or endangered by the U.S. Fish and Wildlife Service were encountered. However, *Escobaria vivipara* (G5S2S3) and *Muhlenbergia bushii* (G5S1S2), which are tracked by the Oklahoma Natural Heritage Inventory (2006), were present. Species are ranked by the ONHI according to level of imperilment at the global [G] and state [S] level on a scale of

pecies that is imperiled and 5 a species that is secure
[Groves et al. 1995]).

Four vegetation associations/land cover types occurred at the study area. Each is described below with a brief list of associated species.

1. *Schizachyrium scoparium - Bouteloua curtipendula* herbaceous association occurred on shallow sandstone derived soils and was the predominant grassland vegetation at the site. Associated species included *Argythamnia mercurialiana, Baptisia australis, Bouteloua hirsuta, Dalea aurea, D. enneandra, D. multiflora, D. purpurea, Euphorbia corollata, Hedeoma drummondii, Ipomoea leptophylla, Krameria lanceolata, Lesquerella ovalifolia, Linum rigidum, Paronychia jamesii, Penstemon cobaea, Polygala alba, Stillingia sylvatica*, and *Tradescantia occidentalis*.

2. *Quercus muehlenbergii - Juniperus virginiana* forest association is a vegetation type not described in Hoagland (2000), but was the predominant forest vegetation at Camp Kickapoo. Two subtypes most likely exist, although further analysis is necessary. The first occupies drier habitats and is characterized by associated species such as *Carex albicans, Cornus drummondii, Opuntia macrorhiza, Q. marilandica, Rhus aromatica, Ruellia humilis, Sideroxylon lanuginosum, Symphoricarpos orbiculatus, Tridens flavus,* and *Viburnum rufidulum*. The moist or mesic subtypes occurred along streams and deep gullies. Associated species include *Arisaema dracontium, Bromus pubescens, Chasmanthium latifolium, Desmodium glutinosum, Elephantopus tomentosus, Juglans nigra, Phryma leptostachya, Polygonatum biflorum, Q. macrocarpa, Sanicula canadensis, Sapindus drummondii,* and *Verbesina alternifolia.*

3. Wetland and aquatic vegetation was of restricted to a small human-made pond and swales on the Canadian River floodplain. Associated species included *Amorpha fruticosa, Cephalanthus occidentalis, Echinochloa crus-galli, Polygonum lapathifolium, Symphyotrichum subulatum*, and *Typha domingensis*

4. Disturbed areas and old-field vegetation included roadsides and areas exhibiting signs of physical disruption. Associated species included *Capsella bursa-pastoris*, *Chamaesyce maculata, C. missurica, Erodium cicutarium, Geranium carolinianum, Lamium amplexicaule*, *Mollugo verticillata, Oenothera biennis, O. laciniata, Oxalis stricta, Phytolacca americana, Portulaca pilosa, Sherardia arvensis, Solanum dimidiatum*, *S. elaeagnifolium, Sorghum halepense* and *Viola bicolor.*

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

Taxonomic group	Species	Native spp.	Introduced spp.
Pteridophyta	3	3	0
Coniferophyta	2	1	1
Magnoliophyta	329	289	40
Magnoliopsida	250	222	28
Liliopsida	79	67	12
Total	334	293	41

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

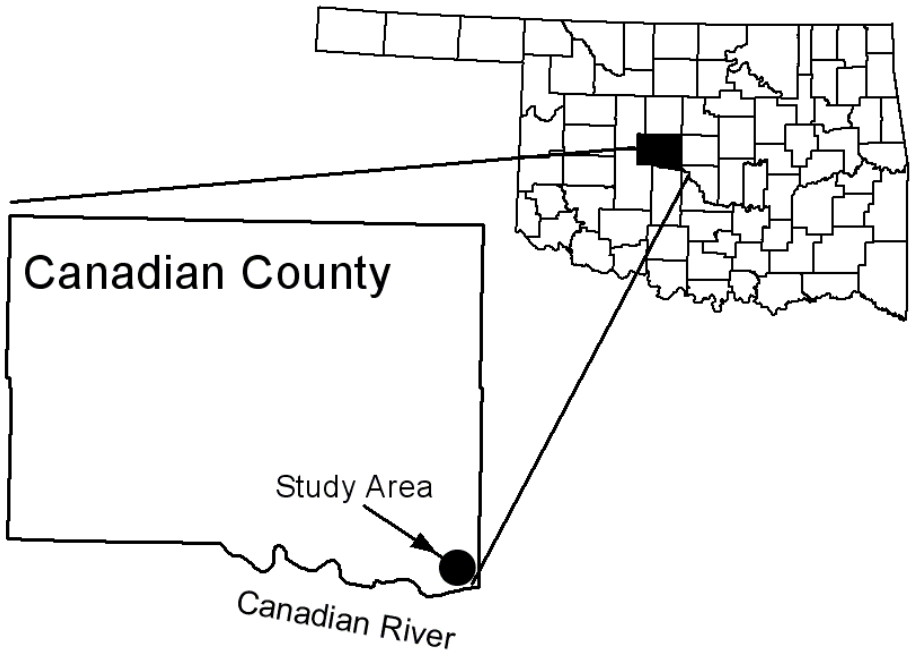

Figure Location of the Canadian County study area.

APPENDIX

Annotated species list. The first entry is habitat (QMJV-M = *Quercus muehlenbergii - Juniperus virginiana* forest association, mesic subtype; QMJV-X = *Q. muehlenbergii - J. virginiana* forest association, xeric subtype; SSBC = *Schizachyrium scoparium - Bouteloua curtipendula* herbaceous association, WETL = wetland and aquatic vegetation, DAOF = disturbed areas and old-field vegetation), followed by life history (A=annual, B=biennial, P=perennial), and collection number. Exotic species are denoted with an asterisk. Voucher specimens were deposited at the Robert Bebb Herbarium at the University of Oklahoma (OKL).

PTERIDOPHYTA

Dryopteridaceae

Woodsia obtusa (Spreng.) Torr.(bluntlobe cliff fern) - QMSJV-M; P; H; AB-6788

Ophioglossaceae

Botrychium virginianum (L.) Sw. (Rattlesnake fern) - QMJV-M; P; H; AB-6766

Pteridaceae

Pellaea atropurpurea (L.) Link (purple cliffbreak) - QMJV-X; P; H; AB-6261

CONIFEROPHYTA

Cupressaceae

Juniperus virginiana L. (Eastern redcedar) - QMJV-X; P; T; AB-6206

Thuja occidentalis L.* (arborvitae) - DAOF; P; T; AB-6630

MAGNOLIOPHYTA
Magnoliopsdia

Acanthaceae

Ruellia humilis Nutt. (wild petunia)- QMJV-X, SSBC; P; H; Ab-6559

Aceraceae

Acer negundo L. (boxelder) - QMJV-M, WETL; P; T; AB-6209

Amaranthaceae

Amaranthus palmeri S. Wats. (Carlessweed) - DAOF; A; H; AB-6608

Iresine rhizomatosa Standl. (Juda's bush) - QSJV-M; P; H; AB-6584

Anacardiaceae

Rhus aromatica Ait. (fragrant sumac)- QMJV-X; P; S; AB-6887

R. glabra L. (smooth sumac) - DAOF, QMJV-X; P; S; AB-6204

Toxicodendron radicans (L.) Kuntze (poison ivy) - QMJV-M; P; S; AB-6252

Apiaceae

Chaerophyllum tainturieri Hook. (hairyfruit chervil) - DAOF; A; H; AB-6922

Sanicula canadensis L. (blacksnakeroot) - QMJV-M; P; H; AB-6198

Spermolepis echinata (Nutt. ex DC.) Heller (bristly scaleseed) - SSBC; A; H; AB-6861

Torilis arvensis (Huds.) Link* (spreading hedgeparsley) - DAOF; A; H; AB-7148

Apocynaceae

Apocynum cannabinum L. (Indianhemp) - SSBC; P; H; AB-6791

Asclepiadaceae

Asclepias amplexicaulis Sm. (clasping milkweed) - WETL; P; H; AB-6806

A. stenophylla Gray (slimleaf milkweed) - SSBC; P; H; AB-6555

A. viridiflora Raf. (green comet milkweed) - SSBC; P; H; AB-7149

A. viridis Walt. (green antelopehorn) - DAOF, SSBC; P; H; AB-6821

Asteraceae

Achillea millefolium L. (common yarrow) - DAOF, SSBC; P; H; AB-6775

Ambrosia psilostachya DC. (Plains ragweed) - DAOF, SSBC; P; H; AB-6551
A. trifida L. (giant ragweed) - DAOF; A; H; AB-6233
Amphiachyris dracunculoides (DC.) Nutt. (prairie broomweed) - DAOF; A; H; AB-6254
Aphanostephus skirrhobasis (DC.) Trel. (Arkansas dozedaisy) - SSBC; A; H; AB-6800
Artemisia ludoviciana Nutt. (white sagebrush) - SSBC; P; H; AB-6631
Baccharis salicina Torr. & Gray (false willow) - WETL; P; S; AB-6548
Bidens bipinniata L. (Spanish needles) - DAOF, QMJV-m; A; H; AB-6585
Carduus nutans L.* (nodding thistle) - DAOF; B; H; AB-6801
Chrysopsis pilosa Nutt. (goldenaster) - SSBC; A; H; AB-6889
Cirsium altissimum (L.) Hill (tall thistle) - QMJV-M; P; H; AB-6599
C. undulatum (Nutt.) Spreng. (wavyleaf thistle) - SSBC; P; H; AB-7166
Conyza canadensis (L.) Cronq. (Canadian horseweed) - DAOF; A; H; AB-6894
C. ramosissima Cronq. (dwarf horseweed) - DAOF; A; H; AB-6244
Echinacea angustifolia DC. (Blacksamson) - SSBC; P; H; AB-6811
Elephantopus carolinianus Raeusch. (Carolina elephantsfoot) - QMJV-M; P; H; AB-6629
Engelmannia peristenia (Raf.) Goodman & Lawson (Engelmann's daisy) - SSBC; P; H; AB-6787
Erigeron strigosus Muhl. ex Willd. (prairie fleabane) - QMJV-M; A; H; AB-6552
Eupatorium serotinum Michx. (thoughtwort)- QMJV-M, WETL; P; H; AB-6632
Evax prolifera Nutt. ex DC. (bighead pygmycudweed) - DAOF; A; H; AB-6860
E. verna Raf. (spring pygmycudweed) - DAOF; A; H; AB-6938
Gaillardia aestivalis (Walt.) H. Rock (lanceleaf blanketflower) - SSBC; P; H; AB-6633
G. suavis (Gray & Engelm.) Britt. & Rusby (perfumeballs) - DAOF, SSBC; P; H; AB-6218
Gamochaeta purpurea (L.) Cabrera (purple everlasting) - DAOF: P; H; AB-6769
Grindelia papposa Nesom & Sun (Spanish gold) - SSBC; A; H; AB-6553
Gutierrezia sarothrae (Pursh) Britt. & Rusby (broom snakeweed) - DAOF, SSBC; P; H; AB-6588
Helianthus annuus L. (common sunflower) - DAOF; A; H; AB-6219
H. petiolaris Nutt. (prairie sunflower) - SSBC; A; H; AB-6590
Heterotheca subaxillaris (Lam.) Britt. & Rusby (camphorweed) - SSBC; A; H; AB-6616
Hieracium longipilum Torr. (hairy hawkweed) - QMJV-X; P; H; AB-6872
Hymenopappus tenuifolius Pursh (Chalk Hill hymenopappus) - SSBC; P; H; AB-6592
Iva annua L. (annual marshelder) - WETL; A; H; AB-6202
Lactuca canadensis L. (Canada lettuce) - DAOF; A; H; AB-6900
Liatris mucronata DC. (cusp blazing star) - SSBC; P; H; AB-6596
L. squarrosa (L.) Michx. (scaly blazing star) - SSBC; P; H; AB-6595
Machaeranthera pinnatifida (Hook.) Shinners (Lacy tansyaster) - SSBC; P; H; AB-6278
Oligoneuron rigidum (L.) Small var. *rigidum* (stiff goldenrod) - QMJV-M; P; H; AB-6598
Palafoxia rosea (Bush) Cory (rosy palafox) - SSBC; A; H; AB-6549
Pyrrhopappus grandiflorus (Nutt.) Nutt. (tuberous desert-chicory) - DAOF; P H; AB-6919
Ratibida columnifera (Nutt.) Woot. & Standl. (upright prairie coneflower) - SSBC; P; H; AB-6269
Rudbeckia hirta L. (blackeyed susan) - SSBC; P; H; AB-6257

Silphium laciniatum L. (compassplant) - SSBC; P; H; AB-6223
Solidago missouriensis Nutt. (Missouri goldenrod) - SSBC; P; H; AB-6550
Sonchus asper (L.) Hill* (spiny sowthistle) - DAOF; A; H; AB-6852
Symphyotrichum drummondii (Lindl.) Nesom var. *drummondii* (Drummond's aster) - QMJV-M; P; H; AB-6597
S. subulatum (Michx.) Nesom (annual saltmarsh aster) - WETL; A; H; AB-6273
Taraxacum officinale G. H. Weber ex Wiggers* (common dandelion) - DAOF; P; H; AB-7155
Thelesperma filifolium (Hook.) Gray var. *filifolium* (stiff greenthread) - SSBC; P; H; AB-6617
Tragopogon dubius Scop.* (yellow salsify) - DAOF; A; H; AB-6907
Verbesina alternifolia (L.) Britt. ex Kearney (wingstem) - QMJV-M; P; H; AB-6601
V. encelioides (Cav.) Benth. & Hook. f. ex Gray (golden crownbeard) - DAOF, SSBC; P; H; AB-6222
V. virginica L. (white crownbeard) - QMJV-M; P; H; AB-6255
Vernonia baldwinii Torr. (Baldwin's ironweed) - SSBC; P; H; AB-6600
Xanthium strumarium L. (rough cocklebur) - DAOF, WETL; A; H; AB-6225

Bignoniaceae
Campsis radicans (L.) Seem. ex Bureau (trumpet creeper) - DAOF; P; V; AB-7152
Catalpa bignonioides Walt. (southern catalpa) - DAOF; P; T; AB-6790
C. speciosa (Warder) Warder ex Engelm. (northern catalpa) - DAOF; P; T; AB-6611

Boraginaceae
Hackelia virginiana (L.) I. M. Johnston (beggarslice) - QMJV-M; P; H; AB-6201
Lithospermum caroliniense (Walt. Ex J. F. Gmel.) MacM. (Carolina puccoon) - SSBC; P; H; AB-6916
L. incisum Lehm. (narrowleaf stoneseed) - DAOF, SSBC; P; H; AB-7168
Myosotis macrosperma Engelm. (largeseed forget-me-not) - QMJV-M; A; H; AB-6842

Brassicaceae
Brassica rapa L.* (field mustard) - DAOF; A; H; AB-6816a
Camelina microcarpa DC.* (littlepod false flax) - DAOF; A; H; AB-6823
Capsella bursa-pastoris (L.) Medik.* (shepherd's purse) - DAOF; A; H; AB-6924
Descurainia pinnata (Walt.) Britt. (western tansymustard) - DAOF; A; H; AB-6942
Draba brachycarpa Nutt. ex Torr. & Gray (shortpod draba) - DAOF; A; H; AB-6943
Lepidium virginicum L. (Virginia pepperweed) - DAOF; A; H; AB-6935
Lesquerella ovalifolia Rydb. ex Britt. subsp. *alba* (Goodman) Rollins & Shaw (roundleaf bladderpod) - SSBC; P; H; AB-6840

Cactaceae
Escobaria missouriense (Sweet) D. R. Hunt (spinystar) - SSBC; P; H; AB-6960
Opuntia macrorhiza Engelm. (twistspine pricklypear) – QMJV-X, SSBC; P; S; AB-6954

Campanulaceae
Triodanis biflora (Ruiz & Pavón) Greene (clasping Venus' looking-glass) - DAOF, SSBC; A; H; AB-6940

Caprifoliaceae
Symphoricarpos orbiculatus Moench (coralberry) - QMJV-X; P; S; AB-6236
Viburnum rufidulum Raf. (rusty blackhaw) - QMJV-X; P; S; AB-6226

Caryophyllaceae
Arenaria serpyllifolia L.* (thymeleaf sandwort) - DAOF; A; H; AB-6911

Cerastium pumilum W. Curtis* (European chickweed) - DAOF; A; H; AB-6948
Paronychia jamesii Torr. & Gray (James' nailwort) - SSBC; P; H; AB-6567
Stellaria media (L.) Vill.* (Common chickweed) - DAOF, QMJV-M;A; H; AB-6918

Celastraceae
Celastrus scandens L. (American bittersweet) - QMJV-M; P; S; AB-6634

Chenopodiaceae
Chenopodium murale L.* (nettleleaf goosefoot) - DAOF; A; H; AB-6565
C. pratericola Rydb. (desert goosefoot) - DAOF; A; H; AB-6606
C. simplex (Torr.) Raf. (mapleleaf goosefoot) - DAOF; A; H; AB-6566

Convolvulaceae
Ipomoea leptophylla Torr. (bush morning-glory) - SSBC; P; H; AB-6893

Cornaceae
Cornus drummondii C. A. Mey. (roughleaf dogwood) - DAOF, QMJV-X; P; T; AB-6871

Cucurbitaceae
Cucurbita foetidissima Kunth (Missouri gourd) - DAOF; P; H; AB-6883
Melothria pendula L. (Guadeloupe cucumber) - DAOF; P; H; AB-6253

Elaeagnaceae
Elaeagnus angustifolia L.* (Russian olive) - DAOF; P; T; AB-6558

Euphorbiaceae
Acalphya virginica L. (Virginia threeseed mercury) - DAOF; A; H; AB-6876
Argythamnia mercurialiana (Nutt.) Muell.-Arg. var. *mercurilaiana* (tall silverbush) - SSBC; P; H; AB-6815
Chamaesyce glyptosperma (Englem.) Small (ribseed sandmat) - SSBC; A; H; AB-6618
C. maculata (L.) Small (spotted sandmat) - DAOF; A; H; AB-6576
C. missurica (Raf.) Shinners (prairie sandmat) - DAOF; A; H; AB-6897
C. nutans (Lag.) Small (eyebane) - DAOF; A; H; AB-6247
Croton glandulosus L. (Vente conmigo) - SSBC; A; H; AB-6258
C. lindheimerianus Scheele (threeseed croton) - SSBC; A; H; AB-6615
C. monanthogynus Michx. (prairie tea) - DAOF, SSBC; A; H; AB-6614
C. texensis (Klotzsch) Muell.-Arg. (Texas croton) - SSBC; A; H; AB-6593
Euphorbia corollata L. (flowering spurge) - SSBC; P; H; AB-6260
E. cyathophora Murr. (fire-on-the-mountain) - DAOF; A; H; AB-6604
E. dentata Michx. (toothed spurge) - DAOF; A; H; AB-6241
E. hexagona Nutt. ex Spreng. (sixangle spurge) - DAOF; A; H; AB-6249
E. marginata Pursh (snow-on-the-mountain) - DAOF; A; H; AB-6216
E. spathulata Lam. (warty spurge) - DAOF; A; H; AB-6844
Stillingia sylvatica Garden ex L. (Queen's delight) - SSBC; P; H; AB-6767

Fabaceae
Amorpha canescens Pursh (leadplant) - WETL; P; S; AB-6772
A. fruticosa L. (desert false indigo) - SSBC; P; S; AB-6272
Amphicarpaea bracteata (L.) Fern. (American hogpeanut) - QMJV-X; A; H; AB-7158
Astragalus lotiflorus Hook. (lotus milkvetch) - QMJV-X; P; H; AB-6945
Baptisia australis (L.) R. Br. ex Ait. f. (blue wild indigo) - SSBC; P; H; AB-6773
Cercis canadensis L. (eastern redbud) - QMJV-M, QMJV-X; P; T; AB-6279
Dalea aurea Nutt. ex Pursh (golden prairie clover) - SSBC; P; H; AB-6268
D. enneandra Nutt. (nineanther prairie clover) - SSBC; P; H; AB-6229

D. multiflora (Nutt.) Shinners (roundhead prairie clover) - SSBC; P; H; AB-6577
D. purpurea Vent. (purple prairie clover) - SSBC; P; H; AB-6881
Desmanthus illinoensis (Michx.) MacM. ex B. L. Robins. & Fern. (prairie bundleflower) - DAOF, WETL; P; H; AB-6230
Desmodium canescens (L.) DC. (hoary ticktrefoil) - QMJV-M; P; H; AB-6568
D. glutinosum (Muhl.) ex Willd. Wood (pointedleaf ticktrefoil) - QMJV-M; P; H; AB-7164
D. nudiflorum (L.) DC. (nakedflower ticktrefoil) - QMJV-M; P; H; AB-6896
D. sessilifolium (Torr.) Torr. & Gray (sessileleaf ticktrefoil) - SSBC; P; H; AB-6571
Gleditsia triacanthos L. (honeylocust) - DAOF; P; T; AB-7159
Gymnocladus dioicus (L.) K. Koch (kentucky coffeetree) - QMJV-M; P; T; AB-7159
Indigofera miniata Ortega (coastal indigo) - SSBC; P; H; AB-6853
Kummerowia stipulacea (Maxim.) Makino* (Korean clover) - DAOF; A; H; AB-3232
Lespedeza cuneata (Dum.-Cours.) G. Don* (Chinese lespedeza) - DAOF; P; H; AB-6265
L. stuevei Nutt. (tall lespedeza) - QMJV-X; P; H; AB-6562
Medicago minima (L.) L.* (burr medick) - DAOF; A; H; AB-6846
Melilotus officinalis (L.) Lam.* (yellow sweetclover) - DAOF; A; H; AB-6792
Mimosa nuttallii (DC.) B. L. Turner (Nuttall's sensitive-briar) - SSBC; P; H; AB-6774
Neptunia lutea (Leavenw.) Benth. (yellow puff) - SSBC; P; H; AB-6959
Oxytropis lambertii Pursh (purple locoweed) - SSBC; P; H; AB-6822
Pisum sativum L.* (garden pea) - DAOF; A; H; AB-6816
Psoralidium tenuiflorum (Pursh) Rydb. (Slimflower scurfpea) - SSBC; P; H; AB-6828
Robinia pseudoacacia L.* (black locust) - DAOF, QMJV-X; P; T; AB-6899
Strophostyles helvula (L.) Ell. (trailing fuzzybean) - DAOF; P; H; AB-6573
Vicia villosa Roth* (winter vetch) - DAOF; A; H; AB-6817

Fagaceae
Quercus macrocarpa Michx. (bur oak) - QMJV-M; P; T; AB-6275
Q. marilandica Muenchh. (blackjack oak) - QMJV-X; P; T; AB-6771
Q. muehlenbergii Engelm. (chinkapin oak) - QMJV-M, QMJV-X; P; T; AB-6207

Geraniaceae
Erodium cicutarium (L.) L'Hér. Ex Ait.* (redstem stork's beak) - DAOF; A; H; AB-6913
Geranium carolinianum L. (Carolina geranium) - DAOF; A; H; AB-6786
G. pusillum L.* (small geranium) - DAOF; A; H; AB-6850

Juglandaceae
Juglans nigra L. (black walnut) - QMJV-M; P; T; AB-7147

Krameriaceae
Krameria lanceolata Torr. (trailing krameria) - SSBC; P; H; AB-6803

Lamiaceae
Hedeoma drummondii Benth. (Drummond's false pennyroyal) - SSBC; P; H; AB-6610
H. hispida Pursh (rough false pennyroyal) - SSBC; A; H; AB-6858
Lamium amplexicaule L.* (henbit) - DAOF; A; H; AB-6926
Salvia azurea Michx. ex Lam. (azure blue sage) - SSBC; P; H; AB-6271
S. lyrata L. (lyreleaf sage) - QMJV-M; P; H; AB-6886

Teucrium canadense L. (Canada germander) - QMJV-M; P; H; AB-6215

Linaceae

Linum rigidum Pursh (stiffstem flax) - SSBC; A; H; AB-6845

Loasaceae

Mentzelia oligosperma Nutt. ex Sims (chickenthief) - SSBC; P; H; AB-6221

Malvaceae

Callirhoe involucrata (Torr. & Gray) Gray (purple poppymallow) - DAOF; P; H; AB-6799

Menispermaceae

*Cocculus carolinus (*L.) DC. (Carolina coralbead) - QMJV-M; P; H; AB-6199

Menispermum canadense L. (common moonseed) - QMJV-M; P; H; AB-6797

Molluginaceae

Mollugo verticillata L. (carpetweed) - DAOF; A; H; AB-6888

Moraceae

Maclura pomifera (Raf.) Schneid. (Osage orange) - DAOF, QMJV-X; P; T; AB-6195

Morus rubra L. (red mulberry) - QMJV-M; P; T; AB-6620

Nyctaginaceae

Mirabilis albida (Walt.) Heimerl (white four o'clock) - SSBC; P; H; AB-6578

M. nyctaginea (Michx.) MacM. (heartleaf four o'clock) - DAOF; P; H; AB-6833

Oleaceae

Fraxinus pennsylvanica Marsh. (green ash) - QMJV-M; P; T; AB-6560

Onagraceae

Calylophus berlandieri Spach (Berlandier's sundrops) - SSBC; P; H; AB-6825

Gaura sinuata Nutt. ex Ser. (wavyleaf beeblossom) - SSBC; P; H; AB-6827

Oenothera biennis L. (common evening-primrose) - DAOF; P; H; AB-6213

O. laciniata Hill (cutleaf evening-primrose) - DAOF; P; H; AB-6785

O. macrocarpa Nutt. (bigfruit evening-primrose) - SSBC; P; H; AB-6781

O. speciosa Nutt. (pinkladies) - SSBC; P; H; AB-6851

Stenosiphon linifolius (Nutt. ex James) Heynh. (false gaura) - SSBC; P; H; AB-6234

Oxalidaceae

Oxalis stricta L. (common yellow oxalis) - DAOF, SSBC; P; H; AB-6923

Papaveraceae

Argemone polyanthemos (Fedde) G. B. Ownbey (crested pricklypoppy) - SSBC; A; H; AB-6793

Passifloraceae

Passiflora lutea L. (yellow passionflower) - QMJV-M; P; H; AB-6264

Phytolaccaceae

Phytolacca americana L. (American pokeweed) - DAOF; P; H; AB

Plantaginaceae

Plantago heterophylla Nutt. (slender plantain) - SSBC; A; H; AB-6937

P. patagonica Jacq. (wooly plantain) - SSBC; A; H; AB-6859

P. rhodosperma Dcne. (redseed plantain) - SSBC; A; H; AB-6837

Polygalaceae

Polygala alba Nutt. (white milkwort) - SSBC; P; H; AB-6224

Polygonaceae

Eriogonum annuum Nutt. (annual buckwheat) - SSBC; A; H; AB-6256

E. longifolium Nutt. (longleaf buckwheat) - SSBC; P; H; AB-6262

Polygonum aviculare L. (prostrate knotweed) - DAOF; A; H; AB-6609

P. lapathifolium L. (curlytop knotweed) - WETL; A; H; AB-6895

P. punctatum Ell. (dotted smartweed) - WETL; A; H; AB-6563
P. scandens L. (climbing false buckwheat) – QMJV-M; P; H; AB-6605
P. virginianum L. (jumpseed) - QMJV-M; P; H; AB-6214
Rumex crispus L.* (curly dock) - DAOF, WETL; P; H; AB-6780

Portulacaceae
Portulaca pilosa L. (kiss me quick) - DAOF; A; H; AB-6304

Ranunculaceae
Clematis pitcheri Torr. & Gray (bluebill) - QMJV-M; P; H; AB-6819
Delphinium carolinianum Walt. subsp. *virescens* (Nutt.) Brooks (Carolina larkspur) - SSBC; P; H; AB-6802

Rosaceae
Geum canadense Jacq. (white avens) - QMJV-M; P; H; AB-6809
Prunus angustifolia Marsh. (Chickasaw plum) - DAOF, SSBC; P; S; AB-6277
P. mexicana S. Wats. (Mexican plum) - QMJV-X; P; T; AB-6557

Rubiaceae
Cephalanthus occidentalis L. (buttonbush) - WETL; P; S; AB-6228
Galium aparine L. (stickywilly) - QMJV-M; A; H; AB-6765
G. circaezans Michx. (licorice bedstraw) - QMJV-M; P; H; AB-6810
G. virgatum Nutt. (southwestern bedstraw) - DAOF; A; H; AB-6856
Hedyotis nigricans (Lam.) Fosberg (diamondflowers) - SSBC; P; H; AB-6240
Houstonia pusilla Schoepf (tiny bluet) - DAOF; A; H; AB-6912
Sherardia arvensis L.* (blue fieldmadder) - DAOF; A; H; AB-6843

Rutaceae
Ptelea trifoliata L. (common hoptree) - SSBC; P; T; AB-6770
Zanthoxylum hirsutum Buckl. (Texas Hercules' club) - QMJV-M; P; T; AB-6820

Salicaceae
Populus deltoides Bartr. ex Marsh. (eastern cottonwood) - WETL; P; T; AB-6200
Salix exigua Nutt. (sandbar willow) - WETL; P; T; AB-6561
S. nigra Marsh. (black willow) - WETL; P; T; AB-6267

Santalaceae
Comandra umbellata (L.) Nutt. subsp. *pallida* (A. DC.) Piehl (pale bastard toadflax) - SSBC; P; H; AB-6866

Sapindaceae
Sapindus drummondii Hook. & Arn. (soapberry) - QMJV-M; P; T; AB-6280

Sapotaceae
Sideroxylon lanuginosum Michx. (gum bully) - QMJV-X; P; T; AB-6890

Scrophulariaceae
Agalinis densiflora (Benth.) Blake (Osage false foxglove) - SSBC; A; H; AB-6570
A. heterophylla (Nutt.) Small ex Britt. (prairie false foxglove) - SSBC; A; H; AB-6569
Castilleja indivisa Engelm. (Indian paintbrush) - SSBC; A; H; AB-6259
Nuttallanthus texanus (Scheele) D. A. Sutton (Texas toadflax) - DAOF, SSBC; A; H; AB-684
Penstemon cobaea Nutt. (cobaea beardtongue) - SSBC; P; H; AB-6783
Veronica arvensis L.* (corn speedwell) - DAOF; A; H; AB-6941
V. peregrina L. (neckweed) - DAOF; A; H; AB-6857

Solanaceae
Physalis cinerascens (Dunal) A. S. Hitchs. (smallflower groundcherry) - DAOF; P; H; AB-6814
P. heterophylla Nees (clammy groundcherry) - DAOF; P; H; AB-6835
P. longifolia Nutt. (longleaf groundcherry) - DAOF; P; H; AB-6589
Solanum dimidiatum Raf. (western horsenettle) - DAOF; A; H; AB-6831
S. elaeagnifolium Cav. (silverleaf nightshade) - DAOF; P; H; AB-6197

Ulmaceae
Celtis laevigata Willd. var. *reticulata* (Torr.) L. Benson (netleaf hackberry) - QMJV-X, SSBC; P; T; AB-6591
C. laevigata Willd. var. *texana* Sarg. (Texan sugarberry) - QMJV-M; P; T; AB-6838
Ulmus americana L. (American elm) - QMJV-M; P; T; AB-6266
U. parvifolia Jacq.* (Chinese elm) - DAOF; P; T; AB-7153
U. pumila L.* (Siberian elm) - DAOF; P; T; AB-6789
U. rubra Muhl. (slippery elm) - DAOF; P; T; AB-6208

Valerianaceae
Valerianella radiata (L.) Dufr. (beaked cornsalad) - WETL; A; H; AB-6863

Verbenaceae
Phryma leptostachya L. (American lopseed) - QMJV-M; P; H; AB-6898
Phyla nodiflora (L.) Greene (turkey tangle fogfruit) – QMJV-M; P; H; AB-6812
Verbena bracteata Lag. & Rodr. (bigbract verbena) - DAOF, SSBC; A; H; AB-6865
V. urtricifolia L. (white vervain) - WETL; A; H; AB-6217

Violaceae
Viola bicolor Pursh (johnny jump-up) - DAOF; A; H; AB-6915

Viscaceae
Phoradendron tomentosum (DC.) Engelm. ex Gray (Christmas mistletoe) - QMJV-M, QMJV-X; P; S; AB-6839

Vitaceae
Ampelopsis cordata Michx. (heartleaf peppervine) - WETL; P; V; AB-6196
Parthenocissus quinquefolia (L.) Planch. (Virginia creeper) - QMJV-M; P; V; AB-6276
Vitis acerifolia Raf. (mapleleaf grape) - WETL; P; V; AB-6582
V. aestivalis Michx. (summer grape) - QMJV-M; P; V; AB-6817a
V. cinerea (Engelm.) Millard var. *cinerea* (graybark grape) - QMJV-M; P; V; AB-6930
V. vulpina L. (frost grape) - QMJV-M; P; V; AB-6818

Liliopsida

Agavaceae
Yucca glauca Nutt. (soapweed) - SSBC; P; T; AB-6796

Araceae
Arisaema dracontium (L.) Schott (green dragon) - QMJV-M; P; H; AB-6782

Commelinaceae
Commelina erecta L. var. *angustifolia* (Michx.) Fern. (whitemouth dayflower) - QMJV-M; P; H; AB-6575
Tradescantia occidentalis (Britt.) Smyth (prairie spiderwort) - SSBC; P; H; AB-6829

Cyperaceae
Carex albicans Willd. ex Spreng. (whitetinge sedge) - QMJV-X; P; G; AB-6952
C. blanda Dewey (eastern woodland sedge) - QMJV-M; P; G; AB-6950
C. brevior (Dewey) Mackenzie (shortbeak sedge) - QMJV-M; P; G; AB-6951
C. leavenworthii Dewey (Leavenworth's sedge) - QMJV-M; P; G; AB-6870

C. oligocarpa Schkuhr ex Willd. (richwoods sedge) - QSJV-M; P; G; AB-6869
Cyperus acuminatus Torr. & Hook. ex Torr. (tapertip flatsedge) - DAOF, SSBC; P; G; AB-6868
C. lupulinus (Spreng.) Marcks (Great Plains flagsedge) - DAOF, SSBC; P; G; AB-7165
C. schweinitzii Torr. (Schweinitz's flatsedge) - SSBC; P; G; AB-6579
Fimbristylis puberula (Michx.) Vahl (hairy fimbry) - SSBC; P; G; AB-6949

Iridaceae
Sisyrinchium angustifolium P. Mill. (narrowleaf blue-eyed grass) - DAOF; P; H; AB-6864

Juncaceae
Juncus bufonius L. (toad rush) - WETL; A; G; AB-6867
J. tenuis Willd. (poverty rush) - QMJV-M; P; G; AB-7157

Liliaceae
Allium canadense L. var. *fraseri* Ownbey (fraser meadow garlic) - SSBC; P; H; AB-6807
Polygonatum biflorum (Walt.) Ell. (smooth Solomon's seal) - QMJV-M; P; H; AB-6794

Orchidaceae
Spiranthes lacera (Raf.) Raf. (northern slender ladies'-tresses) - SSBC; P; H; AB-6581

Poaceae
Agrostis hyemalis (Walt.) B. S. P. (winter bentgrass) - WETL; P; G; AB-6936
Andropogon gerardii Vitman (big bluestem) - SSBC; P; G; AB-6892
Aristida longespica Poir. var. *geniculata* (Raf.) Fern. (slimspike threeawn) - DAOF; A; G; AB-6594
A. oligantha Michx. (prairie threeawn) - DAOF, SSBC; A; G; AB-6622
Bothriochloa laguroides (DC.) Herter (silver beardgrass) - DAOF; P; G; AB-7163
Bouteloua curtipendula (Michx.) Torr. (sideoats grama) - SSBC; P; G; AB-6884
B. hirsuta Lag. (hairy grama) - SSBC; P; G; AB-6245
Bromus catharticus Vahl* (rescuegrass) - DAOF; A; G; AB-6910
B. japonicus Thumb. ex Murr.* (Japanese brome) - DAOF; A; G; AB-6826
B. pubescens Muhl. ex Willd. (hairy woodland brome) - QMJV-M; P; G; AB-6778
B. tectorum L.* (cheatgrass) - DAOF; A; G; AB-6920
Cenchrus spinifex Cav. (coastal sandbur) - DAOF; A; G; AB-6612
Chasmanthium latifolium (Michx.) Yates (Indian woodoats) - QMJV-M; P; G; AB-6235
Chloris verticillata Nutt. (tumble windmill grass) - DAOF; P; G; AB-6231
Cynodon dactylon (L.) Pers.* (bermudagrass) - DAOF; P; G; AB-6891
Dactylis glomerata L.* (orchardgrass) - DAOF; P; G; AB-6798
Dichanthelium aciculare (Desv. ex Poir.) Gould & C. A. Clark (needleleaf rosette grass) - QMJV-M; P; G; AB-6586
D. malacophyllum (Nash) Gould (softleaf rosette grass) - QMJV-M; P; G; AB-6836
D. oligosanthes (J. A. Schultes) Gould var. *scribnerianum* (Nash) Gould (Scribner's rosette grass) - SSBC; P; G; AB-6946
Digitaria cognata (J. A. Schultes) Pilger (Carolina crabgrass) - DAOF; WETL; P; G; AB-6626
Echinochloa muricata (Beauv.) Fern.* (rough barnyardgrass) - WETL; A; G; AB-6587
Elymus canadensis L. (Canada wildrye) - QMJV-M; P; G; AB-7162
Eragrostis curtipedicellata Buckl. (gummy lovegrass) - SSBC; P; G; AB-6879
E. intermedia A. S. Hitchc. (plains lovegrass) - SSBC; P; G; AB-6944
E. secundiflora J. Presl. subsp. *oxylepis* (Torr.) S. D. Koch (red lovegrass) - DAOF; P; G; AB-6613
E. sessilispica Buck. (tumble lovegrass) - SSBC; P; G; AB-6878

E. spectabilis (Pursh) Steud. (purple lovegrass) - SSBC; P; G; AB-6904
E. trichodes (Nutt.) Wood (sand lovegrass) - SSBC; P; G; AB-6602
Hordeum pusillum Nutt. (little barley) - DAOF; A; G; AB-6779
Leersia virginica Willd. (whitegrass) - QMJV-M; P; G; AB-6628
Lolium perenne L.* (perennial ryegrass) - DAOF; P; G; AB-6824
Muhlenbergia bushii Pohl (nodding muhly) - QMJV-M; P; G; AB-6624
M. sylvatica Torr. ex Gray (woodland muhly) - QMJV-M; P; G; AB-6603
Panicum anceps Michx. (beaked panicgrass) - QMJV-M; P; G; AB-6227
P. capillare L. (witchgrass) - DAOF; A; G; AB-6903
P. virgatum L. (switchgrass) - DAOF, WETL; P; G; AB-6270
Paspalum dilatatum Poir.* (Dallisgrass) - SSBC; P; G; AB-7150
P. setaceum Michx. (thin paspalum) - WETL; P; G; AB-6621
Phalaris caroliniana Walt. (Carolina canarygrass) - WETL; A; G; AB-6925
Phragmites australis (Cav.) Trin. Ex Steud.* (common reed) - WETL; P; G; AB-7160
Poa annua L.* (annual bluegrass) - DAOF; A; G; AB-6928
P. arachnifera Torr. (Texas bluegrass) - SSBC; P; G; AB-6909
P. chapmaniana Scribn. (Chapman's bluegrass) - SSBC; A; G; AB-6808
Saccharum giganteum (Walt.) Pers. (sugarcane plumegrass) - WETL; P; G; AB-6953
Schedonnardus paniculatus (Nutt.) Trel. (tumblegrass) - DAOF, SSBC; P; G; AB-6882
Schedonorus phoenix (Scop.) Holub.* (tall fescue) - DAOF; P; G; AB-6813
Schizachyrium scoparium (Michx.) Nash (little bluestem) - QMJV-X, SSBC; P; G; AB-6251
Setaria pumila (Poir.) Roemer & J.A. Schultes (yellow foxtail) - DAOF; A; G; AB-6583)
S. viridis (L.) Beauv.* (green bristlegrass) - DAOF; A; G; AB-6873
Sorghastrum nutans (L.) Nash (Indiangrass) - SSBC; P; G; AB-6248
Sorghum halepense (L.) Pers.* (Johnsongrass) - DAOF; P; G; AB-7151
Spartina pectinata Bosc ex Link (prairie cordgrass) - WETL; P; G; AB-6203
Sporobolus cryptandrus (Torr.) Gray (sand dropseed) - DAOF, SSBC; P; G; AB-6627
S. vaginiflorus (Torr. ex Gray) Wood var. *ozarkanus* (Fern.) Shinners (Ozark dropseed) - SSBC; P; G; AB-6625
Tridens flavus (L.) A. S. Hitchc. (purpletop tridens) - DAOF, QMJV-X; P; G; AB-6242
Vulpia elliotea (Raf.) Fern. (squirreltail fescue) - DAOF; A; G; AB-6935a

Smilacaceae

Smilax bona-nox L. (saw greenbriar) - QMJV-M, QMJV-X; P; H; AB-6211
S. rotundifolia L. (roundleaf greenbriar) - QMJV-M, QMJV-X; P; H; AB-7154
S. tamnoides L. (bristly greenbriar) - QMJV-M; P; H; AB-6556

Typhaceae

Typha domingensis Pers. (Southern cattail) - WETL; P; H; AB-6875

Vascular Flora of a Riparian Site on the Canadian River, Cleveland County, Oklahoma

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This article reports the results of an inventory of the vascular plants from a riparian site in central Oklahoma. One hundred and sixty-three species of vascular plants in 131 genera and 45 families were collected. The most species were collected from the families Asteraceae (32) and Poaceae (26). Fifty-eight species were annuals, 97 perennials, and 8 biennials. Eight species of woody plants were present. Twenty-nine species, or 18% of the flora, were exotic to Oklahoma. No species listed as threatened or endangered by the U.S. Fish and Wildlife Service nor those tracked by the Oklahoma Natural Heritage Inventory were encountered.

INTRODUCTION

Although North America has a long history of botanical inventory, exotic species are often under-represented in herbarium collections. Herbarium collections typically document the native flora of an area. Many botanists have historically shown little interest in collecting "weeds" or non-native species. Thus it is difficult to determine the arrival and establishment of exotic and invasive species (Cronk and Fuller, 2001). The same is true of highly disturbed areas which have historically been under-collected by botanists due to higher concentrations of non-native species (Planty-Tabacchi et al., 1996). In recent years such habitats have become of interest, particularly in Europe, because they harbor a greater occurrence and abundance of exotic species (Ferreira and Moreira, 1995; Kowarik, 1995).

The objective of this study is to inventory the flora of a riparian area that has been heavily impacted by natural and anthropogenic disturbances on the Canadian River. Natural disturbances consist of flooding and channel migration, which often destroy extant vegetation. Anthropogenic disturbances at the site include the abandoned City of Norman Municipal Landfill (NML) and sand and gravel removal for an adjacent asphalt plant. The NML now serves as a national test site for United States Geological Survey (USGS) studies of water pollution associated with landfills. The plant species list resulting from this project will serve as a baseline for USGS researchers and their cooperators working at the NML.

STUDY AREA

The study area occupies 254 hectares on the Canadian River in Cleveland County, Oklahoma (35° 16'N, 95° 44'W). The site has been heavily disturbed by a variety of land uses (Figure), including the NML, which was

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active from 1922 until 1985 (Curtis and Whitney, 2003). Active sand excavation occurs in the southern portion of the study area. In addition, the Canadian River is used for recreational purposes by the citizens of Norman. Past agricultural uses include hay fields and livestock grazing.

The dynamics of the Canadian River has also affected plant species composition. The Canadian River is a braided stream that often ceases to flow during summer months. Discharge on the Canadian River averages 310.16 m^3/second (Tortorelli, 1999). A significant flood event in 1987 pushed the river channel approximately 500m south to the present location. Other major floods were recorded in 1941, 1948, and 1986 (Curtis and Whitney, 2003).

Climate of the study area is semi-arid continental. The hottest month is July, with an average temperature of 27.8°C, and the coldest is January, with an average temperature 2.4°C (Oklahoma Climate Survey 2006). The growing season is six months long (Bourlier et al., 1987). Topography at the site consists of gently rolling, southwest sloping plains. The soils are Quaternary alluvium on terrace deposits. Two soil types are present, the Gracemore silty clay loam and the Gracemore loamy fine sand and/or clay loams, both of the Gracemore-Gracemont Association (Bourlier et al., 1987). Both soils are frequently flooded, moderately alkaline, and calcareous. Underlying the alluvium is a low permeability unit of shale and mudstone (Eganhouse, et al., 1999).

MATERIALS AND METHODS

Voucher specimens were collected from 1m^2 plots placed at 23m intervals along a transect and from random sites throughout the study area. Collections were made at two-week intervals from April through November 2005. Vouchers for species exotic to North America were made from naturalized populations only, thus excluding cultivated and ornamental plants. Specimens were processed at the Robert Bebb Herbarium of the University of Oklahoma (OKL) following standard procedures. Manuals used for specimen identification included Waterfall (1969) and Diggs et al. (1999). Origin, either native or introduced, was determined by using USDA-NRCS (2006). Nomenclature follows the US Department of Agriculture-Natural Resources Conservation Service (USDA-NRCS, 2006). Voucher specimens were deposited at OKL.

RESULT AND DISCUSSION

One hundred sixty-three species of vascular plants in 45 families, and 131 genera were collected (Appendix, Table). The Asteraceae (32), Poaceae (26), Fabaceae (11), and Cyperaceae (10), had the greatest number of species. Fifty-eight species of annuals, eight biennials, and 97 perennials were collected. Eight species of woody plants were collected, five of which were primarily represented by young saplings. No federally listed threatened or endangered species, or species tracked by the Oklahoma Natural Heritage Inventory, were encountered during this study. *Carduus nutans* (Asteraceae) and *Rhynchospora nivea* (Cyperaceae) were records for Cleveland County (Hoagland et al., 2006).

Twenty-nine species (18%) from 14 families were introduced. The family with the greatest number of introduced species was Poaceae (11). Sixteen of the introduced species were annuals or biennial and 13 were perennials. The percentage of exotic species at this site exceeds those reported in recent floristic studies in Oklahoma, which range from 9-13 percent of the flora (Hoagland and Johnson, 2001, 2004a, 2004b; Hoagland and Buthod, 2003, 2004; Hoagland and Wallick, 2003; Hoagland, et al., 2004; Hoagland, et al.,

2004). Given the small size of the flora, exotic species richness would be expected to have a disproportional effect. This is likely augmented by the disturbance history of the site.

Two habitat types predominated at the study site. Wetland and aquatic vegetation included the Canadian River channel and small ephemeral wetlands. Common species included *Amorpha fruticosa, Andropogon glomeratus, Eleocharis obtusa, Juncus torreyi, Salix exigua, S. nigra, Schoenoplectus americanus, Tamarix gallica, and Typha latifolia*. Disturbed areas and old-fields were sites heavily impacted by the human activities described above. These areas were generally represented by fewer species, many of which were introduced. Common species in this habitat included *Ambrosia trifida, Amphiachyris dracunculoides, Convolvulus arvensis*, *Cyperus esculentus, Bromus tectorum, Helianthus maximiliani*, *Torilis arvensis,* and *Verbesina encelioides*.

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Table Summary of floristic collections made in Cleveland County, Oklahoma.*

Taxonomic group	Species	Native spp.	Exotic spp.
Equisetophyta	2	2	0
Coniferophyta	1	1	0
Magnoliophyta	160	131	29
Magnoliopsida	116	100	16
Liliopsida	44	31	13
Total	163	134	29

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

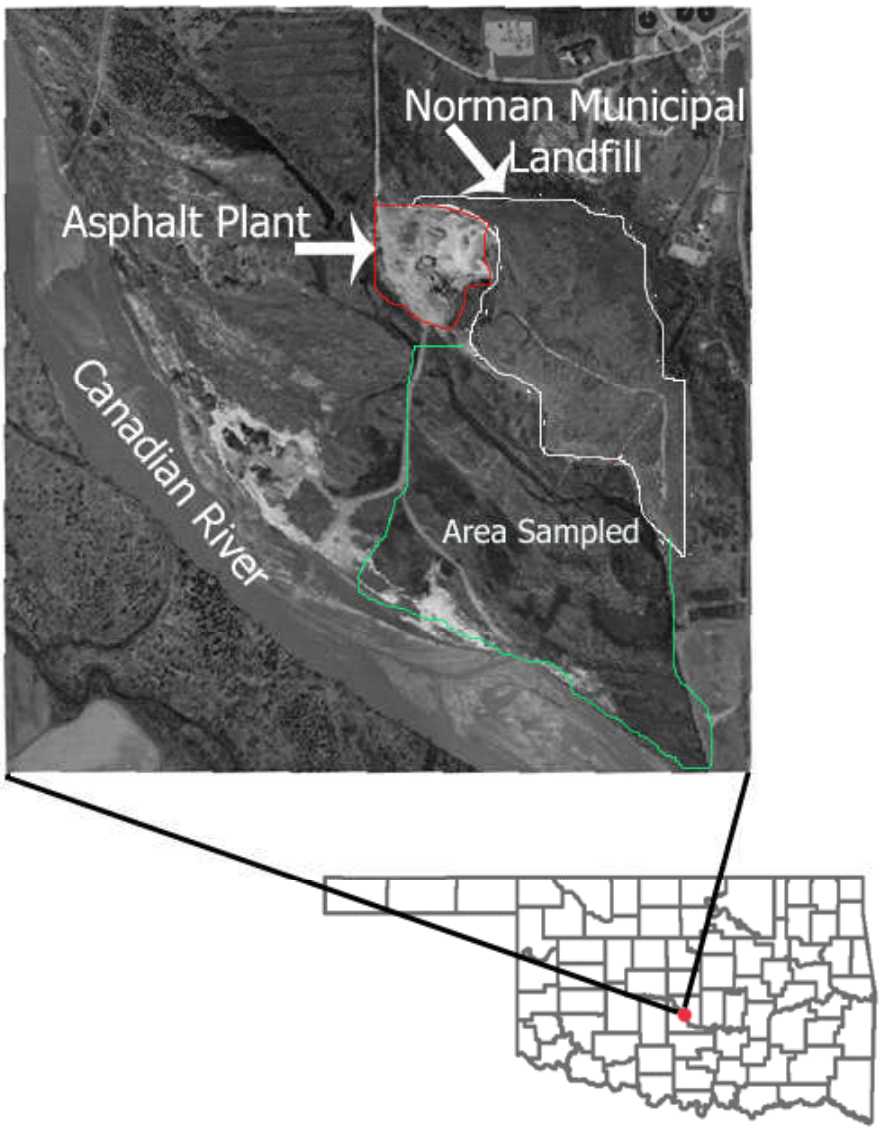

Figure Location of Norman Landfill Site, Cleveland County, Oklahoma.

APPENDIX

Annotated species list for a riparian site on the Canadian River in Cleveland County, Oklahoma. The first entry indicates life history (A = Annual, B = Biennial, P = Perennial), followed by habitat (WETL = wetland and aquatic vegetation, DAOF = disturbed areas and old-field vegetation), and collection number. Exotic species are denoted with an asterisk. Voucher specimens were deposited at the Robert Bebb Herbarium at the University of Oklahoma (OKL).

Coniferophyta

Cupressaceae

Juniperus virginiana L. (eastern red cedar): P, DAOF, #152

Equisetophyta

Equisetaceae

Equisetum hyemale L. var. *affine* (Engelm) A.A. Eat. (scouringrush horsetail): P, WETL, #15

Equisetum laevigatum A. Braun (smooth horsetail): P, WETL, #16

Magnoliophyta

Magnoliopsida

Anacardiaceae

Rhus glabra L. (smooth sumac): P, DAOF, #149

Toxicodendron radicans (L.) Kuntze (poison ivy): P, DAOF, not collected#

Apiaceae

Cicuta maculata L. (spotted water hemlock): B, WETL, #150

Torilis arvensis (Huds.) Link* (hedge parsley): A, DAOF, #85

Asteraceae

Achillea millefolium L.* (common yarrow): P, DAOF, #50

Ambrosia psilostachya D.C. (western ragweed): P, DAOF, #86

Ambrosia trifida L. (giant ragweed): A, DAOF, Lost#

Amphiachyris dracunculoides (DC.) Nutt. (prairie broomweed): A, DAOF, #131

Aphanostephus skirrhobasis DC. (lazy daisy): A, DAOF, #51

Carduus nutans L.* (nodding plumeless thistle): B, DAOF, #154

Chrysopsis pilosa Nutt. (soft goldenaster): A, DAOF, #1

Conyza canadensis (L.) Cronq. (horseweed): A, DAOF, #132

Coreopsis tinctoria Nutt. (plains coreopsis): P, DAOF, #133

Croptilon divaricatum (Nutt.) Raf. (slender scratchdaisy): A, DAOF, #134

Dracopis amplexicaulis (Vahl) Cass. (clasping coneflower): A, DAOF, #158

Eclipta prostrata (L.) L. (false daisy): P, WETL, #53

Erigeron annuus (L.) Pers. (daisy fleabane): A, DAOF, #90

Erigeron philadelphicus L. (Philadelphia fleabane): P, DAOF, #2

Eupatorium serotinum Michx. (lateflowering thoroughwort): P, DAOF, #135

Euthamia gymnospermoides Greene (Texas goldentop): P, WETL, #195

Helianthus hirsutus Raf. (hairy sunflower): P, DAOF, #138

Helianthus maximiliani Schrad. (Maximilian sunflower): P, DAOF, #139

Helianthus petiolaris Nutt. (prairie sunflower): A, DAOF, #4

Heterotheca canescens (DC.) Shinners. (hoary false goldenaster): P, DAOF, #116

Heterotheca subaxillaris (Lam.) Britt. & Rusby (camphorweed): A, DAOF, #56

Iva annua L. (annual marshelder): A, DAOF, #141

Lactuca canadensis L. (Canada lettuce): B, DAOF, #5

Pluchea odorata L. Cass (purple camphorweed): P, DAOF, #91
Rudbeckia hirta L. (blackeyed susan): P, DAOF, #57
Rudbeckia grandiflora (D. Don) J.F. Gmel. Ex D.C. (blackeyed susan): P, DAOF, #142
Solidago gigantea Ait. (giant goldenrod): P, DAOF, #143
Sonchus asper (L.) Hill *(spiny sowthistle): A, DAOF, #158
Symphyotrichum ericoides (L.) Nesom var. *ericoides* (white heath aster): P, DAOF, #196
Thelesperma filifolium (Hook.) Gray var. *filifolium* (stiff greenthread): P, DAOF, #145
Verbesina encelioides (Cav.) Benth. & Hook. f. ex Gray (golden crownbeard): A, DAOF, #199
Xanthium strumarium L. (rough cocklebur): A, DAOF, #146
Amaranthaceae
Amaranthus cruentuss L. (slim amaranth): A, DAOF, #44

Apiaceae
Cicuta maculata L. (spotted water hemlock): B, WETL, #117
Conium maculatum L.* (poison hemlock): B, WETL, #45
Torilis nodosa (L.) Gaetrn.* (knotted hedgeparsley): A, DAOF, #148

Apocynaceae
Apocynum cannabinum L. (Indianhemp): P, WETL, #47

Asclepiadaceae
Asclepias viridis Walt. (green antelopehorn): P, DAOF, #49
Asclepias arenaria Torr. (sand milkweed): P, DAOF, #118

Bignoniaceae
Campsis radicans (L.) Seem. ex. Bureau (trumpet creeper): P, DAOF, #52
Catalpa bignonioides Walt. (southern catalpa): P, WETL/DAOF, #6

Boraginaceae
Heliotropium convolvulaceum (Nutt.) Gray (phlox heliotrope): A, DAOF, #119

Brassicaceae
Lepidium virginicum L. (Virginia pepperweed): A, WETL, #60
Rorippa sessiliflora (Nutt.) A.S. Hitchc. (stalkless yellowcress): A, DAOF/WETL, #7
Rorippa palustris (L.) Bess. (bog yellowcress): A, WETL, #120
Campanulaceae
Triodanis perfoliata (L.) Nieuwl. (clasping Venus' looking-glass): A, DAOF, #8

Caryophyllaceae
Arenaria serpyllifolia L.* (thymeleaf sandwort): A, DAOF, #10

Chenopodiaceae
Chenopodium ambrosioides L.* (Mexican tea): A, WETL, #9

Convolvulaceae
Convolvulus arvensis L.* (field bindweed): P, DAOF, #11

Euphorbiaceae
Chamaesyce missurica (Raf.) Shinners (prairie sandmat): A, DAOF, #156
Cnidoscolus texanus (Muell.-Arg) Small (bull nettle): P, DAOF, #157
Euphorbia marginata Pursh (snow on the mountain): A, DAOF, #159

Fabaceae
Amorpha fruticosa L. (false indigo): P, WETL, # 95
Chamaecrista fasciculata (Michx) Greene var. *fasciculata*, (partridge pea): P, DAOF, #96
Desmanthus illinoensis (Michx.) MacM. ex. B.L. Robins & Fern. (Illinois bundleflower): P, DAOF, #97
Desmodium ciliare (Muhl ex Willd.) DC. (hairy small-leaf ticktrefoil): P, DAOF, #191

Indigofera miniata Ortega (coastal indigo): P, DAOF/WETL, #123
Lathyrus hirsutus L.* (Caley pea): A, DAOF, # 66
Lespedeza stuevei Nutt.(tall lespedeza): P, DAOF, #192
Medicago lupulina L. (black medick): P, DAOF, #193
Melilotus officialis (L.) Lam. (yellow sweet clover): B, DAOF, #99
Strophostyles helvola (L.) Elliott (trailing fuzzybean): A, WETL./DAOF, #160
Vicia villosa Roth* (winter vetch): B, DAOF, #162

Gentianaceae
Eustoma exaltatum (L.) Salisb. ex G. Don ssp. *russellianum* (Hook.) Kartesz
(showy prairie gentian): P, DAOF, #144
Sabatia campestris Nutt. (prairie rose): A, DAOF/WETL, #100

Lamiaceae
Lamium amplexicaule L.* (henbit deadnettle): A, DAOF, #20
Lycopus americanus Muhl. ex W. Bart. (American water horehound): P, WETL, #163
Teucrium canadense L. (American germander): P, DAOF, #165

Lythraceae
Ammannia coccinea Rottb. (valley redstem): A, WETL, #87
Lythrum alatum Pursh (winged lythrum): P, DAOF/WETL, #126
Rotala ramosior (L.) Koehne (lowland rotala): A, WETL, #70

Malvaceae
Callirhoe involucrata (Torr. & Gray) Gray (purple poppymallow): P, DAOF, #22
Mirabilis nyctaginea (Michx.) MacM. (heartleaf four o'clock): P, DAOF, #101

Onagraceae
Gaura coccinea Nutt. ex Pursh (scarlet beeblossom): P, DAOF, #23
Gaura mollis James (velvetweed): P, DAOF, #24
Gaura villosa Torr. (woolly beeblossom): P, DAOF/WETL, #127
Ludwigia peploides (Kunth) Raven (floating primrose-willow): P, WETL, #193
Oenothera laciniata Hill (cutleaf evening-primrose): A, DAOF, #37
Oenothera biennis L. (common evening-primrose): B, DAOF/WETL, #84

Oxalidaceae
Oxalis stricta L. (common yellow oxalis): P, DAOF, # 72

Papaveraceae
Argemone polyanthemos (Fedde) G.B. Ownbey (crested pricklypoppy): A, DAOF, #161

Plantaginaceae
Plantago patagonica Jacq. (woolly plantain): A, DAOF, #25

Polygonaceae
Polygonum hydropiperoides Michx. (swamp smartweed): P, WETL, #75
Polygonum lapathifolium L. (curlytop knotweed): A, WETL, #194
Polygonum ramosissimum Michx. (bushy knotweed): A, WETL, #102
Rumex crispus L.* (curly dock): P, WETL, #76

Primulaceae
Samolus valerandi L. ssp. *parviflorus* (Raf.) Hulten (seaside brookweed): P, WETL, #78

Ranunculaceae
Clematis terniflora DC.* (sweet autumn virginsbower): P, DAOF, #79
Ranunculus sceleratus L. var. *sceleratus* (cursed buttercup): P, WETL, #80

Rubiaceae
Galium aparine L. (stickywilly): A, DAOF, #129

Sherardia arvensis L.* (blue fieldmadder): A, DAOF, #39

Salicaceae
Populus deltoides Bart. ex Marsh. (eastern cottonwood): P, WETL, #175
Salix exigua Nutt. (sandbar willow): P, WETL, #176
Salix nigra Marsh (black willow): P, WETL, #177

Scrophulariaceae
Agalinis heterophylla (Nutt.) Small ex. Britt. (prairie false foxglove): A, DAOF/WETL, #178
Agalinis aspera (Dougl. ex. Benth.) Britt. (tall false foxglove): A, DAOF/WETL, #179
Castilleja indivisa Engelm.(Indian paintbrush): A, DAOF, #111
Leucospora multifida (Michx.) Nutt. (narrowleaf paleseed): A, DAOF, #88
Veronica anagallis-aquatica L. (water speedwell): P, WETL, #40
Veronica peregrina L. (neckweed): A, WETL, #180

Solananceae
Datura wrightii Regel (sacred thorn-apple): P, DAOF, #182
Physalis angulata L. (cutleaf ground cherry): A, WETL/DAOF, #183
Physalis heterophylla Nees (clammy groundcherry): P, DAOF, #184
Solanum elaeagnifolium Cav. (silverleaf nightshade): P, WETL, #185
Solanum physalifolium Rusby (hoe nightshade): A, DAOF, #186
Solanum rostratum Dunal (buffalobur nightshade): A, DAOF, #187

Tamariaceae
Tamarix gallica L.* (salt cedar): P, WETL/DAOF, #114

Valerianaceae
Valerianella radiata (L.) Dufr. (beaked cornsalad): A, DAOF, #42

Verbenaceae
Phyla lanceolata (Michx.)Greene (lanceleaf frogfruit): P, WETL, #83
Phyla nodiflora (L.) Greene (turkey tangle frogfruit): P, WETL, #82
Verbena stricta Vent. (hoary verbena): P, DAOF, #189

Vitaceae
Vitis cinerea (Engelm.).Engelm ex. Millard (sweet grape): P, DAOF, #190

Liliopsida
Commelinaceae
Commelina virginica L. (Virginia dayflower): P, DAOF, #151

Cyperaceae
Carex festucacea Schkuhr ex Willd. (fescue sedge): P, WETL, #62
Cyperus esculentus L.* (yellownutsedge): P, WETL, #12
Cyperus odoratus L. (fragrant flatsedge): A, WETL, #153
Cyperus squarrosus L. (bearded flatsedge): A, WETL, #54
Cyperus strigosus L. (strawcolored flatsedge): P, WETL, #174
Eleocharis obtusa (Willd.) J.A. Schultes (blunt spikerush): P, WETL, #13
Fuirena simplex Vahl (western umbrella-sedge): P, WETL, #14
Schoenoplectus americanus (Pers.) Volk. ex. Schinz & Keller (chairmaker's bulrush): P, WETL, #155
Schoenoplectus maritimus (L.) Lye (cosmopolitan bulrush): P, WETL, #122
Rhynchospora nivea Boeckl. (showy whitetop): P, WETL, #112

Iridaceae
Sisyrinchium angustifolium P. Mill. (narrowleaf blue-eyed grass): P, DAOF, #18

Juncaceae
Juncus acuminatus Michx. (tapertip rush): P, WETL, #67
Juncus biflorus Ell. (bog rush): P, WETL, #195
Juncus marginatus Rostk. (grassleaf rush): P, WETL, #124
Juncus torreyi Coville (Torrey's rush): P, WETL, #19

Lilaceae
Ornithogalum umbellatum L.* (star of bethleham): P, DAOF, #21

Poaceae
Andropogon ternarius Michx. (splitbeard bluestem): P, DAOF, #170
Andropogon glomeratus (Walt.) B.S.P. (bushy bluestem): P, WETL, #164
Aristida oligantha Michx. (prairie threeawn) : A, DAOF, # 174
Bromus catharticus Vahl* (rescuegrass) : A, DAOF, # 89
Bromus japonicus Thunb. ex Murr.* (Japanese brome): A, DAOF, #26
Bromus tectorum L.* (cheatgrass): A, DAOF, #27
Cenchrus spinifex Cav. (coastal sandbur): A, DAOF/WETL, #166
Cynodon dactylon (L.) Pers.* (Bermuda grass): P, DAOF, #105
Dichanthelium acuminatum (Sw.) Gould & C.A. Clark var. *fasciculatum* (Torr.) Freckmann (western panicgrass): P, DAOF, #174
Digitaria cognata (J.A. Schultes) Pilger (fall witchgrass): P, DAOF, #125
Echinochloa crus-galli (L.) Beauv.* (barnyardgrass): A, DAOF/WETL, #28
Elymus canadensis L. (Canada wildrye): P, DAOF, #168
Elymus virginicus L. (Virginia wildrye): P, DAOF, #29
Festuca brevipila Tracey* (hard fescue): P, DAOF, #169
Hordeum pusillum Nutt. (little barley): A, WETL/DAOF, #30
Koeleria macrantha (Ledeb.) J.A. Schultes (prairie Junegrass): P, DAOF/ WETL, #31
Leptochloa fusca (L.) Kunth ssp. *fascicularis* (Lam.) Snow (bearded sprangletop): P, DAOF/WETL, #32
Lolium perenne L. ssp. *multiflorum* (Lam.) Husnot* (Italian ryegrass): P, DAOF, #33
Panicum virgatum L. (switchgrass): P, WETL/DAOF, #35
Phragmites australis (Cav.) Trin. ex. Steudel* (common reed): P, WETL, #171
Polypogon monspeliensis (L.) Desf.* (rabbitsfoot grass): A, WETL, #36
Saccharum ravennae (L.) L.* (Ravenna grass): P, WETL, #172
Schizachyrium scoparium (Michx.) Nash var. *scoparium* (little bluestem)*:* P, DAOF, #173
Setaria parviflora (Poir.) Kerguèlen (marsh bristlegrass): P, WETL, #109
Sorghum halepense (L.) Pers.* (Johnson grass): P, DAOF, #110
Sporobolus cryptandrus (Torr.) Gray (sand dropseed): P, DAOF, #128

Typhaceae
Typha domingensis Pers. (southern cattail)): P, WETL, #188

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Critic's Choice Essay

Cedar-apple Rust

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Department of Biology, University of Central Oklahoma, Edmond, OK 73034

The photograph on the cover illustrates a phenomenon of nature that can be seen in the Oklahoma springtime at about the same time that the redbuds are in flower and the morels are fruiting. The orange-colored masses represent a stage in the life cycle of cedar-apple rust, *Gymnosporangium juniperi-virginianae,* and this stage is occurring on the eastern red cedar (*Juniperus virginiana*).

Rust fungi are obligate plant parasites; that is, they require a living host in order to obtain nutrition and survive. Rust fungi have among the most complicated of all fungal life cycles with most rusts requiring two hosts to complete their life cycles. You may have heard of the wheat rust (*Puccinia graminis*) that, throughout the history of cultivated crops, has been a devastating plant pathogen. Its second host is the barberry (*Berberis* spp.).

As the common name suggests, the cedar-apple rust divides its time between *Juniperus* species and apple or flowering crab trees. Since we have the photo of the stage on the *Juniperus,* that is where we will begin our examination of the life cycle (Fig. 1).

At first, brown gall-like structures that are rather hard and less than 2 inches in diameter form (Fig. 2). They can be seen developing on cedar trees in the wintertime and have been referred to as "cedar apples." Then, in response to spring rains, the galls expand considerably and send out the telial horns (Fig. 3). These orange, finger-like gelatinous structures, which are masses of teliospores, grow from the galls. The teliospores are two-celled and later a basidium grows from each and releases four basidiospores. The basidiospores are carried by the wind to distances of up to three miles, where they land and infect the leaves of an apple tree. In late spring or early summer light yellowish orange spots form on the upper surface of the leaves (Fig. 4). Small flask-shaped structures called spermagonia appear on the leaf surface. The spermagonia are sticky and produce spermatia (spores) that insects carry to another spermagonium where fertilization takes place. The hyphae (fungal filaments) that result from fertilization grow toward the lower surface of the leaf where small pustules called aecia are formed. The aecia release aeciospores during mid-summer that are wind-dispersed to *Juniperus* trees and the infection process starts over. The entire life cycle takes about two years to complete, with the longest developmental stage on the *Juniperus*.

The most damage is done to the apple trees, so the rust is of concern to apple growers because of their commercial importance. Trees may lose the infected leaves and apple production and quality will be diminished. Fungicidal sprays are available to treat both tree species. For more information and additional photos on the cedar-apple rust, visit http://www.ento.okstate.edu.

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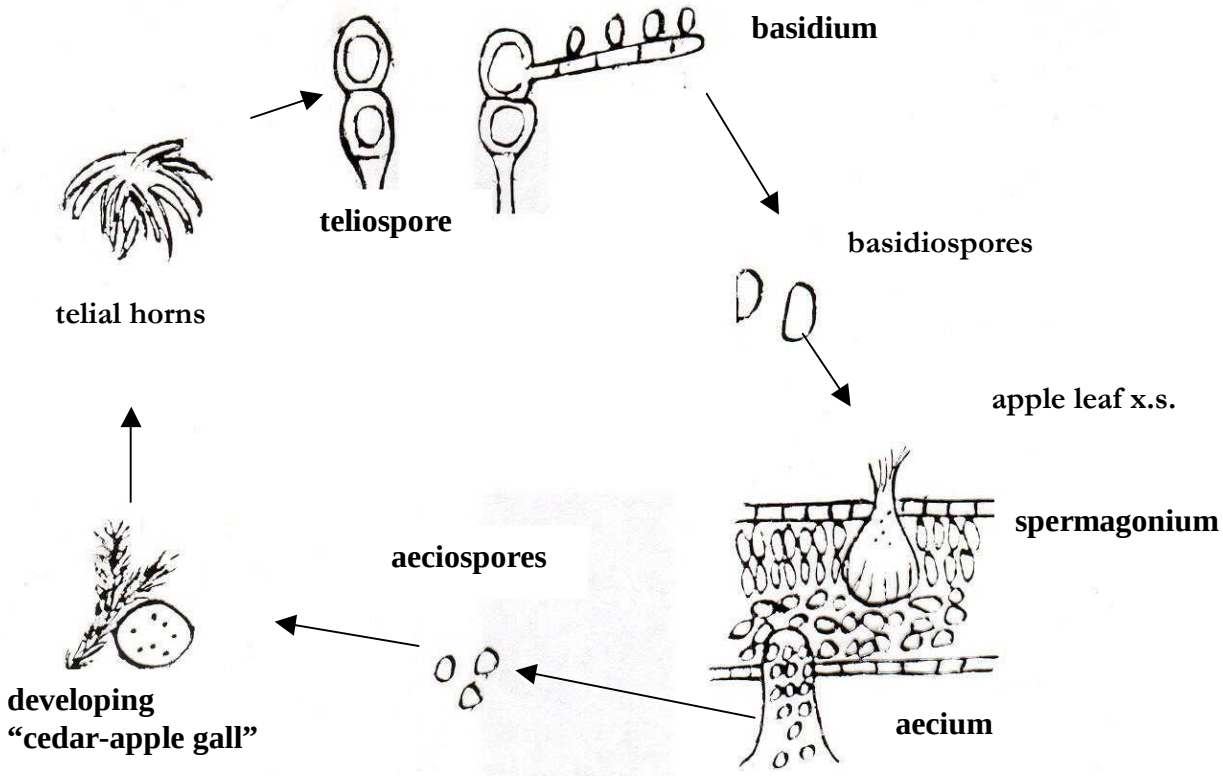

Figure 1 Life cycle of *Gymnosporangium juniperi-virginianae*

Figure 2 *Gymnosporangium juniperi-virginianae* "Cedar-apple gall". Photo by author.

Figure 3 Telial horns. Photo by L.B. Stabler

Figure 4 Rust spots on apple. Photo courtesy of Oklahoma State University Department of Entomology and Plant Pathology.

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