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PRELIMINARY ECOLOGICAL STUDY OF THE SHINNERY OAK AREA OF WESTERN OKLAHOMA

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PRELIMINARY ECOLOGICAL STUDY OF THE SHINNERY

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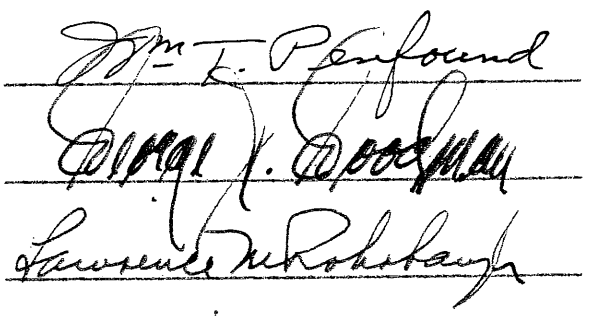
A THESIS

APPROVED FOR THE DEPARTMENT OF PLANT SCIENCES

BY



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CHAPTER I

INTRODUCTION

The comments of various adventurers, explorers, and military men in the early history of our country have often been of great value in the investigation of modern scholars. Some examples which follow are the reports of a few men who commented about a small shrub in the grassland areas in what is now western Oklahoma and the Texas panhandle.

While on his way toward Santa Fe from Fort Smith in 1839 Josiah Gregg (12) wrote these words which later appeared in his second volume of Commerce of the Prairies:

> . . . we encamped in a region covered with sandy hillocks . . . an immense sand-plain was now opening before us . . . being entirely barren of vegetation in some places, while others were completely covered with an extraordinarily diminutive growth which has been called shin-oak . . . which were heavily laden with acorns . . . although the trunks . . . were seldom thicker than oat-straws, and frequently not a foot high.

Six years later, in September 1845, near the Antelope Hills of western Oklahoma, Lt. J. W. Abert (10) noted that,

". . . along the Washita, . . . the uplands were thickly spread over by diminutive species of oak commonly called 'shin oak' not exceeding two feet in height. . . ."

While exploring the "Red River of Louisiana," R. B. Marcy (7) wrote on the 5th of June 1852,

> . . . the country we traversed was exceedingly monotonous and uninteresting being a continuous succession of barren sand hills, producing no other herbage than the artemisia, and a dense growth of dwarf oak bushes, about eighteen inches high, which seem to have attained their full maturity, and bear an abundance of small acorns. The same bush is frequently met with upon the Canadian river, near this longitude, and is always found upon very sandy soil.

This was near the area of present day Sayre, Beckham County, Oklahoma (5).

On Edward F. Beale's expedition his journalist and assistant F. E. Engle (6) wrote that,

> . . . On December 10, 1858 . . . we passed between the Antelope Hills, . . . On looking at the river from elevated points, so that I could observe it from some distance, only a few mottes of timber could be seen, and not in such quantities to admit a great deal of shelter.

Over a century ago this "diminutive species of oak," "shin oak," or simply "shinnery" was conspicuous enough to cause comment. Today, it attracts even more comment, mostly from ranchers, because of cattle loss due to shinnery poisoning in the early spring, and from farmers, because of land lost to shinnery which could yield a few bales of cotton or produce pasture for a few cows.

It is believed that the word "shinnery" is not based on its stature, i.e. shin-high, but rather is derived from the French cheniere meaning "oak island." This term is still employed in southern Louisiana in reference to the island areas protruding above the marshes which are clothed in evergreen oaks (15, 16).

The word "shinnery" has been used not only with a particular species of oak (Quercus havardi) found in western Oklahoma and adjacent Texas but also for several other species found in the Cross Timbers of Oklahoma and Texas and in other parts of the American Southwest. There are references to its use in application to other genera of plants elsewhere in the United States (2, 4, 8, 18).

The present study deals primarily with a single species, Quercus havardi Rydb. which has the following type locality, according to Rydberg's original description (17), "TEXAS: Sandhills of the Staked Plains."

Though shinnery has been talked about, written about, and discussed for many years very little has been done in the way of actual scientific study. There have been some very good taxonomic studies accomplished and in conjunction with these studies occasional ecological comments have been made. Actual ecological investigation has been confined to a discussion in terms of the entire ecological distribution of vegetation in Oklahoma or the Plains. In the past few years the U. S. Department of Agriculture has been making

studies on the eradication and control of the plant.

After the early "exploratory studies" in the shinnery areas across the American Plains there is almost a complete lack of reference of a scientific nature to this vegetation.

The original description of Quercus havardi appeared in 1901 in a taxonomic publication by Rydberg (17). Later, in his Trees and Shrubs of New Mexico, Wooton (25) speaks of the ". . . Shin-oak or Shinry (Quercus havardii) . . . as a low deciduous-leaved shrub, rarely over 3 feet high." Then, in 1915, Wooton and Standley (26) commented that "The plant is generally spoken of as 'shinnery' or 'shin-oak' and the sands it covers go by the name of 'shinnery sands'."

The first ecological comments on shinnery that I have found were made in 1931 by Bruner (1). In his discussion of the chaparral he states that it ". . . is represented in the central part of western Oklahoma by communities of 'shin oak'." He also adds that several species of oaks constitute the complex. There are some brief comments concerning size, shape, soil type, and areas covered by the ". . . circular zones. . . ." In his study, Bruner does not mention the variability between these individual clumps or the geographical limits of this particular group of oaks.

Perhaps the most extensive work undertaken concerning the shinnery was that by Muller (13, 14, 15) in the early 1950's. His studies were principally of a taxonomic nature but did include several very worthwhile notations on habit,

hybrid variation, and association between motte area, leaf shapes and clone height.

Recent studies by the U. S. Department of Agriculture and researchers from several universities indicate that this oak can be eradicated or controlled by using several of the recently developed herbicides (9, 22).

It is with all the past discussions, thoughts, and ideas in mind that I have attempted to include some other aspects of this very interesting ecological type in Oklahoma.

The scope of this investigation of the shinnery oak in western Oklahoma is five-fold: (1) description of the study areas with information on the climate, geology, and soils; (2) classification of the oak, variation throughout its range, and possible hybridization; (3) a description of the shinnery oak community and its contact with other vegetation types; (4) a discussion of the growth habits as to size, age, reproduction, and habitat factors; and (5) the methods of eradication and control currently being used and those proposed on the basis of this study.

CHAPTER II

DESCRIPTION OF STUDY AREA

Location

This study was limited to Oklahoma and includes areas from just south of the Salt Fork of Red River in Harmon County north slightly past the North Canadian (Beaver) River in central Woodward County. The western limit of the study is the 100th meridian, the western border of the main body of Oklahoma, and the eastern limit is roughly the 98th meridian though the oak which I am defining as shinnery oak has an eastern limit near 98° 30' west longitude. The counties where I found shinnery oak are Harmon, Beckham, Roger Mills, Ellis, Woodward, Dewey, Greer, Jackson, and Blaine. Influence due to hybridization was apparent in the oak regions of these other counties: Major, Custer, Caddo, Comanche, Grady, Stephens, Jefferson, Love, and Murray (Fig. 1).

Climate

The climate in the shinnery oak areas of western Oklahoma is temperate, and of continental origin. The climate is characterized by rapid changes and marked extremes in temperatures and by rather erratic rainfall. Seasonal

characteristics are distinct and transition periods from season to season are gradual. Fall and winter cold fronts move across the plains from the north and cause abrupt drops in temperature, but these are usually of short duration and the winters could be considered mild. The summers are long and hot with the prevailing southerly winds and high evaporation rates which deplete moisture rather quickly.

The mean monthly minimum temperature for the coldest month, January, ranges from a low of about 35° F. to about 40° F. The mean monthly maximum temperature, recorded in July, ranges from about 81° F. to about 86° F. (Table 1).

Precipitation ranges from an annual mean of about 21 inches to over 24 inches. Most of the rain falls in the spring months, principally in May. The late fall and early winter months have the least amounts, ranging from 0.5 to 1 inch (Table 1) (23, 24). The vast majority of the shinnery oak occurs west of the 25 inch rainfall line in Oklahoma (Fig. 2).

Geology and Soils

The shinnery oak occurs on soils derived from materials, mostly dune sands, of the Tertiary and Quaternary Periods, and specifically in the Pliocene and Pleistocene epochs. The formations included in the Pliocene epoch include dune sands and the Ogallala formation. These formations are chiefly in Ellis, Roger Mills, and Woodward Counties. The

formations of the Pleistocene epoch include high terrace deposits and dune sands. These are located chiefly in Harmon and Beckham Counties with some areas in Blaine, Dewey, and Woodward Counties. Some shinnery may also occur on dune sands of recent origin such as in river bottoms or areas adjacent to the rivers where the prevailing winds have deposited sands (11).

The shinnery oak in western Oklahoma is found chiefly on two soil series, the Brownfield, where the taller mottes are located, and the Nobscot, where one finds the rather small, or short, mottes and the scattered shrub. Some shinnery does occur on a loamy fine sand of the Miles series in spite of the small amounts of calcium carbonate present.

According to the report by the National Cooperative Soil Survey (20),

> The Brownfield series includes loose sandy soils with reddish friable subsoils and no horizon of carbonate accumulation. These soils occur in the Reddish Chestnut and Reddish Brown soils zones of the High Plains. The parent materials are very sandy earths that appear to be aeolian.

The surface horizon of these soils is brown, quite loose, and neutral to slightly acid. The subsurface soils are lighter in color but otherwise similar to the surface horizon. Probably the most important feature of this soil type is the clay content of the B_2 horizon which tends to retain more moisture which is available for plant use. This may be a reason for the greater growth of the shinnery oak growing on this soil.

In a "Tentative Series" report, "recommended for establishment," by the National Cooperative Soil Survey (21) the Nobscot Series is described as being

> . . . of very sandy Intrazonal Soils much like Brownfield but having more sandy textural B horizons of loamy fine sand to fine sandy loam. It occurs in the Reddish Chestnut zone, mainly in western Oklahoma, and has distinct horizonation. The parent materials are sands, presumably eolian and early Pleistocene or Pliocene, low in weatherable minerals.

It is possible that the sandy textured B horizon is the really important aspect here in that less moisture is available to plants as opposed to the Brownfield soils.

Occasional small areas upon which shinnery is found are in the Miles Series which is a reddish fine sandy loam (19). However, the shinnery occurs on the loamy fine sand sections of this series. An example of this is in the area about nine miles north of Cheyenne, Roger Mills County. Soils containing calcium carbonate usually do not permit a growth of oaks but in this case where the soil is quite sandy and adjacent to areas already containing shinnery it is invaded by the oak, though they are quite small and the annual growth is very slow.

On top of the Antelope Hills in northwestern Roger Mills County the soil is derived from a sandstone impregnated with calcium carbonate. Here there was a very low growth of shinnery which had a very slow growth rate.

Occasional mottes were noticed which were in the shape of a ring with no oak growth in the middle. These

were usually in the form of a circle about a rather large mound of sand. After mentioning this to Dr. Lewis Derr of the Soil Conservation Service at Stillwater, Oklahoma, who is conducting soil surveys in the shinnery areas, he gave the apparent reason for this feature. According to him, "These mounds without oaks contain a deposit of calcium carbonate in the B horizon." On the basis of the above, chemical analysis of the soils of representative sizes of shinnery should be checked to determine if slight collections of calcium carbonate not in a definite horizon have an effect on the size or growth rate.

CHAPTER III

CLASSIFICATION AND DESCRIPTION OF SHINNERY OAK

Quercus havardi Rydb. is one of the many species in the Subgenus Lepidobalanus End., or White Oaks. It was named after Dr. Valery Havard, the collector of the type specimen, by Rydberg in 1901 (17).

This oak, as treated in this study, is one of tremendous variation with a broad range in almost all aspects. The color of the leaves range from light green to dark green to bluish green. In the early spring, during emergence of the leaves, some of them may be green while others have a red or pinkish coloring. After frost some of the leaves remain green for a while, others turn brown, and still others become various shades of red.

The upper surface of the leaves may be dull or shiny regardless of the color. This dullness may or may not be due to pubescence. Those with a shiny surface may be without pubescence or may have very scattered stellate hairs. The lower surfaces all have stellate pubescence, although not to the same degree, with some having scattered hairs and others having closely spaced or matted hairs.

The margins of the leaves vary from rather smooth in outline to deeply lobed. Some of the lobes may be pointed but are not sharply tipped as in the blackjack oak. Other leaves are smoothly-lobed. The number of lobes varies from a single pair of lobes to several pairs although in some cases the lobes are not paired but appear alternately along either side of the leaf.

The size of the leaves varies in length from short (30 to 50 mm) to moderate (80 to 100 mm) and in cases even long (120 to 140 mm). The width of the leaves ranges from narrow (10 to 15 mm) to wide (50 to 60 mm). In most cases the leaves appear to be narrow as compared with their length. The smaller leaves are those in the class 30 to 50 mm long and 10 to 15 mm wide. The larger leaves are 120 to 140 mm long and 50 to 60 mm wide. Some leaves appear rather short as compared with width (70 to 80 mm long by 40 to 50 mm wide).

The twigs also vary in color from a light tan, through brown, to almost black. Some twigs have a reddish cast especially during early growth. The diameter of the leaf bearing twigs in some forms is small (2 mm) and in others rather thick (4 to 5 mm). Some twigs have pubescence which is either dense or scattered, whereas others are glabrous. The buds have the same range of colors as the twigs but a greater percentage of them are pubescent. There were a few collections of the oak that had glabrous buds.

The fruits exhibit as great a range of size, shape, and color as do the other parts of the plant. The acorns are tan, brown, black, or reddish. Their shape varies from conical, to cylindroidal, to distinctly globose. Some globose acorns were wider nearer the tip. The acorn size ranges from about 20 mm to 30 or 35 mm in length and from near 15 mm to 30 mm in width. The acorn cups also have a range of colors, from light tan to dark brown. The edges of the cups are sometimes quite smooth, sometimes slightly toothed, and in some cases very fimbriate. The depth of the cups is also variable with some being very shallow and others being deeper than they are wide. The cups have a range in width from about 15 mm to nearly 35 mm.

Probably the most important aspect of the great variation exhibited in this oak is that no single characteristic studied seems to be associated with any other characteristic. Sixteen characters were selected for investigation. Two or three variations of each character were punched on McBee Keysort cards. Specific characters, such as leaf color and fruit shape, were then separated by spindling the Keysort cards. In no case did there seem to be any specific correlation between any of the sixteen entities. Correlation of morphological characters with geographical areas was not checked through the use of the Keysort cards. However, there does appear to be some correlation between leaf character and particular geographical areas. In Roger Mills County

there are some localities with shinnery containing leaves broadest above the middle and slightly wider as compared with those in other locations. Those specimens collected in Woodward County appear somewhat uniform in color, being rather dark green.

Muller (14) stated that,

> Typical Quercus Havardi (undiluted by hybridization) is still to be found over vast areas. In comparatively ancient times there existed a wide contact between Quercus Havardi and the more easterly Quercus stellata, both of which are arenophilous species. Subsequent shifting of the climatic cycle toward xericism has nearly broken this contact and interrupted a series of hybridizations which might well have swamped Quercus Havardi.

He further stated, "Along the 'breaks' of the Plains Quercus Havardi comes in contact with Quercus Mohriana quite extensively and there results some degree of hybridization and consequent confusion."

Concerning the mottes Muller (14) wrote, "The prominences [mottes] are plants exhibiting more or less evidence of hybridity with Quercus stellata. . . ." As for this comment I believe it may hold true in some cases but certainly not all, for some of the taller mottes exhibited leaf characteristics far different from Quercus stellata. The locations where the similarity occurs most frequently are in those regions that I am calling "influence areas" where Quercus havardi does come in contact with the post oak, Quercus stellata. A good example of such an area is in the Wichita Mountains of southwestern Oklahoma and in the area of

shinnery in central Blaine County.

Quercus havardi in past collections and in some recent papers has been confused with Quercus undulata. Rydberg (17) stated, "As Quercus undulata and Quercus Havardi have the same habit and the leaves of the latter have almost the same structure and form, although deeper lobed, it is not strange that James confused them." On the basis of this report, Quercus undulata may be one of the oaks which contributes to the hybrid complexity of shinnery in this area.

Another oak which may possibly hybridize with Quercus havardi is Quercus gambelii, a more western species. This is not confirmed, although some forms of the shinnery exhibit characteristics of Gambel's Oak.

CHAPTER IV

THE SHINNERY OAK COMMUNITY

Shinnery oak is located in the plains grasslands and is developed principally in the mixed prairie and short grass plains. In some cases, though rarely, it is developed in tall grass prairies.

The major grasses associated with the oak are little bluestem (*Andropogon scoparius*), triple-awn grass (*Aristida spp.*), sandbur (*Cenchrus spp.*), buffalo grass (*Buchloe dactyloides*), sand dropseed (*Sporobolus cryptandrus*), hairy grama (*Bouteloua hirsuta*), and blue grama (*Bouteloua gracilis*). There are many other minor grasses, some native and some introduced, which are not frequent enough throughout the range to warrant mention here.

The most common woody species which are associated with the shinnery are sandsage (*Artemisia filifolia*), skunk-brush (*Rhus aromatica* var.), western hackberry (*Celtis reticulata*), yucca (*Yucca glauca*), and grape vines (*Vitis spp.*). In some cases along the eastern fringe *Quercus havardi* may mix with and hybridize with post oak (*Quercus stellata*). Another oak found growing with the post oak in these situations

is blackjack oak (Quercus marilandica). In Blaine County the red cedar (Juniperus virginiana) was scattered in the shinnery.

Shinnery oak comes in contact with many other vegetation types and at these points there is a certain amount of interdigitation. Those vegetation types growing on sandy soil similar to shinnery soils mix with the shinnery much more than those growing on the red-bed soils. Shinnery mixes infrequently with the short grass types and even less with the mesquite-grassland type.

Probably the most frequent contact and mixing of shinnery with another vegetation type is with the sandsage-grassland which constitutes a good part of the contact zone in the north, west, and central shinnery areas. These mictia occur in Ellis, Roger Mills, Beckham, Woodward, and Dewey Counties. The principal plant of this vegetation type is sagebrush with some skunkbrush, western hackberry, and many of the grasses associated with shinnery.

Contact with the mixed grass prairie is probably the next most frequent. This occurs in each of the above counties in addition to Harmon, Greer, and Blaine Counties. The principal vegetation here is little bluestem, triple-awn grasses, and the grama grasses.

In the eastern part of the range of shinnery, chiefly in Blaine County, and in those areas where influence by Quercus havardi may be seen the shinnery contacts the

blackjack-postoak community. There may be some red cedar and hackberry growing with the principal vegetation.

Contact with short grass types is limited to the western part of the shinnery areas. Most contact with this vegetation occurs in Roger Mills County where there has been much erosion into the upper Permian formations. The chief grass associated with this vegetation type is buffalo grass. Several of the other smaller grasses previously mentioned, such as the triple-awn and grama grasses, are also present. There may be occasional sand-plum (Prunus spp.) and in the main erosion channels some American elm and hackberry.

The least amount of mixing of the shinnery oak with another vegetation type occurs where contact is made with the mesquite grasslands. The vegetation occurs in conjunction with the shinnery chiefly in Harmon County though some does occur in southern Beckham County. The principal plant of the vegetation type is mesquite (Prosopis glandulosa). Other important plants are pricklypear cactus (Opuntia spp.) and the short grasses, buffalo and grama grasses. The lack of mixing of this vegetation with shinnery is probably due to the soil type, that of the mesquite being alkaline and with a high content of clay.

CHAPTER V

GROWTH HABITS OF THE SHINNERY OAK

Size and Age

This oak appears in some areas as sizeable trees up to forty to fifty feet high. Usually the first year's growth is from one to two feet, depending on the location. Most of the fields containing shinnery have oaks of this stature. Occasionally in these fields are mottes, or clumps, with plants three to four feet tall. These individual mottes, in most cases, cover a much larger area than adjacent mottes having oaks ten to fifteen feet tall. It is during this latter stage of development that the undergrowth of other plants starts to decrease. When the trees in mottes are thirty to forty feet tall the undergrowth has largely disappeared and consists only of an occasional grape or greenbrier.

The smallest shinnery seen was on top of one of the Antelope Hills or Buttes in northwestern Roger Mills County. It was growing in sandstone impregnated with calcium carbonate. The tallest, as well as oldest, shinnery seen was in and near Boiling Springs State Park in central Woodward County.

The smaller shrubs (one to two feet tall) attain an age of one to possibly four or five years and in some cases may reach ten to twelve years in the drier regions such as in the Antelope Hills. I found the second group (three to four feet high) to be in the range from five to eighteen years and in rare cases twenty years. The third group (ten to fifteen feet tall) ranges from twenty years up to an age of thirty to thirty-five years. Near Boiling Spring State Park, where I was fortunate in finding some trees recently felled, I encountered the largest group (thirty to forty feet tall) with ages from sixty-five to seventy years. In the other cases ages were obtained by cutting cross-sections of several trees in representative mottes, sanding, polishing, and counting the annual rings. This was difficult in some cases and strict accuracy could be questioned since in some very dry years the annual rings were barely perceptible. Furthermore, in some years with several rainy periods in the summer there appeared to be indications of false growth rings.

The growth in diameter of the shinnery oak varies according to rainfall, soil type, or soil moisture. There is no indication of a correlation between annual increase in diameter and height or age of the oak. The data on aging represent averages of trees in several locations in each county (Table 2, Fig. 1).

The southernmost county, Harmon, had trees which grew in diameter more rapidly than those of any other county. This

average was 5.2 mm per year for those trees checked. Ellis County shinnery had the lowest annual increase of 1.1 mm per year. Woodward County shinnery exhibited an annual increase in diameter of 4.8 mm per year even though the collections were further north than those in Ellis County. More extensive collections and analysis are desired to determine if the growth rate is actually this high.

Roots and Rhizomes

Due to the difficulty in digging up trees to study the root form of the shinnery my information came from viewing recent road cuts and talking to soil scientists and county agents.

The roots of shinnery penetrate deep into the underlying soil layers. There is not much branching of the root system until penetration into the B_2 horizon between 25 and 50 inches below the surface. Branching then occurs freely and the roots spread widely from the tree intermingling with roots from adjacent trees. In those soils where a distinct calcareous layer has formed the root system may flatten out and not penetrate this layer.

The other underground parts of the shinnery are the rhizomes which are responsible for most of the vegetative reproduction and motte formation. These rhizomes develop from the main stem of a fairly young plant and grow under the ground for several feet. They may or may not develop

additional above-ground shoots but usually do if the "parent" plant is damaged or destroyed. In some cases the rhizome may reach a diameter of three to four inches. I found the rhizomes to be no deeper than one to two feet under the soil surface. In the stage of development between mottes with trees ten to fifteen feet tall and those thirty to forty feet tall the rhizomes appear to die and rot away. I was rarely able to locate evidence of living rhizomes in the older mottes.

Reproduction

Quercus havardi rarely, if ever, reproduces through the agency of acorns. In fact, I saw not a single case of germination of acorns. Instead, most of the reproduction appears to be through the sprouting of the rhizomes. If destruction of the above ground parts of shrubs through the eighteen to twenty year age group occurs, the buds of the rhizomes sprout and within one to two months new growth appears above the ground. The growth during the first year proceeds at a rapid pace until stems one to two feet tall are produced. Due to the absence of rhizomes in the twenty to thirty-five year age group reproduction by this means rarely occurs. Instead sprouts develop from the main trunk itself. This sprouting is very slow, and if damage occurs late enough in the growing season may not occur during that particular growing season at all. In several cases sprouting did not occur even during the next growing season. In older trees

sprouting did not appear from cut stumps except in one or two cases. This occurred only during the second growing season after cutting.

Effects of Habitat Factors

As concerns the shinnery oak, cattle are probably of interest primarily from the standpoint of overgrazing. Grazing tends to lower the combustible material which could catch fire and destroy shinnery and also relieves the shinnery of some competition allowing it to grow even larger.

The developing buds and young leaves of the shinnery oak are poisonous to the cattle that eat them (9, 22). This is one reason why cattlemen are interested in ridding their fields of this oak.

Insects seem to do little damage to the shinnery. In several localities a great number of insect galls appeared on the leaves of only one or two mottes in a large field of shinnery. The entire motte appeared to be affected while adjacent mottes were not affected. Apparently certain biotypes are susceptible to a particular insect while others are not. Practically all of the acorns returned to the laboratory were infested with larvae of insects. This may be the reason for the low fertility of shinnery acorns.

During the winter I noticed that the bark had been chewed from around the lower portions of fairly young oaks. This damage may have been due to rabbits or possibly the

kangaroo rats which are quite abundant in this area. Squirrels and blue jays probably carry away a great number of the acorns.

In one area a fire, apparently occurring in the autumn, had burned over a small field of shinnery. The major damage appeared to be the killing of the above ground parts of the smaller oaks. Some damage was evident along the periphery of the mottes, although death was confined to lower branches of individual trees and occasionally to entire smaller trees of the group. Even though the above ground parts of the smaller plants were killed, perennation was occurring over the entire area by sprouting from the rhizomes. Reproduction by damaged trees in the mottes had not started by early summer of the growing season following the fire. Since death occurred only in the smaller oaks while the mottes were mostly spared suggests that the mottes may form a sort of fire protection due to the lack of combustible plant material under them. It also appeared that the larger the motte the greater was this protection.

CHAPTER VI

ERADICATION AND CONTROL

Recently the need of greater range productivity has emphasized the necessity of ridding the western ranges of shinnery. Chemical spraying is probably the most effective of the several methods presently used to destroy this oak. Workers at the U. S. Southern Great Plains Field Station at Woodward, Oklahoma have been carrying on a research program using several of the recently available growth regulators including 2,4-D, 2,4,5-T and 2(2,4,5-TP) (9, 22). Application is accomplished by either spraying from airplanes or ground equipment. Use of 2,4,5-T early in the development of leaves in the spring at the rate of one pound acid-equivalent per acre applied for three successive years kills nearly 90% of the shinnery oak. This treatment also kills over 95% of the sand sagebrush, skunkbrush, and sand plum.

Mowing is probably the most undesirable and least effective method of control. Most of the shinnery causing the greatest loss of grassland is too large to mow and that shinnery which is small enough to mow develops several shoots for each one cut.

In talking with several ranchers and scientists in the shinnery area it became evident that fire was a major factor in the type of shinnery produced. Some of these men were original pioneers in the area. These early settlers reported almost yearly fires, abundant grass, and the absence of tall mottes of the oak. Both ranchers and scientists believed that periodic, hot fires kept this community at such height that grasses and other forage plants could compete successfully with the shinnery. My own observations have suggested that the absence of regular fires has been responsible for the tall mottes and trees throughout this vegetation type. These discussions and observations suggest that regular, destructive fires controlled the height of the shinnery at the time of settlement. It appears, also, that fire may still be an excellent and economical means of controlling shinnery height and of increasing forage production.

CHAPTER VII

DISCUSSION

During the many years since early explorers first mentioned the shinnery oak, very little has been accomplished to explain its great variety, its geographical limits, the reason for the peculiar motte-forming characteristic, or for the increased height of some mottes.

With the present protection from large and regular fires and the reduction of the competing vegetation by over-grazing, shinnery oak can be expected to continue to grow taller and possibly produce a forest condition. This is indicated by the fact that in some areas the oak has become tree-like and the soil in some shinnery has approached that of a forest soil.

In the locales where motte formation is well advanced, the soil under the mottes may be more acid than the areas of mixed shinnery and grasses. Investigation of the soil pH in variously sized mottes, mixed shinnery oak grasslands, grasslands, and shinnery recently destroyed under various conditions would be desirable. Increased height of the mottes through the years may be a combination of several soil

factors in addition to a lack of destructive fires. Some of these are particle differences in the soil, available soil moisture, and availability of minerals. The results of complete physical and chemical analysis of the soil would possibly answer such questions.

The shinnery oak may be controlled or destroyed by chemicals and its stature may be regulated by periodic burning. Such control should produce an increase of range grasses such as existed before the twentieth century, provided the new areas are not overgrazed. It would be quite desirable to have research of this nature, such as burning moderately sized plots of the oak on several time schedules and studying the quantitative results.

After cutting some of the trees and shrubs of the shinnery, I noticed that in smaller and younger individuals new growth from rhizomes developed rather quickly. The older trees, on the other hand, sprouted only from stumps and only after a much longer period. This I found to be due largely to the lack of rhizomes in the older mottes. Investigation as to the comparative sprouting from rhizomes and stumps appears necessary.

Certainly additional information is desired concerning the taxonomy of Quercus havardi. I believe that further taxonomic studies should rely on methods other than morphological ones. Such methods could be cytotaxonomic, serological, chromatographic, or biochemical in nature. Some

progress may be possible through phenological observations. Any added information on the taxonomy of the oak should shed light on the hybridization which has occurred and is occurring. It is possible that additional data on hybridization could be obtained in studies similar to those recently accomplished by Cottam, Tucker, and Drobnick (3) in the hybridization zone of Quercus gambelii and Quercus turbinella in southern Utah and northern Arizona. Their study employed the use of microclimatic investigations to determine the postpluvial climates of the area. Investigation of this type on the shinnery would have to be on a larger scale due to the extensive area in question.

Cattle poisoning is a problem in the ranchland areas of the shinnery in the early spring during emergence of the leaves. Research on the chemical nature of the causal agent may result in development of more effective antidotes.

Accurate mapping of the shinnery oak areas through the use of aerial photographs would be desirable. This information would be of use to soil scientists and geologists as well as botanists who wish to make further ecological investigations.

CHAPTER VIII

SUMMARY

This investigation is a preliminary ecological study of the shinnery oak areas of western Oklahoma and involves primarily one species of oak, Quercus havardi Rydb.

The shinnery is scattered throughout the western third of the main body of Oklahoma principally on sandy soils derived from materials of the Pliocene and Pleistocene epochs. The soils involved are the Nobscot Series, with oaks of smaller stature, and Brownfield Series, having the larger trees. Some shinnery also appears on soils of the Miles Series. The principal shinnery areas are located west of the 25-inch isohyet.

Shinnery occurs in the plains grassland area and is developed principally in the region of mixed prairie and shortgrass plains. Contacts with vegetation types include sandsage-grassland, mixed grassland, short grassland, black-jack-postoak, and mesquite-grassland.

The writings of early explorers regarding the shinnery areas indicated the dwarf stature of this oak with occasional clumps or mottes protruding above the grasslands. The lack

of regular fires in the area through the past half-century appears to be the principal factor concerned with the present height of the oak as compared with the oaks before settlement by farmers and ranchers.

Certain recent studies concern the taxonomy of Quercus havardi and the fact that this oak is one of extreme hybridization. Influence of Quercus havardi on the other oaks of the white oak group is apparent in the areas east of the main shinnery belt. The extreme hybridization of Quercus havardi allows tremendous variation of leaves, stems, buds, and fruits as concerns shape, pubescence, color, and phenology. Over the entire range there does not appear to be a single character which is linked with any other. In a few cases a given character was predominant in a particular geographical area. Hybridization appears to involve Quercus stellata, Quercus mohriana, Quercus undulata, and possibly Quercus gambelii.

Four principal size-age groups are apparent: (1) one to two feet tall (one to four or five years old), (2) three to four feet tall (five to eighteen years in age), (3) ten to fifteen feet tall (twenty to thirty or thirty-five years), and (4) thirty to forty feet tall (with ages of sixty-five to seventy years). The average annual increase in diameter per county ranged from a low of 1.1 mm per year to a high of 5.2 mm per year.

Reproduction appears to be almost completely by rhizomes. There was occasional, though delayed, sprouting from the stumps of cut trees. Not a single case of new plants developing from acorns was noted.

The height of shinnery in the past, with a resultant increase in forage, is believed to have been controlled by fire. On certain ranches excellent control of shinnery is now being accomplished by chemicals, such as 2,4-D and 2,4,5-T.

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TABLE 1

AVERAGE ANNUAL TEMPERATURE AND PRECIPITATIONS OF THE SHINNERY OAK AREAS OF WESTERN OKLAHOMA*

Station	Month	Temperature	Precipitation
Woodward, Woodward County	Jan.	37.2	.87
	Feb.	41.2	1.16
	Mar.	48.7	1.35
	Apr.	59.6	2.63
	May	67.8	3.93
	June	78.2	3.42
	July	83.0	2.19
	Aug.	82.2	2.27
	Sept.	73.7	2.00
	Oct.	62.5	2.20
	Nov.	47.5	1.18
	Dec.	39.3	.91
	Annual	60.1	24.11
Arnett, Ellis County	Jan.	36.1	.67
	Feb.	40.2	.89
	Mar.	47.4	1.01
	Apr.	57.6	2.18
	May	65.9	3.63
	June	76.1	3.38
	July	81.0	2.11
	Aug.	80.2	2.41
	Sept.	72.3	1.62
	Oct.	61.5	2.04
	Nov.	46.8	.84
	Dec.	38.8	.65
	Annual	58.7	21.43

TABLE 1--Continued

Station	Month	Temperature	Precipitation
Cheyenne, Roger Mills County	Jan.	(Data not	.82
	Feb.		1.00
	Mar.	available)	1.24
	Apr.		3.11
	May		4.56
	June		3.47
	July		1.55
	Aug.		2.65
	Sept.		1.74
	Oct.		2.20
	Nov.		1.02
	Dec.		.79
	Annual		24.15
Elk City, Beckham County	Jan.	38.2	.86
	Feb.	42.1	.86
	Mar.	49.6	1.24
	Apr.	59.9	2.28
	May	68.0	4.70
	June	78.0	2.79
	July	82.1	1.67
	Aug.	81.6	1.86
	Sept.	73.3	1.82
	Oct.	62.6	2.05
	Nov.	48.5	.88
	Dec.	40.2	.94
	Annual	60.3	21.95

TABLE I--Concluded

Station	Month	Temperature	Precipitation
Mangum, Greer County**	Jan.	39.1	.96
	Feb.	44.0	.96
	Mar.	51.3	1.37
	Apr.	61.8	2.46
	May	69.7	4.90
	June	79.5	2.68
	July	84.1	1.86
	Aug.	83.6	1.97
	Sept.	75.3	2.09
	Oct.	64.5	2.22
	Nov.	49.8	.93
	Dec.	42.4	.93
	Annual	62.1	23.33
Hollis, Harmon County	Jan.	40.4	.83
	Feb.	44.7	.90
	Mar.	52.2	.96
	Apr.	62.5	2.53
	May	71.1	4.96
	June	81.3	2.90
	July	85.5	1.88
	Aug.	85.0	1.84
	Sept.	76.4	2.28
	Oct.	65.1	1.91
	Nov.	50.5	.76
	Dec.	42.2	.94
	Annual	63.1	22.69

*Source: Based on data furnished by the U. S. Department of Commerce, Weather Bureau. Mean Temperature and Precipitation, Oklahoma, 1957.

**U. S. Department of Commerce, Weather Bureau, Climatological Summary, Mangum, Oklahoma, n.d.

TABLE 2

GROWTH OF SHINNERY OAK PER YEAR
IN EACH COUNTY

County	Age	Diameter In mm	Growth In Diameter Per Year	
Harmon	10	45	4.5 mm	
	15	70	4.7 mm	
	11	64	5.8 mm	
	7	45	6.4 mm	
	11	51	4.6 mm	
	20	102	5.1 mm	
	15	70	4.7 mm	
	12	64	5.3 mm	
	15	76	5.6 mm	
	13	64	5.4 mm	Average:
				5.2 mm/yr.
Beckham	24	108	4.5 mm	
	24	70	2.9 mm	
	15	30	2.0 mm	
	22	47	2.1 mm	
	19	44	2.5 mm	
	24	76	3.2 mm	
	14	24	1.7 mm	
	20	24	1.2 mm	
	18	51	3.1 mm	
	15	76	5.1 mm	
	18	70	3.9 mm	
	19	95	5.0 mm	
	10	38	3.8 mm	
	10	32	3.2 mm	
	3	13	4.3 mm	
	6	25	4.2 mm	
	4	13	3.2 mm	
	6	19	3.2 mm	
	6	19	3.2 mm	
	8	25	3.1 mm	
	5	19	3.8 mm	
	2	6	2.0 mm	
	8	38	4.8 mm	
	4	13	3.3 mm	
	3	13	4.3 mm	
	17	25	1.5 mm	
	15	25	1.7 mm	Average:
				3.1 mm/yr.

TABLE 2--Concluded

County	Age	Diameter In mm	Growth In Diameter Per Year	
Roger Mills	17	48	2.8 mm	
	11	16	1.5 mm	
	34	62	1.8 mm	
	7	12	1.7 mm	
	6	12	2.0 mm	
	11	16	1.5 mm	Average:
				1.9 mm/yr.
Ellis	5	5	1.0 mm	
	5	7	1.4 mm	
	4	4	1.0 mm	
	4	4	1.0 mm	
	4	4	1.0 mm	
	3	4	1.3 mm	
	8	8	1.0 mm	
	8	9	1.1 mm	
	5	10	2.0 mm	
	8	8	1.0 mm	
	5	6	1.2 mm	
	7	10	1.4 mm	
	7	7	1.0 mm	
	6	8	1.3 mm	
	6	6	1.0 mm	
	6	10	1.7 mm	Average:
				1.1 mm/yr.
Woodward	62	305	4.9 mm	
	40	266	6.7 mm	
	62	305	4.9 mm	
	52	216	4.1 mm	
	55	266	4.9 mm	
	50	203	4.1 mm	Average:
				4.8 mm/yr.

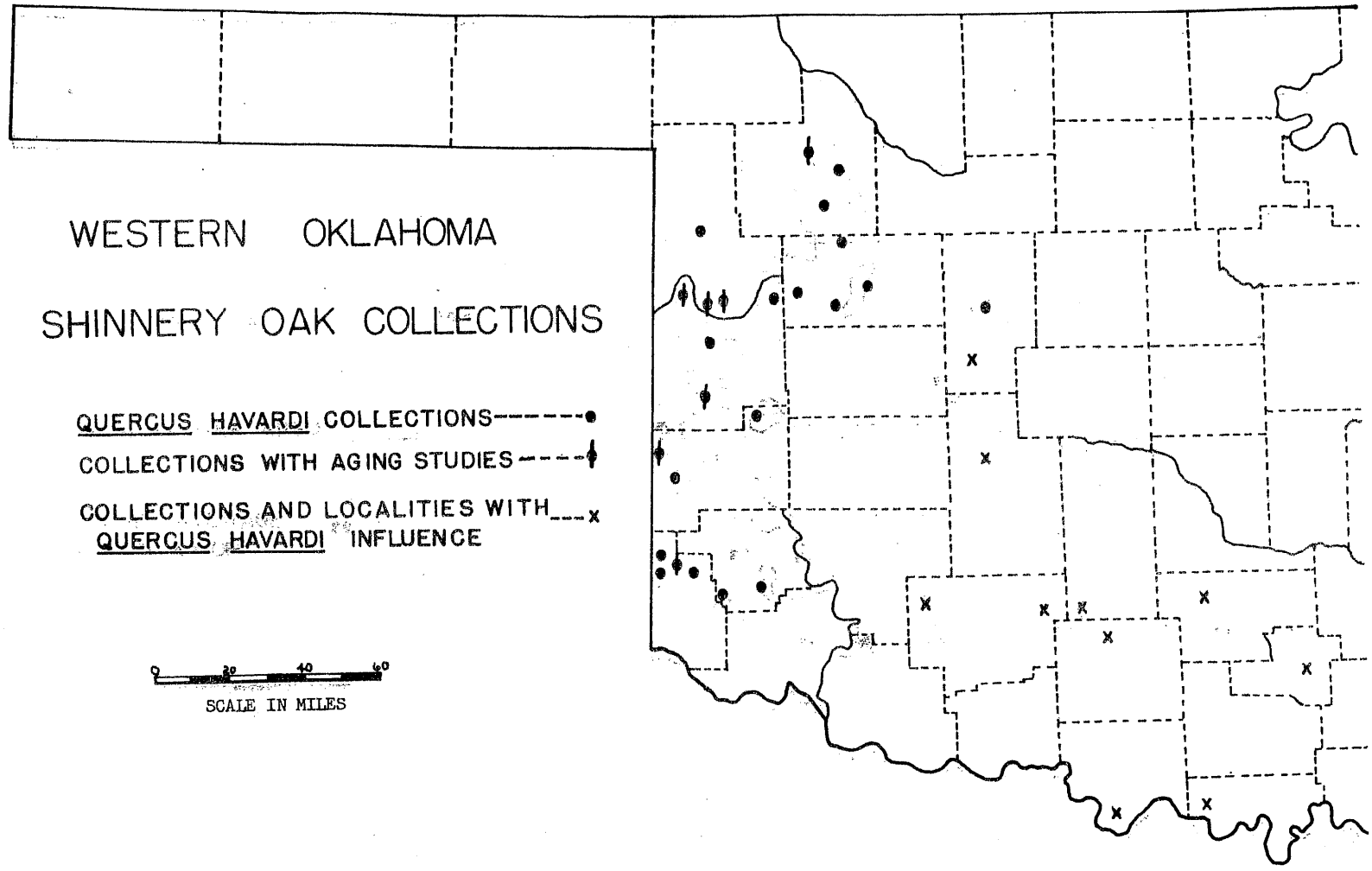
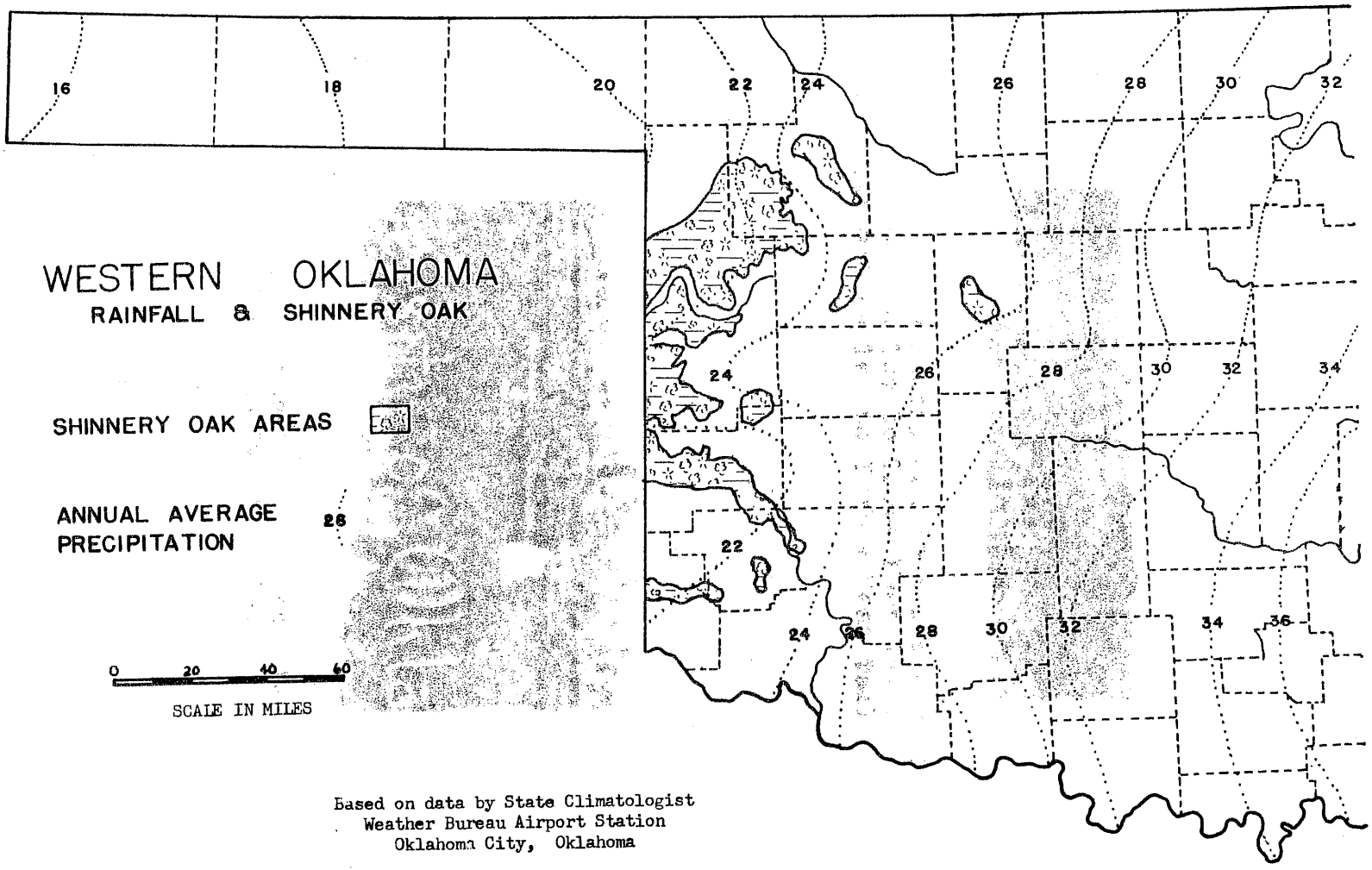

WESTERN OKLAHOMA
SHINNERY OAK COLLECTIONS
QUERCUS HAVARDI COLLECTIONS
COLLECTIONS WITH AGING STUDIES
COLLECTIONS AND LOCALITIES WITH QUERCUS HAVARDI INFLUENCE
0
20
40
60
SCALE IN MILES

Figure 1



Based on data by State Climatologist
Weather Bureau Airport Station
Oklahoma City, Oklahoma

Figure 2

Fig. 3. Shinnery Oak in Ellis County Low Growth Two to Three Feet Tall. The Mottes Ten to Twelve Feet Tall.

Fig. 4. Shinnery Oak in Beckham County Eight to Ten Feet Tall.

Fig. 5. Shinnery Oak in Harmon County Fifteen to Twenty Feet Tall.

Fig. 6. Shinnery Oak in Beckham County Thirty to Forty Feet Tall.

Fig. 7. Collections of Shinnery Oak from Harmon County Illustrating Variety of Forms.

Fig. 8. Collections of Shinnery Oak from Beckham County Illustrating Variety of Forms.

Fig. 9. Shinnery Oak in Roger Mills County Illustrating Motte Formation.

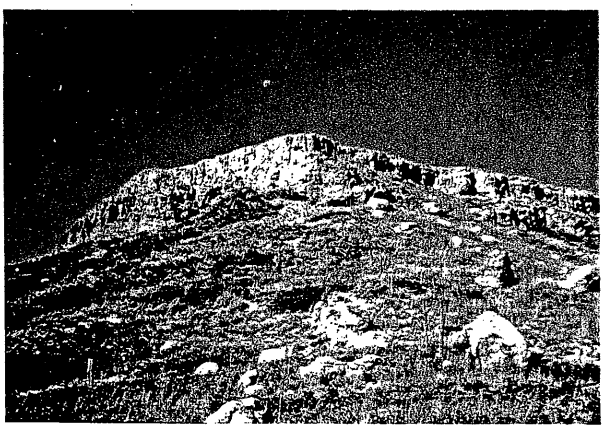


Fig. 10. Shinnery Oak in Antelope Hills Region of Roger Mills County Illustrating Motte Formation.