A TAXONOMIC AND ECOLOGICAL STUDY OF FAGACEAE OF THE NORTHWEST HIGHLAND RIM

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A TAXONOMIC AND ECOLOGICAL STUDY OF FAGACEAE OF THE NORTHWEST HIGHLAND RIM

An Abstract

Presented to

the Graduate Council of

Austin Peay State University

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

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by

Richard Jorg Jensen

August 1972

ABSTRACT

An investigation of Fagaceae was undertaken to determine the taxonomic and ecological status of the family in the forests of the Northwest Highland Rim. The study consisted of field observations, collections, and random pairs sampling in predetermined habitats. Seven habitats were delimited on the basis of subjectively evaluated moisture differences.

Sampling of these habitats revealed seven distinct forest communities, five of which included some Fagaceae as dominants. Taxonomic study indicated that Fagaceae was represented by three genera, nineteen species, two varities, and at least four hybrids. Three range extensions are noted and taxonomic status of one of the varieties is discussed. Ecological studies revealed the distribution of the species of Fagaceae across a moisture gradient and the apparent habitat preferenda of each species, variety, and hybrid. Chi-square and community coefficient analysis support the hypothesis that species distribution is correlated with soil moisture. Species associations were determined by incidental observations and frequency of joint occurrence on the sampling sites.

A TAXONOMIC AND ECOLOGICAL STUDY OF FAGACEAE OF THE NORTHWEST HIGHLAND RIM

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August 1972

To the Graduate Council:

I am submitting herewith a Thesis written by Richard Jorg Jensen entitled "A Taxonomic and Ecological Study of Fagaceae of the Northwest Highland Rim." I recommend that it be accepted in partial fulfillment of the requirements for the degree Master of Science, with a major in Biology.

Edward W. Chester
Major Professor

We have read this thesis and recommend its acceptance:

Floyd L. Brown
Second Committee Member

David H. Snyder
Third Committee Member

Accepted for the Council

Wayne C. Stamps
Dean of the Graduate School

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And to my wife, Faye, my gratefulness for her understanding patience and assistance in completing this work.

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ERRATA

Page 4 - Paragraph 2, line 11: six communities.

Page 10 - Paragraph 2, line 5: disappearance should read decimation.

Page 43 - Paragraph 2, lines 2 and 3: reverse abscissa and ordinate.

Page 52 - The following paragraph should precede the discussion of Quercus Michauxii:

> Quercus marilandica - Blackjack oak is found on the same type of habitat as Quercus coccinea. Not only are the habitat preferenda and common associates the same, but the chi-square level and the distribution graph (Fig. 2) are virtually identical.

Page 62 - Paragraph 2, line 10: insert a comma after Schneckii.

Page 63 - Paragraph 3, line 12: bur should read bud.

_____, line 14: occupy should read prefer.

Page 69 - Paragraph 1, line 3: Sone should read Some.

CHAPTER I

INTRODUCTION

Nature of the Problem

Fagaceae is a diverse and cosmopolitan family of trees and shrubs. The number of genera is variously given as five (Gleason, 1952; Rendle, 1959), six (Lawrence, 1951), seven (Hylander, 1956), or eight (Hutchinson, 1967) with the number of species given as 400 (Rendle, 1959), 500 (Gleason, 1952), or 600 (Lawrence, 1951). These discrepancies have little effect on this paper since only three of the genera (these three being recognized by all authors) occur within the study area. These genera are Castanea (American chestnut), Fagus (American beech), and Quercus (oaks). Only Quercus is represented by more than one species, but distinguishing these species is often difficult. One purpose of this study was to confirm the presence of those species of Fagaceae previously reported from the study area and to determine the presence of any unreported species, varieties, and hybrids. Those species encountered in the study area are herein discussed from an ecological viewpoint, with particular reference to their habitat preferenda and qualitative sociology.

Description of the Study Area

The study area has been termed the Northwest Highland Rim and as such has the following boundaries: to the north,

the Dripping Springs Escarpment; to the east, the eastern boundary of Montgomery County, Tennessee; to the south, the northern boundaries of Dickson and Houston Counties, Tennessee; and to the west, the Tennessee River. All sampling and collecting was confined to Stewart and Montgomery Counties, Tennessee, but the areas to the immediate northwest appear very similar to these political regions.

Braun (1950) placed the Highland Rim of Tennessee in the Western Mesophytic Forest Region of the Eastern Deciduous Forest Formation. This forest was considered an ecotone between the Mixed Mesophytic Forest Region to the east and the Oak-Hickory Forest Region to the west. More recently, Kuchler (1964) has described this area as consisting of a mosaic of Oak-Hickory Forest and Bluestem Prairie.

Physiographically, the Northwest Highland Rim is part of the Pennyroyal District and is underlain by middle Mississippian limestones (Fenneman, 1938). The soils of the area vary considerably depending on the topography and location. A general description of the soils may be found in the Five Rivers Resource Conservation and Development Project Plan (1972). This publication describes the soils as being developed from cherty-clay or cherty-loam material derived from cherty limestone bedrock. To the west, the soils are developed from Coastal Plain gravel and sand deposits with pockets of clay materials. Some loess is present on the gently rolling and nearly level upland areas.

The soils of Stewart County are discussed extensively by Marcher (1962), who depicts most of the county as lime-

stone soils with gravel and sand soils confined to ridges of the northern portions and alluvium occurring along the Cumberland and Tennessee Rivers. The soils of Montgomery County have been studied but these data have not been published. A general description by Killebrew (1874) describes these soils as being calcareous and siliceous and resting upon a bed of red clay with layers of interstratified chert.

Climatically, the Northwest Highland Rim is in a temperate region. Temperatures range from a maximum of 112°F to a minimum of -18°F. The mean January temperature is 39.3°F and the mean July temperature is 79.2°F. The growing season lasts approximately 206 days with the last killing frost in the spring occurring about April 3 and the first killing frost in the fall occurring about October 26. Rainfall is heaviest in December and January, lightest in September and October, and averages about 48.5 inches yearly (U. S. D. A., 1941).

Literature Review

Although there has been no treatment of Fagaceae of the Northwest Highland Rim as a group, there are numerous references concerning the forests of the Highland Rim of Tennessee. Many are of regional or national scope and give only morphological descriptions, ranges, and brief ecological statements of all species. Those used in this study include Sargent (1933), Rehder (1940), Braun (1950), Fernald (1950), Kuchler (1964), Fowells (1965), and Gleason (1952). Of a more local nature are the works of Killebrew (1874), Frick (1939), Svenson (1941), Shanks (1952, 1953, 1954),

Clebsch (1957), Yarbrough (1966), Scott (1967), Brock (1969), Duncan and Ellis (1969), and Ellis, Wofford, and Chester (1972).

Four of the above papers are concerned only with woody species. Shanks (1952, 1953, 1954) compiled a checklist of all woody species in Tennessee and indicated the distribution of each. Clebsch (1957) published a checklist of woody species of Stewart and Montgomery Counties, Tennessee and included ecological notes. In 1969, Brock presented a survey of the woody species of Stewart State Forest, Stewart County, Tennessee including a list of species and brief ecological notes on each species. Duncan and Ellis (1969) conducted a study of the forest communities of Montgomery County, Tennessee in which six community were defined with respect to location and species composition. Also, Duncan and Ellis presented a list of all tree species encountered in their study.

CHAPTER II

METHODS AND MATERIALS

The taxonomic and ecological studies were conducted simultaneously. Trees to be sampled were selected from throughout Montgomery and Stewart Counties, Tennessee. Although a strictly randomized sampling procedure was not used, an attempt was made to sample all areas equally. Specimens were collected and preserved according to standard procedure. Voucher specimens have been deposited in the Austin Peay State University Herbarium.

Seven forest habitats were delimited on the basis of subjectively determined moisture values. These were, from driest to wettest: limestone bluffs, xeric ridges, slopes of mostly southern exposure, slopes of mostly northern exposure, ravines, upland flatlands, and streambanks. Four sites for each habitat were selected in the study area. Sampling was then conducted according to the random pairs method described by Phillips (1959).

At each sampling site, 25 random pairs were recorded. Pairs were selected at eight-meter intervals along predetermined transect lines and the species and diameter breast height (dbh) were recorded for each tree. Only trees with a dbh of 10.1 cm or greater were sampled. The dbh was measured with a steel tape and recorded to the nearest one-tenth inch. This sampling procedure produced a sample of

200 trees from each habitat and a total of 1400 trees in the study area. Species area curves, as described by Oosting (1956), indicate that this sampling was adequate.

The procedure used for conducting the random pairs sampling varied with the habitat types. On the northerly facing and southerly facing slopes three transects were made. The first transect was along a line midway up the slope and parallel to the crest of the slope and consisted of nine pairs. The other two transects were made parallel to and approximately sixteen meters above and sixteen meters below the first. These transects consisted of eight pairs each. A similar method was used in sampling the upland flatlands. The first transect of nine pairs was run through the middle of the forest stand. Two parallel transects of eight pairs each were then run at a distance of sixteen meters to either side of the first transect.

Single line transects were used in sampling the ravines, limestone bluffs, and streambanks, with one exception (see streambank c, Appendix I). A single line was followed through the longitudinal center of the ravines. Along the limestone bluffs, a single line approximately ten meters from and parallel to the edge of the bluff was used. The streambanks were also sampled by single lines, these being parallel to and approximately ten meters from the stream itself.

Sampling of the xeric ridges was accomplished with two transects. One consisted of twelve pairs, the other of thirteen pairs; both were parallel to and approximately

ten meters from the crest.

The location of each of the 28 sampling sites is given in Appendix I.

CHAPTER III

RESULTS

Because of the twofold nature of this work, the results are presented in two parts. The first, dealing with the taxonomic results, includes keys for the identification of the species of Fagaceae, a brief statement of the status of each taxon, and an annotated list of Fagaceae encountered. The second part presents the ecological results in the form of a brief discussion of each species, accompanied by illustrating tables and graphs.

Taxonomic Results

The taxonomic portion of this study has resulted in the determination of 25 forms of Fagaceae on the Northwest Highland Rim. These represent nineteen species, two varieties, and four hybrids. An alphabetical list of these is presented in Table I. Nomenclature throughout this paper follows that of Fernald (1950).

The following keys have been constructed by using observed characters and by comparison with other keys including those of Sargent (1933), Dyal (1936), Rehder (1940), Palmer (1942), Fernald (1950), and Gleason (1952). Suffixing the keys are discussions of each taxon. In these discussions, the works of Trelease (1924), Sargent (1933), Small (1933), Rehder (1940), Fernald (1950), Gleason (1952),

TABLE I : Fagaceae of the Northwest Highland Rim

Castanea dentata (Marsh.) Borkh.
Fagus grandifolia Ehrh.
Quercus alba L.
Q. coccinea Muenchh.
Q. falcata var. falcata Michx.
Q. falcata var. pagodaefolia Ell.
X Q. Fernowii Trel.
X Q. fontana Laughlin
Q. imbricaria Michx.
X Q. leana Nutt.
Q. lyrata Walt.
Q. macrocarpa Michx.
Q. marilandica Muenchh.
Q. Michauxii Nutt.
Q. Muehlenbergii Engelm.
X Q. mutabilis Palmer & Steyerm.
Q. nigra L.
Q. palustris Muenchh.
Q. Phellos L.
Q. Prinus L.
Q. rubra L.
Q. Shumardii var. Shumardii Buckl.
Q. Shumardii var. Schneckii (Britt.) Sarg.
Q. stellata Wang.
Q. velutina Lam.

Little (1953), Harlow and Harrar (1958), and Gleason and Cronquist (1963) will be frequently referred to.

Key to Genera

1. Fruits covered with a spiny husk; nuts 2-4 per fruit..... 2
   2. Leaves 15-20 cm long, 5 cm wide, dark yellow-green above, pale yellow-green below, with ascending, inwardly curved teeth; mature buds ovoid-acute, dark chestnut brown, about 6 mm long..... Castanea
   2. Leaves 6-12 cm long, 2.5-8 cm wide, dark bluish-green above, light green and glabrous or pilose below, coarsely serrate; mature buds 15-25 mm long, 3 mm wide, lustrous brown above the middle, reddish brown below the middle..... Fagus
1. Fruits not covered with a spiny husk; nuts one per fruit ..... Quercus

Castanea

The American chestnut, Castanea dentata, once one of the dominant trees in the Eastern United States, is now found only as isolated populations and occasional stump sprouts. A blight introduced into the United States about 1900 (Harlow and Harrar) has caused the disappearance of this species. The large, spiny fruits were once an important food source for wild animals and were of economic importance in the eastern states.

Fagus

Fagus grandifolia, American beech, ranges from Cape Breton Island in Canada to northwest Florida and west to eastern Wisconsin, eastern Illinois, southeastern Missouri, western Arkansas, eastern Oklahoma, and eastern Texas. The smooth, gray bark and long, narrow buds are characters useful in field identification.

Two varieties of American beech, var. grandifolia and var. caroliniana (Loud.) Fern. & Rehd., are recognized by all authors except Harlow and Harrar, who describe three races as white beech, red beech, and gray beech. Sargent, Rehder, and Fernald recognize Fagus grandifolia var. grandifolia f. pubescens Fern. & Rehd. and Sargent and Fernald recognize Fagus grandifolia var. caroliniana f. mollis Fern. & Rehd. Gleason and Gleason and Cronquist do not recognize any formae. I have not observed the var. caroliniana or either of the formae in the specimens I have collected or studied.

Quercus

Quercus, the genus of the oaks, has three subgenera (Rehder [1947] cited in Irgens-Moller [1955]), two of which, Lepidobalanus and Erythrobalanus, occur in the study area. These two subgenera are commonly called the white oaks and black oaks, respectively. Species within a subgenus may hybridize but hybridization between species of different subgenera is unknown (Irgens-Moller, 1955). I have chosen to treat the subgenera separately. Therefore the following keys take a specimen first to subgenus, then to species.

Key to Subgenera of Quercus

1. Leaves without bristletips; non-glandular hairs spreading from one level..... Lepidobalanus
1. Leaves with bristletips; non-glandular hairs spreading from more than one level..... Erythrobalanus

Key to Lepidobalanus

1. Leaves distinctly lobed..... 2
1. Leaves not distinctly lobed; dentate or serrate..... 5
   2. Lower leaf surface completely glabrous or, rarely, sparsely pubescent, leaves 12-22 cm long, 5-10 cm wide; acorns 1.5-3.5 cm long, sessile or peduncled, cup with warty or corky scales; twigs glabrous; mature buds dark red-brown, ellipsoid, glabrous, 3-5 mm long..... Q. alba
   2. Lower leaf surface finely pubescent to densely tomentose..... 3
3. Twigs and branchlets pubescent; squarish middle lobes giving leaves a cruciform appearance; leaves 9-13 cm long, 8-12 cm wide; acorns 1-1.5 cm long, sessile or nearly so, cup hemispheric or pyriform; mature buds about 3 mm long, ovoid or conical-ovoid, bright chestnut brown ..... Q. stellata
3. Twigs and branchlets glabrous; leaves not cruciform.... 4
   4. Leaves to 30 cm long, 15 cm wide with the two center sinuses extending almost to the midrib, upper half of blade shallowly lobed, apex rounded; mature buds conical-ovoid, 3-6 mm long with light red-brown scales; acorn cups deeply saucer-shaped, the marginal scales producing a fringe..... Q. macrocarpa
   4. Leaves to 25 cm long, 10 cm wide with 5-9 lobes divided by broad, irregular sinuses, apex acute; mature buds ovoid-globose, about 3 mm long with light chestnut-brown scales; acorn 1.5-2.5 cm long, cup covering half to all of nut..... Q. lyrata
5. Leaves obovate, 13-20 cm long, 7-13 cm wide, dark green above, pale green to silvery white and pubescent below; mature buds about 6 mm long, red, puberlous; acorns 2.5-3.5 cm long, cup with large, free scales covering up to half the nut; trees of moist habitats..... Q. Michauxii
5. Leaves elliptic to oblong-lanceolate, 10-20 cm long, 3.5-10 cm wide, yellow-green above, pale and finely pubescent below; trees of dry habitats..... 6
   6. Leaves nearly elliptical, crenate; bark deeply and broadly fissured; mature buds 5-8 mm long, conical with bright chestnut-brown scales; acorns 2.5-3.5 cm long, cup about 2 cm wide with concrescent scales.... ..... Q. Prinus
   6. Leaves oblong-lanceolate, serrate; bark ashy gray, rough and flaky; mature buds about 3 mm long, ovoid-conical, chestnut-brown scales white and scarious at the margins; acorns 1-1.5 cm long, cup with numerous small scales covering up to half the nut..... ..... Q. Muehlenbergii

Key to Erythrobalanus

1. Leaves uniformly pubescent or tomentose on the lower surface..... 2
1. Leaves glabrous on the lower surface except for axillary tufts..... 7
   2. Leaves entire, irregularly lobed, or shallowly three lobed..... 3
   2. Leaves conspicuously three lobed..... 5
3. Leaves shallowly three lobed, broadest near the apex, 14-18 cm long and wide; mature buds about 6 mm long, light red-brown with rusty hairs, prominently angled; acorns 15-20 mm long, the turbinate, large scaled cup covering about half the nut..... Q. marilandica
3. Leaves not three lobed, broadest near the middle..... 4
   4. Leaves 10-15 cm long, 2.5-5 cm wide, entire, lustrous and glabrous above, paler or brownish and pubescent below; mature buds about 3 mm long with ciliate, light brown scales; acorns 12-16 mm long on peduncles up to 12 mm long, the turbinate cup covering up to half the nut..... Q. imbricaria
   4. Leaves 8-20 cm long, 3.5-10 cm wide, often irregularly lobed, dark green and glabrous above except for occasional pubescence on the midrib, pubescent and paler below; mature buds 3-6 mm long, light brown..... X Q. leana
5. Lower surface of leaves green and lightly pubescent; mature buds 7-10 mm long, tomentose and strongly angled; acorns 15-20 mm long, ovate with deep, fringed cups..... Q. velutina
5. Lower surface of leaves grayish or whitish tomentose; mature buds 3-7 mm long; acorns 10-15 mm long, globose with shallow cups..... 6
   6. Leaves 3-5 lobed, lobes falcate, the terminal lobe often long acuminate, the base of the leaves rounded, sometimes cuneate; mature buds 3-6 mm long with chestnut-brown puberlent scales with short, pale hairs; trees of dry habitats..... Q. falcata var. falcata
   6. Leaves 5-7 lobed, the terminal lobe rarely exceeding the lateral lobes in length, leaf bases cuneate to truncate; mature buds 5-7 mm long with red-brown puberlous, sometimes ciliate scales; trees of moist habitats..... Q. falcata var. pagodaefolia
7. Leaves to three lobed..... 8
7. Leaves 5-11 lobed..... 9
   8. Leaves entire, 5-12 cm long, 1-2.5 cm wide, glabrous above and below except for tufts in the vein axils; mature buds about 3 mm long, covered by chestnut-brown scales with pale margins; acorns 10-15 mm long with shallow, saucer-shaped cups..... Q. Phellos
   8. Leaves entire to three lobed, 5-10 cm long, 2.5-5 cm wide, often broadest near the apex, glabrous above and below except for occasional tufts in the vein

axils; mature buds 3-6 mm long with reddish-brown scales; acorns 10-15 mm long, the saucer-shaped cup covering about a third of the nut..... Q. nigra

9. Leaves 7-11 lobed, the lobes tapering distally and not noticeably longer than the undivided portion of the blade, leaves 12-20 cm long, 10-12 cm wide, upper surface dull and glabrous, lower surface glabrous except for inconspicuous axillary tufts; mature buds about 6 mm long, reddish-brown; acorns 1.5-3.5 cm long, the cup shallowly saucer-shaped, 2-3 cm wide and covering about a fourth of the nut..... Q. rubra

9. Leaves 5-9 lobed, the lobes often expanded distally and longer than the undivided portion of the blade, the upper surface lustrous..... 10

10. Leaves generally 7 lobed, the upper surface pubescent along the midrib, the lower surface and petioles lightly pubescent..... Q. velutina

10. Leaves 5-7 (sometimes 9) lobed, the upper surface glabrous, the lower surface glabrous except for axillary tufts, petioles glabrous..... 11

11. Mature buds 7-10 mm long, tomentose and strongly angled; acorns 15-20 mm long, the turbinate cups with large, pubescent scales, the uppermost loose, forming a fringe.... ..... Q. velutina

11. Mature buds 3-6 mm long, glabrous or lightly pubescent, not angled; acorns not as above..... 12

12. Acorn nuts 10-13 mm long, hemispheric, cups 1-1,5 cm wide, shallowly saucer-shaped; mature buds about 3 mm long with reddish-brown scales; leaves 7.5-12 cm long, 5-10 cm wide with conspicuous axillary tufts below, the base cuneate, sometimes truncate..... ..... Q. palustris

12. Acorn nuts 12-30 mm long, oblong to ellipsoid; mature buds 3-6 mm long..... 13

13. Acorn nuts 12-20 mm long, ovoid-ellipsoid; mature buds 3-6 mm long with dark reddish-brown scales, often pubescent above the middle; leaves with inconspicuous axillary tufts on the lower surface..... 14

13. Acorn nuts 19-30 mm long, oblong-ovoid; mature buds 5-7 mm long with gray to gray-brown glabrous or downy scales; leaves with conspicuous axillary tufts on the lower surface..... 15

14. Acorn cups turbinate to hemispheric, nut ovoid with concentric rings at the base..... Q. coccinea

14. Acorn cups deeply cup-shaped with the marginal scales often forming a fringe, nut ellipsoid, often striate, with or without irregular concentric rings at the base..... X Q. fontana

15. Acorns with flatly saucer-shaped cups covering only a fourth of the nut, scales often tuberculate..... ..... Q. Shumardii var. Shumardii

15. Acorns with deeply saucer-shaped or sub-turbinate cups covering a third of the nut, scales thin, rarely tuberculate..... Q. Shumardii var. Schneckii

Quercus alba, white oak, is a very common tree in this area and throughout the Eastern United States. It is found in all states east of the Mississippi River and extends into southeastern Canada. West of the Mississippi River, it is found in southeastern Minnesota, Iowa, Missouri, eastern Oklahoma, and eastern Texas.

White oak is easily identified in the field by the combination of leaf characters and the flaky, grayish-white bark. Sargent and Rehder describe one variety, Q. alba var. latiloba (Sarg.) Palmer & Steyerm. which is treated as a forma by Gleason and Fernald. Trelease describes nine formae while Fernald presents only three.

X Quercus Fernowii (Q. alba X Q. stellata) was first described by Vasey and confirmed by Trelease in 1917 (Trelease, 1924). The leaf shape and fruits of the specimen collected are similar to those of Q. alba while the pubescent lower leaf surface, and pubescent twigs are characteristic of Q. stellata.

Quercus coccinea, commonly called scarlet oak, is found in all states east of the Mississippi River except Wisconsin and Florida. West of the Mississippi River it is found only in southeastern Missouri. This species is very difficult to distinguish from several others unless mature fruits and buds are available. Sargent recognizes a variety, Q. coccinea var. tuberculata Sarg., which differs in having tuberculate scales on the acorn cup. Other authors do not recognize this variety.

Quercus falcata var. falcata, southern red oak, is found from eastern Texas along the Coastal Plain to southern New Jersey. Northward, it extends into eastern Oklahoma, southeastern Missouri, southern Illinois, and along the Ohio River Valley to West Virginia. It is absent in the Appalachian Mountains. This species may be distinguished in the field by its tomentose, three to five lobed leaves, the lobes of which are often falcate.

Two other varieties of southern red oak have been described although one of these is apparently only a forma. Q. falcata var. pagodaefolia, cherrybark oak, is recognized by most authors and is easily distinguishable from the typical variety by leaf and bark characters. The range of cherrybark oak also differs from that of the typical variety, cherrybark being restricted to the Coastal Plain north of central Florida and with outliers in middle Tennessee and south-central Missouri. The variety Q. falcata var. triloba (Michx.) Nutt. of Sargent and Fernald is not described by Rehder, Gleason, or Harlow and Harrar and is treated as a forma by Trelease. This variety is described as having leaves broadened toward the apex with three shallow, subapical, rounded lobes.

X Quercus fontana (Q. coccinea X Q. velutina), coclut oak, was first described by Laughlin (1967). The leaves of this hybrid are virtually identical to those of Q. coccinea. The fruits and buds, however, have characters of both parents. The buds are larger and more angled than those of Q. coccinea and the acorns, while often having concentric

rings at the base as do those of Q. coccinea, have cups similar to those of Q. velutina and are more similar to Q. velutina in size and shape.

Quercus imbricaria, shingle oak, ranges from southern Michigan south to northern Arkansas, northern Mississippi, northern Alabama, and northern Georgia and from the Piedmont of New Jersey, Virginia, North Carolina, and South Carolina west to eastern Nebraska, eastern Kansas, and eastern Iowa. Shingle oak may be confused with willow oak, Q. Phellos, but the leaves of shingle oak are much larger. No varieties of shingle oak have been reported but Trelease describes leaves with a few teeth as f. spinulosa Trel.

X Q. leana (Q. imbricaria X Q. velutina), Lea's oak, was first described by Nuttall in 1835 (Trelease, 1924). The leaves tend to resemble Q. imbricaria in shape and size, though often they are irregularly lobed. The undersurface of the leaves is pubescent with hairs of the Q. imbricaria type. I have compared my specimens with those of several herbaria and found them to be identical.

Quercus lyrata, overcup oak, is another species found mostly on the Coastal Plain. Its range extends from New Jersey south to northwest Florida and west to eastern Texas. It is found in the Mississippi River Valley north to southern Illinois. Outliers have been reported from middle Tennessee and northern Georgia. The fruits of overcup oak, from which the common name derives, are easily recognized. The leaves may be confused with those of Q. macrocarpa, but they are generally smaller and more acute at the apex.

No varieties of overcup oak have been reported but Fernald and Trelease describe f. viridis Trel. as having leaves with green lower surfaces.

Quercus macrocarpa, bur oak or mossycup oak, derives its name from its large fruit and fringed cup. Bur oak ranges from south-central Texas north to the Dakotas and Canada, then east to Maine and southwest to middle Tennessee and northern Arkansas. It is absent in the Appalachian Mountains, the Piedmont, and the Coastal Plain except for occasional outliers. Bur oak has large leaves with rounded apices and, usually, two deep, narrow sinuses near the middle. If leaf characters fail, it may be distinguished from Q. lyrata by the fluted twigs and larger, conspicuously conical buds.

One variety has been described by Rehder and Gleason, Q. macrocarpa var. olivaeformis (Michx. f.) Trel. This variety has smaller, more deeply divided leaves and smaller acorns covered over one-half by the cup. Fernald treats this as f. olivaeformis while Sargent and Harlow and Harrar do not recognize it. Trelease describes ten formae including olivaeformis.

Quercus marilandica, blackjack oak, ranges from southeastern New York south to central Florida, west across Pennsylvania to southern Michigan, southern Iowa, and southeastern Nebraska to west-central Oklahoma and eastern Texas. Generally easily recognized in the field, blackjack oak may be confused with the forma triloba of Q. falcata. Examination of buds, fruits, and bark will determine the species.

No varieties of blackjack oak have been described though Trelease gives eleven formae. One of these, f. quinqueloba Trel., resembles Q. velutina. Again, examination of fruits, buds, and bark is sufficient to determine the species.

Quercus Michauxii, swamp chestnut oak, is primarily a Coastal Plains species, ranging from New Jersey south to Florida, west to eastern-most Texas, and north in the Mississippi River Valley to southern Illinois and southern Indiana. Outliers are found in southern Kentucky and northern Tennessee. This tree is often confused with Q. Muehlenbergii and Q. Prinus because of the variation of the leaves. Examination of the bark, fruits, terminal buds, and noting the habitat allows ready determination of the species.

No varieties of swamp chestnut oak have been described but Trelease presents f. viridis Trel. as having green lower leaf surfaces. The specific epithet of this oak has been debated over the years. Fernald, Gleason, Harlow and Harrar, and Gleason and Cronquist use Michauxii while Sargent and Rehder prefer Prinus L. Bernard and Fairbrothers (1967) report that C. H. Muller, having examined the Linnean type specimen of Q. Prinus, has concluded that this specimen is identical to what is presently called Q. Michauxii. Thus, the swamp chestnut oak should be Q. Prinus L. (1753) and not Q. Michauxii Nutt. (1818).

Quercus Muehlenbergii, chinkapin oak, ranges from northwest Florida north on the Piedmont to New Jersey and eastern New York, west through southern Michigan, southern Wisconsin, Iowa, and eastern Nebraska, south to central Texas. As men-

tioned above, chinkapin oak may be mistaken for Q. Michauxii or Q. Prinus if only leaf characters are used for identification.

There have been no varieties of chinkapin oak described but Fernald recognizes f. alexanderi (Britt.) Trel. as having obovate to obovate-oblong leaves. Trelease describes f. alexanderi as having smaller acorn cups with finer scales and f. stellulata Trel. as having yellow, scurfy twigs.

Quercus nigra, water oak, is found along the Coastal Plain from Virginia south to central Florida and west to eastern Texas and southeastern Oklahoma. It ranges north in the Mississippi River Valley to southern Illinois and extends into southwestern Kentucky and south-central Tennessee. The leaves of Q. nigra are highly variable and some forms may be mistaken for Q. Phellos and Q. lyrata though examination of fruits and terminal buds allows determination.

Sargent recognizes one variety of water oak, var. tridentifera (Sarg.) Trel., but Fernald and Trelease regard this as a forma. Gleason, Rehder, and Harlow and Harrar do not recognize any varieties or formae of Q. nigra. The specimen I collected is apparently of the f. tridentifera of Fernald and Trelease and represents a range extension for Q. nigra.

Quercus palustris, pin oak, has a range extending from eastern New York west Ohio, southern Michigan, Illinois, and southeastern Iowa and south to North Carolina, south-central Tennessee, and northern Arkansas. The leaves of pin oak are often confused with those of Q. coccinea and Q. Shumardii.

Discrimination of these species often requires mature fruits and mature terminal buds.

Pin oak illustrates slight variation in most morphological characters. No varieties or formae have been described. It has been my observation that the leaves show some significant variation. Usually the leaves have cuneate bases but often the bases are truncate. These leaf types may occur on separate trees or on the same individual.

What appears to be a hybrid of Q. palustris and Q. Shumardii has been found in the study area. This tree exhibits the following characters: Leaves 3-5 (rarely 7) lobed, 10-15 cm long, 7-12 cm wide, glabrous on both sides except for conspicuous axillary tufts below; terminal buds 3-6 mm long, grayish-brown and glabrous; acorns 10-15 mm long, nut globose, cup with numerous imbricate scales covering about a third of the nut. If this specimen is the hybrid suggested above, then the proper name for it is X Quercus mutabilis Palmer & Steyerm.

Quercus Phellos, willow oak, is another species found principally on the Coastal Plain. Its range extends from Long Island south to northwest Florida and west to eastern Texas and southeastern Oklahoma. In the Mississippi River Valley it is found north to southeastern Missouri, southern Illinois, and southern Kentucky. Willow oak is absent, except for occasional outliers, in the Appalachian Mountains and southern Florida.

Three formae of Q. Phellos have been described. Trelease includes f. microcarpa Trel., having lanceolate-toothed

leaves, and f. latifolia Trel., having elliptical, somewhat toothed leaves. Fernald describes f. intonsa Fern. as being silky-tomentose on the lower surface. I have encountered none of these formae in the study area.

Quercus Prinus, chestnut oak, is found from southwestern Maine south to the Piedmont of Georgia and northern Alabama, and west to southeastern Michigan, central Ohio, southern Indiana, southeastern Illinois, and the Tennessee River. Outliers are found on the Coastal Plain of Georgia, west Tennessee, and northern Mississippi. As previously stated, the leaves may be mistaken for Q. Michauxii or Q. Muehlenbergii but the deeply furrowed bark is a distinctive feature.

Chestnut oak has no varieties or formae and the correct form of its specific epithet is uncertain. Sargent and Rehder treat Q. Prinus as Q. montana Willd. If Bernard and Fairbrothers (1967) are correct (see above in discussion of Q. Michauxii) then this nomenclature may have to be reinstated.

Quercus rubra, northern red oak, ranks second to Q. alba in the extent of its range. It is found everywhere east of the Mississippi River except in Florida and the Coastal Plain from North Carolina to Texas. West of the Mississippi River it extends from northern Minnesota south to northern Arkansas and eastern Oklahoma. Often mistaken for Q. velutina or Q. Shumardii, northern red oak may be distinguished by its tapering leaf lobes, lack of conspicuous axillary tufts on the lower surface of the leaves, and the fruits and buds.

As with Q. Michauxii, Q. Prinus, and Q. montana, Q. rubra has caused much confusion in the botanical world. Linnaeus originally applied Q. rubra to several oaks including northern red oak and southern red oak. In 1771, du Roi (in Lawrence, 1951) treated northern red oak as Q. rubra and southern red oak as Q. falcata. However, in 1915, Sargent (in Lawrence, 1951) applied Q. rubra to southern red oak and Q. borealis Michx. f. to northern red oak. Rehder finally proposed thet Q. rubra be declared nomen ambiguum and today many taxonomists prefer Sargent's classification (Lawrence, 1951).

Fernald describes one variety of northern red oak, Q. rubra var. borealis (Michx. f.) Farw., which differs in having a deeper, turbinate cup and a smaller nut. This variety corresponds to Q. borealis var. borealis of Sargent while Sargent's Q. borealis var. maxima (Marsh.) Ashe corresponds to Fernald's Q. rubra var. rubra. Little, and Harlow and Harrar treat northern red oak as Q. rubra with no varieties described. Trelease assigned species status to both varieties, Q. borealis Michx. f. having the deep, turbinate cups and Q. maxima Ashe having the shallow, saucer-shaped cups. Palmer (1942) retained Sargent's classification in dealing with the red oak complex.

Quercus Shumardii var. Shumardii, Shumard oak, is found from the Coastal Plain of North Carolina south to northern Florida, west to central Texas, eastern Oklahoma, and southeastern Kansas, and north to southern Illinois, central Indiana, and southwestern Ohio. Outliers are found in Michigan,

Pennsylvania, and Virginia and it is absent in the Appalachian Mountains. This species may be confused with Q. rubra and Q. coccinea if only leaf characters are considered in attempting to distinguish between them.

A variety of Q. Shumardii, var. Schneckii, Schneck's red oak, is distinguished by the acorn cup being deeper and rarely with tuberculate scales. The status of this variety is another point of disagreement among taxonomists. Trelease, Little, Gleason and Cronquist, and Harlow and Harrar do not recognize Schneck's oak as a varietal form while Sargent, Rehder, Fernald, and Gleason do. Small gives Schneck's oak species status.

Not only are the fruits of these two varieties different, but Palmer (1942) cites differences in their ranges, Schneck's oak extending further west in Oklahoma and Kansas and further north in Missouri, Illinois, and Indiana. I have also noticed that the leaves of Q. Shumardii var. Shumardii often have broader lobes and shallower sinuses than do the leaves of Q. Shumardii var. Schneckii.

Quercus stellata, post oak, ranges from southeastern New England south to central Florida and west to southern Ohio, southern Indiana, southeastern Iowa, eastern Kansas, Oklahoma (except the Panhandle), and eastern Texas. Post oak is easily identified by its cruciform leaves.

One variety of post oak has been described, Q. stellata var. Margaretta (Ashe) Sarg., confined to the Coastal Plain. Trelease described eighteen formae of Q. stellata, but I have found none of these in the study area.

Quercus velutina, black oak, rivals Q. alba and Q. rubra in the extent of its range. It is found in all states east of the Mississippi River although in Florida, Wisconsin, Michigan, and New England it is only local. West of the Mississippi River it is found from southeastern Minnesota south to Iowa, southeastern Nebraska, eastern Kansas, eastern Oklahoma, and eastern Texas. Most often mistaken for Q. rubra, black oak may be distinguished by the more pubescent undersurface of the leaves, larger, angled buds, and smaller acorns.

Trelease describes one variety of black oak, Q. velutina var. acuta Trel., which has shallow sinuses and triangular lobes. He also lists nine formae. Fernald lists four formae of which I have observed the following; f. macrophylla (Dippel) Trel., with shallow sinuses and very broad lobes; f. dilaniata Trel., with deep sinuses and very narrow, many-toothed lobes; and f. typica, with medium sinuses and lobes as wide as the sinuses.

Annotated Check List of Fagaceae

The following annotated list is arranged in alphebetical order of genera and species. It was compiled by inspecting specimens in the herbaria of the following universities: Austin Peay State University (APSU); Miami University (MU); University of Tennessee (TENN); Vanderbilt University (VDB); and Western Kentucky University (WKU). Not all specimens which were studied are cited. Specimens cited are those exhibiting the greatest similarity with specimens collected in

the study area and exhibiting most clearly the characters necessary for identification. The information for each specimen is presented thusly: scientific name and author; common name; county and state; location and date of collection; collector and collector's number; herbarium abbreviation; and inscription number (if collector's number not available).

Herbarium abbreviations for the University of Tennessee, Vanderbilt University, and Miami University are those specified by Lanjouw and Stafleu (1964). Since the herbaria of Austin Peay State University and Western Kentucky University are not included in Lanjouw and Stafleu (1964), the abbreviations used are mine.

Castanea dentata (Marsh.) Borkh. American chestnut. Tazewell Co., Va.: Rt. 263 near "Burkes Garden," 12 July, 1966, K. A. Nicely 1252 (WKU); Blount Co., Tn.: near Balsum Point on Mt. LeConte, 20 July, 1970, J. Lund s. n. (TENN); Lewis Co., Tn.: Hwy. 99, just over Maury Co. line, 26 Aug., 1969, R. Kral 36355 (VDB); Huron Co., Ohio: 9 June, 1967, G. T. Jones s. n. (MU) 32056; Stewart Co., Tn.: LBL, half mile south of marker 10L3, 18 July, 1966, B. Evans 01959 (APSU); Montgomery Co., Tn.: corner of Dotsonville Rd. and Hwy. 79, 23 July, 1970, E. W. Chester 2365 (APSU).

Fagus grandifolia Ehrh. American beech. Preble Co., Ohio: 12 Aug., 1963, H. Ball s. n. (MU) 17701; Sevier Co., Tn.: along Greenbrier Prong of Little Pigeon River, 12 May, 1963, A. J. Sharp & E. Clebsch 31268 (TENN); Tazewell Co., Va.: streambank in "Burkes Garden," 27 June, 1965, K. A. Nicely & G. B. Straley 986 (WKU); Cheatham Co., Tn.: at the Narrows, 24 July, 1970, G. J. Gonsoulin 1396 (VDB); Stewart Co., Tn.: LBL, half mile south of marker 9P1, 28 June, 1966, E. Wofford 01660 (APSU); Montgomery Co., Tn.: Glenwood, 19 Sept., 1942, R. E. Shanks 2195 (APSU).

Quercus alba L. White oak. Stewart Co., Tn.: LBL, one-fourth mile east of marker 8N3, 5 July, 1966, E. Wofford 01834 (TENN); Edmonson Co., Ky.: Reservoir Hill, 22 Aug., 1968, H. W. Elmore 685 (WKU); Preble Co., Ohio: 12 Aug., 1963, H. Ball s. n. (MU) 17736; Cheatham Co., Tn.: Harpeth River, 24 June, 1970, G. J. Gonsoulin 1407 (VDB); Montgomery Co., Tn.: in ravine northeast of Greenwood Cemetery, 5 Sept.,

1948, A. Clebsch 187 (APSU).

Quercus coccinea Muenchh. Scarlet oak. Benton Co., Tn.: dry ridge, 11 July, 1952, T. J. Walker 16634 (TENN); Henderson Co., N. C.: Aug., 1933, F. O. Grover s. n. (MU) 29318; Coffee Co., Tn.: south of Manchester, 8 June, 1966, R. Kral 26818 (VDB); Stewart Co., Tn.: LBL, Blue Springs Rd., 2.9 miles north of jct. with Ft. Henry Rd., 20 Sept., 1971, L. J. Schibig 6 (APSU); Montgomery Co., Tn.: northeast of Clarksville near Red River, 2 Nov., 1941, R. E. Shanks 1162 (APSU).

Quercus falcata var. falcata Michx. Southern red oak. Warren Co., Ky.: 12 miles south of Bowling Green, 24 June, 1970, K. A. Nicely 2845 (WKU); Coffee Co., Tn.: near Manchester, 4 July, 1947, E. Clebsch & A. Clebsch 4753 (TENN); Hardeman Co., Tn.: 29 Aug., 1930, H. K. Svenson s. n. (MU) 19972; Coffee Co., Tn.: south of Manchester, 8 June, 1966, R. Kral 26819 (VDB); Stewart Co., Tn.: LBL, marker 9M4, 7 July, 1966, W. H. Ellis 01787 (APSU); Montgomery Co., Tn.: north of Hwy. 41, one mile east on Sango Rd., 24 Aug., 1968, E. W. Chester 2138 (APSU).

Quercus falcata var. pagodaefolia Ell. Cherrybark oak. Obion Co., Tn.: Walnut Log, 2 Oct., 1938, J. M. Shaver 5741 (VDB); Fayette Co., Tn.: half mile southeast of Jones Chapel, 2 Nov., 1957, E. A. Hebb H-447 (TENN); Stewart Co., Tn.: LBL, Neville Bay camping area, 14 Nov., 1970, L. J. Schibig 25 (APSU); Montgomery Co., Tn.: north of Hwy. 41, one mile east on Sango Rd., 24 Aug., 1968, E. W. Chester 2138 (APSU).

X Quercus Fernowii Trel. Montgomery Co., Tn.: K. Thomas farm on Guthrie Hwy., near Spring Creek, 15 Sept., 1956, F. Brown & A. Clebsch s. n. (APSU).

Quercus imbricaria Michx. Shingle oak. Wilson Co., Tn.: north of Gladeville, 23 Aug., 1947, F. H. Norris & R. E. Shanks 7340 (TENN); Seneca Co., Ohio: 9 Sept., 1969, G. T. Jones s. n. (MU) 58530; Bedford Co., Tn.: east of Shelbyville, 12 Aug., 1969, R. Kral 36310 (VDB); Warren Co., Ky.: six miles east of Bowling Green, 10 May, 1968, E. Donoho 81 (WKU); Stewart Co., Tn.: LBL, half mile west of marker 7K5, 27 July, 1965, W. H. Ellis 00749 (APSU); Montgomery Co., Tn.: Paradise Hill Rd., two miles southeast of Clarksville, 15 Oct., 1949, F. Brown & A. Clebsch 695 (APSU).

X Quercus leana Nutt. Lea's oak. Erie Co., Ohio: 15 Oct., 1911, Miller s. n. (MU) 4743; Houston Co., Tn.: near Dry Branch of Yellow Creek, 5 July, 1951, R. E. Shanks 15824 (TENN); Montgomery Co., Tn.: 1.5 miles west of Oakwood, one-fourth mile south of Hwy.,76, 8 July, 1950, A. Clebsch s. n. (APSU).

Quercus lyrata Walt. Overcup oak. Grundy Co., Tn.: G. Haynes farm near Pelham, 24 Nov., 1956, A. J. Sharp 21801 (TENN); Allendale Co., S. C.: 2.5 miles southwest of Milletville, 8 Sept., 1967, J. R. Bozeman & J. S. Radford 11407

(WKU); Davidson Co., Tn.: Vanderbilt campus, 13 Sept., 1938, J. M. Shaver 5760 (VDB); Richland Co., Ohio: 5 May, 1896, E. Wilkinson s. n. (MU) 4804; Stewart Co., Tn.: LBL, Ginger Bay camping area, 14 Nov., 1970, L. J. Schibig & R. Driskill 27 (APSU); Montgomery Co., Tn.: Long Pond Slough, 20 July, 1971, E. W. Chester 2490 (APSU).

Quercus macrocarpa Michx. Bur oak. Davidson Co., Tn.: west of Nashville, 17 May, 1941, R. E. Shanks 1496 (TENN); Davidson Co., Tn.: Peabody College campus, 6 Sept., 1938, J. M. Shaver 5761 (VDB); Lorain Co., Ohio: 16 Sept., 1902, F. O. Grover s. n. (MU) 4746; Montgomery Co., Tn.: Smith Branch Recreation Area, 18 Nov., 1968, E. W. Chester 2206 (APSU).

Quercus marilandica Muenchh. Blackjack oak. Warren Co., Ky.: Rt. 31, 1.5 miles south of Bowling Green, 27 June, 1968, K. A. Nicely 2060 (WKU); Benton Co., Tn.: dry ridge, 11 July, 1952, T. J. Walker 16636 (TENN); Burlington Co., N. J.: 19 May, 1932, M. A. Chrysler s. n. (MU) 20129; Cheatham Co., Tn.: Trace Creek, 23 July, 1970, G. Gonsoulin 1465 (VDB); Trigg Co., Ky.: LBL, Hwy. 453, two miles south of marker 8.0, no date, L. J. Schibig 16 (APSU); Montgomery Co., Tn.: northeast of Clarksville near Red River, 2 Nov., 1941, R. E. Shanks 1161 (APSU).

Quercus Michauxii Nutt. Swamp chestnut oak. Fayette Co., Tn.: Ames Plantation, 19 Oct., 1957, E. A. Hebb H-440 (TENN); St. Mary's Ohio: 6 Sept., 1899, A. Wetzstein s. n. (MU); Tipton Co., Tn.: along the Hatchie River, 4 Oct., 1969, D. Demaree 63111 (VDB); Trigg Co., Ky.: LBL, below dam at Hematite Lake, 17 Oct., 1970, L. J. Schibig & R. Driskill 23 (APSU); Montgomery Co., Tn.: bank of West Fork Creek, 16 Sept., 1948, A. Clebsch & E. Clebsch s. n. (APSU).

Quercus Muehlenbergii Engelm. Chinkapin oak. Wythe Co., Va.: ten miles east of Wytheville, 13 July, 1965, K. A. Nicely & G. B. Straley 912 (WKU); Cocke Co., Tn.: bluffs on Newport Rd., 12 June, 1953, A. J. Sharp 17911 (TENN); Preble Co., Ohio: 12 May, 1963, H. Ball s. n. (MU) 17712; Cheatham Co., Tn.: Trace Creek, 23 July, 1970, G. Gonsoulin 1475 (VDB); Stewart Co., Tn.: LBL, one mile east of marker 10P2, 10 Aug., 1966, E. Wofford 02363 (APSU); Montgomery Co., Tn.: Liberty Rd., half mile from jct. with Hwy. 79, 30 Oct., 1968, E. W. Chester 2203 (APSU).

Quercus nigra L. Water oak. Bladen Co., N. C.: county rd. 1320, 2.1 miles from jct. of 1320 and 1318, 31 Aug., 1967, P. J. Crutchfield 5592 (WKU); Winter Park, Fla.: 30 Dec., 1927, F. O. Grover s. n. (MU) 30670; Carroll Co., Tn.: Oct., 1947, G. B. Shivery 2510 (TENN); Benton Co., Tn.: Lipes Switch, 22 Sept., 1940, J. M. Shaver 5755 (VDB).

Quercus palustris Muenchh. Pin oak. Warren Co., Ky.: Greenhill Rd., eight miles from Bowling Green, 18 May, 1968, E. Donoho 59 (WKU); Hardeman Co., Tn.: .7 miles southeast of Hog Town, E. A. Hebb H-428 (TENN); Seneca Co., Ohio: 9 Sept.,

1969, G. T. Jones s. n. (MU) 58529; Davidson Co., Tn.: Vanderbilt campus, 18 Sept., 1938, J. M. Shaver 5730 (VDB); Stewart Co., Tn.: LBL, half mile west of marker 7N1, 5 July, 1966, E. Wofford 01782 (APSU); Montgomery Co., Tn.: Hwy. 112, 10.7 miles east by south of Clarksville, 3 Aug., 1949, F. Brown & A. Clebsch s. n. (APSU).

Quercus Phellos L. Willow oak. Warren Co., Ky.: Boyce-Fairview Rd., one mile from Hwy. 231, 24 June, 1970, K. A. Nicely 2844 (WKU); Rutherford Co., Tn.: two miles northeast of Eagleville, 3 May, 1959, H. R. DeSelm 2006 (TENN); Winter Park, Fla.: 27 Oct., 1927, F. O. Grover s. n. (MU); Coffee Co., Tn.: 8 July, 1966, R. Kral 26815 (VDB); Stewart Co., Tn.: LBL, one mile west of marker 7N3, 1 Sept., 1966, E. Wofford 02453 (APSU); Montgomery Co., Tn.: Sango Comm., six miles southeast of Clarksville, 13 Sept., 1967, E. W. Chester 1891 (APSU).

Quercus Prinus L. Chestnut oak. Blount Co., Tn.: northeast of Look Rock Campground, 18 Sept., 1965, R. D. Thomas s. n. (TENN); Warren Co., Ky.: Barren River Rd., eight miles northwest of Bowling Green, 13 June, 1968, K. A. Nicely 1863 (WKU); Cheatham Co., Tn.: Harpeth River, 24 July, 1970, G. J. Gonsoulin 1414 (VDB); Rutherford Co., N. C.: 19 July, 1933, F. O. Grover s. n. (MU) 29311; Stewart Co., Tn.: LBL, road leading to Wallace Cemetery, 17 Oct., 1970, L. J. Schibig 24 (APSU); Montgomery Co., Tn.: Hwy. 79, east of Cumberland River, 26 July, 1956, F. Lawrence & A. Clebsch 14235 (APSU).

Quercus rubra L. Northern red oak. Blount Co., Tn.: Look Rock lookout, 12 Sept., 1965, R. D. Thomas s. n. (TENN); Barren Co., Ky.: Hwy. 68 near Glasgow, 4 May, 1968, E. Donoho 23 (WKU); Bartholomew Co., Ind.: 14 July, 1934, R. C. Friesner s. n. (MU) 19903; Cheatham Co., Tn.: Harpeth River, 2 July, 1970, G. Gonsoulin 1472 (VDB); Stewart Co., Tn.: LBL, one-fourth mile east of marker 8N3, 5 July, 1966, E. Wofford 01840 (APSU); Montgomery Co., Tn.: bluffs along Cumberland River, 28 Sept., 1941, R. E. Shanks 861 (APSU).

Quercus Shumardii var. Shumardii Buckl. Shumard oak. Pulaski Co., Ark.: 30 Oct., 1931, D. Demaree s. n. (MU) 20278; Davidson Co., Tn.: Nashville, 4 Sept., 1938, J. M. Shaver 5748 (VDB); Claiborne Co., Tn.: in pasture, 6 Aug., 1966, H. R. DeSelm s. n. (TENN); Stewart Co., Tn.: LBL, Neville Bay camping area, no date, L. J. Schibig 29 (APSU); Montgomery Co., Tn.: APSU campus, 7 Nov., 1970, E. W. Chester 2385 (APSU).

Quercus Shumardii var. Schneckii (Britt.) Sarg. Schneck oak. Bedford Co., Tn.: west of Center Methodist Church, 7 Aug., 1947, R. E. Shanks, A. J. Sharp & E. Clebsch 5671 (TENN); West Feliciana Parish, Miss.: Tunica Hills, 15 Sept., 1970, S. B. Jones 20241 (VDB); Stewart Co., Tn.: LBL, effluence of Panther Creek, 20 Sept., 1971, L. J. Schibig 9 (APSU); Montgomery Co., Tn.: Lynnwood's Landing, 13 Sept., 1947, A. Clebsch & E. Clebsch s. n. (APSU).

Quercus stellata Wang. Post oak. Henderson Co., N. C.: 23 July, 1933, F. O. Grover s. n. (MU) 29288; Warren Co., Ky.: Dutch Gardens, Bowling Green, 16 June, 1968, K. A. Nicely & H. W. Elmore 1865 (WKU); Franklin Co., Tn.: High-land Rim Forest, 5 June, 1962, H. R. DeSelm & D. Ratledge 30589 (TENN); Cheatham Co., Tn.: Trace Creek, 23 July, 1970, G. Gonsoulin 1474 (VDB); Stewart Co., Tn.: LBL, Blue Springs Rd., just north of Hughes Creek Rd., 27 Sept., 1971, L. J. Schibig 13 (APSU); Montgomery Co., Tn.: vicinity of Popular Springs, 14 July, 1967, E. W. Chester 1757 (APSU).

Quercus velutina Lam. Black oak. Lorain Co., Ohio: 18 Sept., 1902, F. O. Grover s. n. (MU) 30733; Warren Co., Ky.: Boyce-Fairview Rd., one mile from Hwy. 231, 24 June, 1970, K. A. Nicely & E. E. Gough 2807 (WKU); Davidson Co., Tn.: Percy Warner Park, 19 Oct., 1948, Ju-chien Tseng 31 (VDB); Knox Co., Tn.: Knoxville, no date, H. R. DeSelm 2022 (TENN); Lyon Co., Ky.: LBL, Hwy. 453, near marker 5D3, 6 July, 1966, E. Wofford 01914 (APSU); Montgomery Co., Tn.: Shady Grove, 3 Sept., 1949, F. Brown & A. Clebsch s. n. (APSU).

Ecological Results

As mentioned in Chapter II, it was determined that there are seven forest communities on the Northwest Highland Rim. These were delimited on a subjectively evaluated moisture gradient and sampled to determine the species present and the importance values of each species. It is generally accepted in ecological works that moisture conditions do vary among habitats in the manner assumed in this study (Oosting, 1956; Braun-Blanquet, 1932). The assumption is that moisture differences will be reflected in the composition of the forest stands on each type of habitat. To test this hypothesis, the community coefficient of Jaccard, as described by Phillips (1959), was calculated for each of the communities.

I assumed that, since the slopes of mostly northern exposure were placed in the middle of the moisture gradient, there would be a decrease in similarity of communities as one proceeded toward the wetter or drier areas. The values of

the community coefficient range from zero for totally dissimilar communities to one for identical communities. By arbitrarily assigning the community of the northerly facing slopes a value of one and then calculating the community coefficients for the other communities, this assumption was confirmed. Table II presents the data determined in this manner and reflects the moisture gradient as envisioned by me. This gradient, from driest to wettest, is: limestone bluffs; xeric ridges; southerly facing slopes; northerly facing slopes; ravines; upland flatlands; and streambanks.

To further test this hypothesis, if any of the communities is assigned a coefficient of one, then the two communities most similar to it should occupy adjacent positions in the moisture gradient. Table III depicts just such a situation with two exceptions, both occurring at the extremes of the moisture gradient. These exceptions apparently result not only from moisture differences but from the decidedly different soil conditions which they illustrate. Although the streambanks and upland flatlands have similar moisture conditions, there is considerable difference in the soils. The soils of the streambanks are more similar to those of the ravines than to those of the upland flatlands. Thus one would expect the streambank community to most resemble the ravine community, which it does as determined by the community coefficients which were calculated, but are not included herein. Likewise, the limestone bluffs and xeric ridges have similar moisture conditions and dissimilar soils.

TABLE II : Moisture Gradient of the Northwest Highland Rim Communities as Determined by Community Coefficient

Habitat	Community Coefficient
Limestone Bluffs (LB)	.320
Xeric Ridges (XR)	.324
Southerly Facing Slopes (SFS)	.733
Northerly Facing Slopes (NFS)	1.000
Ravines (R)	.693
Upland Flatlands (UF)	.565
Streambanks (SB)	.112

TABLE III : Relationship of Adjacent Communities along the Moisture Gradient

Habitat	Community Coefficient
LB	
	.079
XR	1.000
	.684
SFS	
XR	
	.684
SFS	1.000
	.733
NFS	
SFS	
	.733
NFS	1.000
	.693
R	
NFS	
	.693
R	1.000
	.609
UF	
R	
	.609
UF	1.000
	.087
SB	

The soils of the limestone bluffs are most similar to those of the northerly and southerly facing slopes and the bluff community most resembles these slope communities.

The communities so determined were named according to the three species with the greatest importance values. These importance values were calculated by the summation of each species' relative frequency, relative density, and relative dominance. The procedures for determining these values are found in Phillips (1959). The following names have been assigned to the communities: Red cedar-White ash-Chinkapin oak community of limestone bluffs; Chestnut oak-White oak-Post oak community of xeric ridges; White oak-Black oak-Post oak community of slopes of mostly southern exposure; American beech-Tulip poplar-White oak community of slopes of mostly northern exposure; Red elm-Tulip poplar-American beech community of ravines; Black gum-Sweet gum-Red maple community of upland flatlands; and Box elder-Silver maple-Sycamore community of streambanks.

These trinomials reflect the importance of the Fagaceae in each community. In two of the communities, all three dominants are Fagaceae while in another community two of the dominants are Fagaceae. Still two other communities have one species of Fagaceae as a dominant. Therefore, members of Fagaceae are dominants in all but two of the seven communities, the two most mesic.

Tables IV-X list the species of Fagaceae of each community and their importance values. These figures confirm the

TABLE IV : Fagaceae Found on the Limestone Bluffs

Species	Importance Value
Quercus Muehlenbergii	29.1
Q. rubra	13.6
Q. Shumardii var. Schneckii	1.6
Q. falcata var. falcata	1.3
	45.6

TABLE V : Fagaceae Found on the Xeric Ridges

Species	Importance Value
Quercus Prinus	77.3
Q. alba	50.1
Q. stellata	40.3
Q. marilandica	20.6
Q. coccinea	19.3
Q. velutina	13.3
X Q. fontana	8.0
Q. rubra	1.8
	230.7

TABLE VI : Fagaceae Found on the Slopes of Mostly Southern Exposure

Species	Importance Value
Quercus alba	81.3
Q. velutina	59.4
Q. stellata	30.3
Q. falcata var. falcata	10.5
Q. Muehlenbergii	4.9
Q. rubra	3.8
Fagus grandifolia	2.0
Q. coccinea	1.6
X Q. fontana	1.6
Q. Shumardii var. Shumardii	1.5
Q. marilandica	1.3
	198.2

TABLE VII : Fagaceae Found on the Slopes of Mostly Northern Exposure

Species	Importance Value
Fagus grandifolia	56.0
Quercus alba	24.8
Q. velutina	23.2
Q. rubra	12.1
Q. falcata var. pagodaefolia	9.3
Q. Muehlenbergii	3.4
Q. falcata var. falcata	3.2
Q. Michauxii	1.5
Q. imbricaria	1.3
Q. stellata	1.2
	136.0

TABLE VIII : Fagaceae Found in the Ravines

Species	Importance Value
Fagus grandifolia	23.8
Quercus alba	13.8
Q. rubra	6.3
Q. Shumardii var. Schneckii	5.2
Q. Muehlenbergii	2.7
Q. falcata var. pagodaefolia	2.1
Q. imbricaria	1.3
	55.2

TABLE IX : Fagaceae Found on the Upland Flatlands

Species	Importance Value
Quercus velutina	13.3
Q. Phellos	7.8
Q. alba	3.6
Q. palustris	3.2
Fagus grandifolia	2.4
Q. lyrata	1.8
Q. falcata var. falcata	1.8
Q. falcata var. pagodaefolia	1.2
	35.1

TABLE X : Fagaceae Found on the Streambanks

Species	Importance Value
Quercus Shumardii var. Schneckii	4.8
Q. rubra	2.3
Q. Michauxii	1.5
Q. imbricaria	1.4
Q. macrocarpa	1.2
	11.2

dominance of Fagaceae in some communities and their minor importance in others. It is evident that Fagaceae dominate the drier communities (with the exception of the limestone bluffs). Since all species combined have a total value of 300 in any community, it can be seen that Fagaceae account for 76.9 per cent, 66.1 per cent, and 45.3 per cent of the total importance value of the xeric ridges, southerly facing slopes, and northerly facing slopes, respectively. Yet, in the wetter ravines, upland flatlands, and streambanks they account for only 18.4 per cent, 11.8 per cent, and 3.7 per cent respectively of the total importance values.

Not only are Fagaceae of less importance in the wetter and the very driest habitats, but the species occupying these habitats differ. The remainder of this discussion will deal with the habitat preferenda and qualitative sociology of each species of Fagaceae. The qualitative sociology is based on field observations and the frequency of joint occurrence of the various species in a particular habitat. Associated species listed are those occurring on at least 30 per cent of the sites on which a particular species occurred. These discussions will be supplemented by chi-square tests of habitat preferenda and graphs depicting the occurrence of selected species across the moisture gradient.

The null hypothesis for the chi-square test was that each species would occur in equal numbers in the seven communities. If the derived chi-square value is found to have a significance level $\geq .950$, the null hypothesis is rejected. This implies that the differences in habitat conditions are

affecting the species' distribution. The following contingency table illustrates the derivation of the chi-square value for Fagus grandifolia.

Habitat	Observed	Expected	O-E	$(O-E)^2$	$\frac{(O-E)^2}{E}$
LB	0	6.71	-6.71	45.02	6.71
XR	0	6.71	-6.71	45.02	6.71
SFS	1	6.71	-5.71	32.60	4.86
NFS	29	6.71	22.29	496.84	74.04
R	15	6.71	8.29	68.72	10.24
UF	2	6.71	-4.71	22.18	3.31
SB	0	6.71	-6.71	45.02	6.71
	47			$X^2=$	112.58

In the accompanying graphs the number of individuals of each species is plotted on the abscissa and the communities are plotted on the ordinate. No attempts were made to measure the moisture differences between the habitat types. They are plotted equidistantly for convenience only. The abbreviations used are: LB = limestone bluffs; XR = xeric ridges; SFS = southerly facing slopes; NFS = northerly facing slopes; R = ravines; UF = upland flatlands; and SB = streambanks.

The following presentation is arranged alphebetically by genus and species.

Castanea dentata - Because of the rare occurrence of this tree, it is difficult to ascertain its habitat preferenda. The few trees and stump sprouts found were growing on dry slopes and ridges, habitats similar to those described by Fernald (1950).

Fagus grandifolia - As indicated in Fig. 1, American beech was found most frequently on moderately moist areas, being most common on northerly facing slopes and in ravines. This corresponds to the rich uplands of Fernald (1950) and Gleason (1952). The chi-square level of significance is $\geq .995$, suggesting that moisture is affecting the distribution of this species. A statement to this effect is found in Harlow and Harrar (1958).

Common associates of American beech are generally cited as sugar maple, black cherry, tulip poplar, and various hickories. Associates determined for this area were Acer saccharum Marsh., Carya glabra (Mill.) Sweet, Quercus alba, Nyssa sylvatica Marsh., Carya ovata (Mill.) K. Koch, Cornus florida L., Quercus rubra, Ulmus rubra Muhl., Liriodendron Tulipifera L., and Juglans nigra L.

Quercus alba - White oak has a wide range of tolerance, being found in six of the seven communities. However, white oak is much more abundant on the drier sites as indicated in Fig. 1. The chi-square level of significance for the distribution of white oak is $\geq .995$. Fowells (1965) states that white oak grows best on northerly and easterly slopes and on moderately dry slopes while being seldom found on extremely dry, shallow soils and wet bottoms. Fernald (1950) and Braun (1961) list dry hillsides and mesic woods as the most favored sites. These descriptions are in accord with the findings of this study.

The most common associates of white oak are cited as other oaks, hickories, tulip poplar, white ash, American

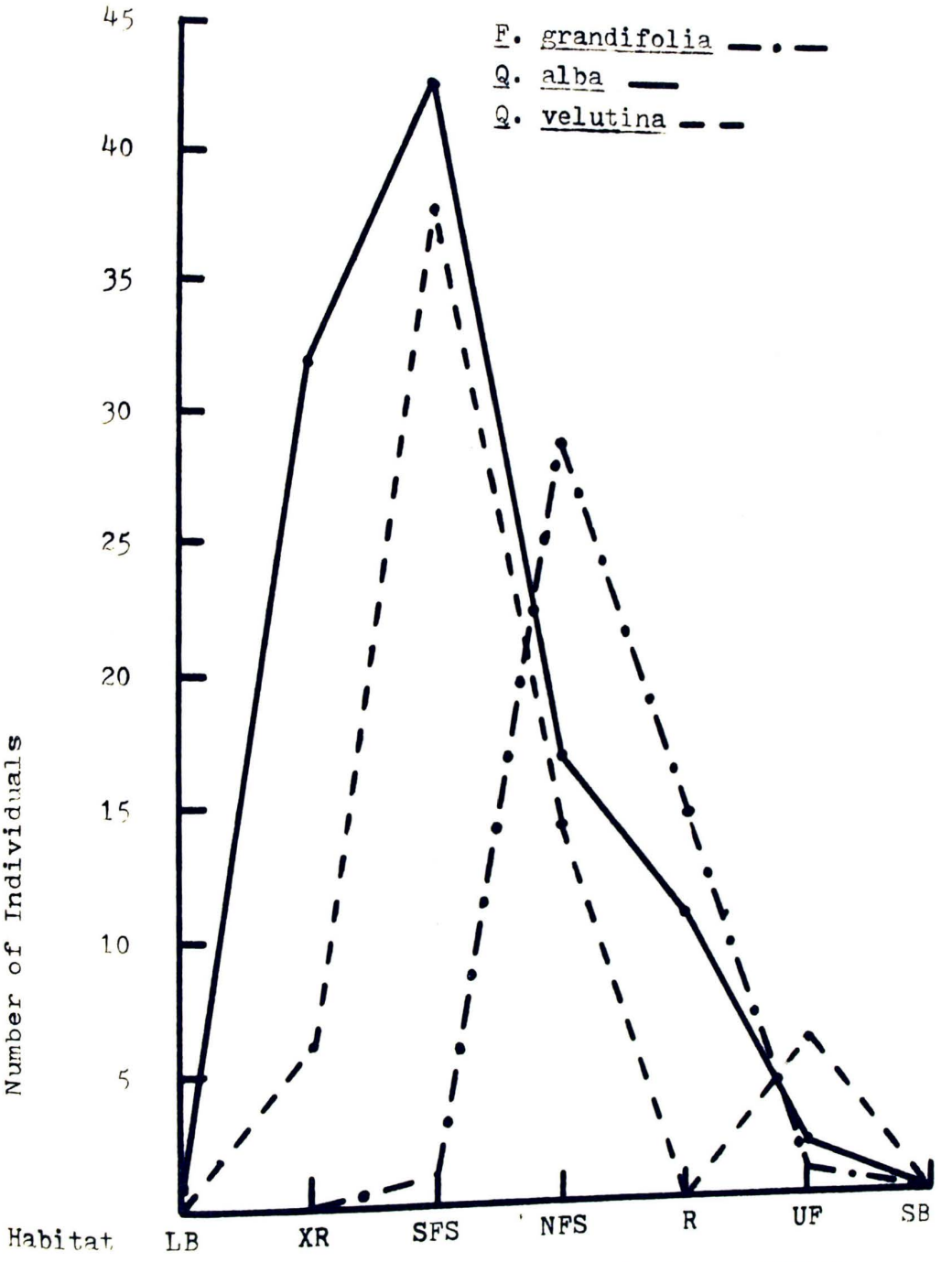

Figure 1 : Distribution of Fagus grandifolia, Quercus alba, and Quercus velutina across the moisture gradient.

beech, and sugar maple. On the Northwest Highland Rim, white oak was most frequently associated with Carya glabra, Nyssa sylvatica, Quercus velutina, Acer saccharum, Cornus florida, Carya tomentosa Nutt., Quercus stellata, Carya ovata, Carya ovalis (Wang.) Sarg., Fagus grandifolia, Liriodendron Tulipifera, Ulmus rubra, and Quercus Prinus.

Quercus coccinea - Scarlet oak was found in appreciable numbers only on the xeric ridges (Fig. 2), thus indicating a very narrow range of tolerance. The chi-square level of significance for this distribution is $\geq .995$. Gleason (1952), Sargent (1933), and Harlow and Harrar (1958) list dry, sandy soils as the most common habitat for scarlet oak. This is precisely where scarlet oak was found in my sampling. However, I have observed that rarely this tree occurs on moist soils in ravines.

Black, southern red, chestnut, white, and post oaks, various hickories, black gum, and sweet gum are most commonly cited as associates of scarlet oak. The list of associates for the study area includes Carya glabra, Quercus alba, Quercus stellata, Quercus velutina, Carya tomentosa, Nyssa sylvatica, Oxydendrum arboreum (L.) DC., and Quercus marilandica.

Quercus falcata var. falcata - Although southern red oak was found at both extremes of the moisture gradient, Fig. 3 illustrates that it was most common on the moderately dry, southerly facing slopes. The chi-square level of significance for this distribution is $\geq .995$. Sargent (1933) and Harlow and Harrar (1958) stated that southern red oak is

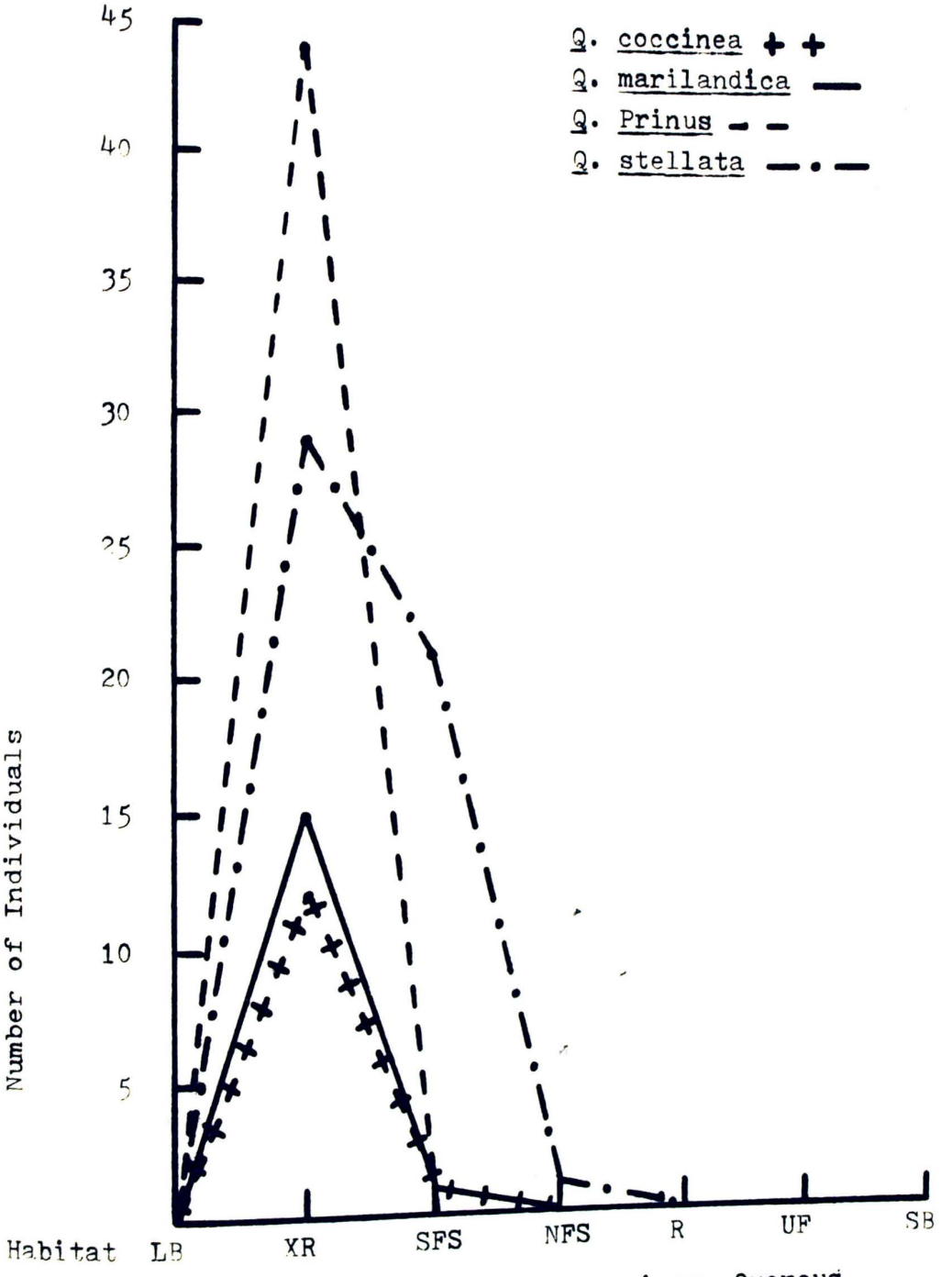

Figure 2 : Distribution of Quercus coccinea, Quercus marilandica, Quercus Prinus, and Quercus stellata across the moisture gradient.

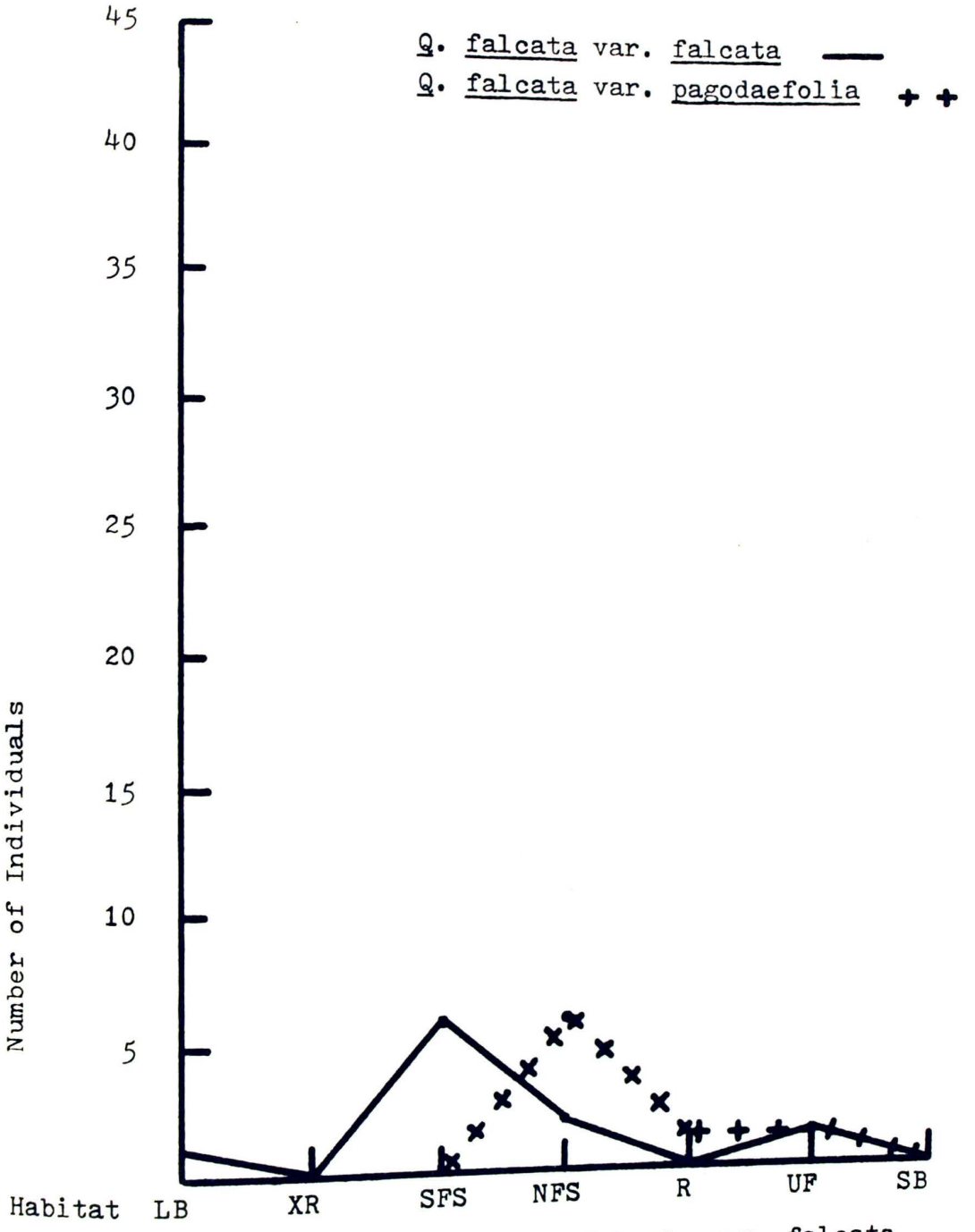

Figure 3 : Distribution of Quercus falcata var. falcata and Quercus falcata var. pagodaefolia across the moisture gradient.

found on dry hillsides and drier, poorer soils of uplands. These statements correspond favorably with results of my study.

Common associates of southern red oak within my study area were Quercus alba, Carya glabra, Carya tomentosa, Liquidambar Styraciflua L., Quercus stellata, Quercus velutina, Carya ovalis, and Celtis occidentalis L. This list is very similar to a list of the commonly cited associates: white, black, scarlet, post, and blackjack oaks, sweet gum, black gum, and various hickories.

Quercus falcata var. pagodaefolia - Cherrybark oak, a variety of southern red oak, was found to have different ecological requirements than the typical variety, illustrated in Fig. 3. The probability that its preference for northerly facing slopes is real is $\geq .995$, as revealed by chi-square analysis. Harlow and Harrar (1958) describe bottomlands and loamy ridges as the best sites for cherrybark oak while Fowells (1965) cites first bottoms and well-drained terraces.

Commonly cited associates of cherrybark oak are swamp chestnut, white, and Shumard oaks, sweet gum, white ash, and shellbark, shagbark, mockernut, and bitternut hickories. The most common associates in my study area were Liquidambar Styraciflua, Celtis occidentalis, Nyssa sylvatica, Prunus serotina Ehrh., Ulmus rubra, and Fagus grandifolia.

X Quercus fontana - Trees fitting the description of coclut oak were found to be rather common on the xeric ridges

(Fig. 4). They may represent a hybrid swarm, but if so, one covering approximately ten acres. The habitat was very similar to that described by Laughlin (1967) in his original paper. A chi-square level of significance of $\geq .995$ was calculated for the distribution of this hybrid.

Laughlin (1967) stated that both parent species, Quercus coccinea and Quercus velutina, were quite common where he found the hybrid. Post oak, white oak, and mockernut hickory were also in the vicinity. These same species, with the addition of Carya glabra, Nyssa sylvatica, and Oxydendrum arboreum, were found to be the most common associates of coclut oak in my study area.

Quercus imbricaria - Shingle oak is not an abundant tree, as indicated by the fact that only three stems were included in the sampling. The chi-square level of $\geq .100$ is very insignificant and probably results from finding so few individuals. However, the occurrence of these trees on the more mesic sites suggests the habitat preferenda of this species. Fernald (1950) lists rich hillsides and fertile bottomlands of streambanks as the favored sites. The three trees found in my sampling occurred on a northerly facing slope, a ravine, and a streambank, sites which correspond to those cited.

Trees commonly associated with shingle oak are elms, hickories, pin oak, and overcup oak. Within the study area the associates were Carya cordiformis (Wang.) K. Koch, Quercus rubra, Acer rubrum L., Carya ovata, Liriodendron

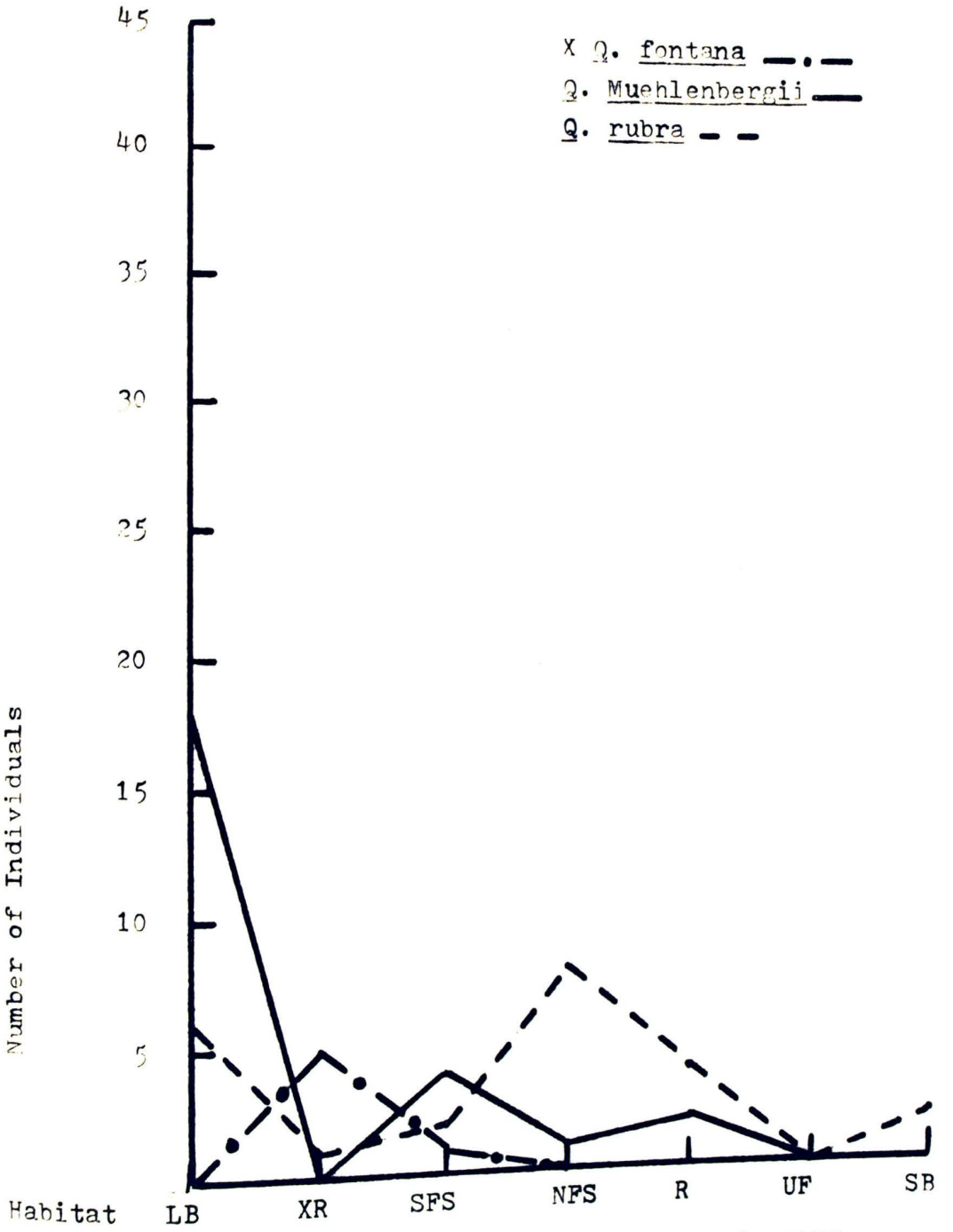

Figure 4 : Distribution of X Quercus fontana, Quercus Muehlenbergii, and Quercus rubra across the moisture gradient.

Tulipifera, Nyssa sylvatica, Prunus serotina, and Ulmus rubra.

Quercus lyrata - Apparently a rare tree in the study area, overcup oak was encountered only once in the sampling, but I have observed it at other localities, notably on streambanks and bottoms. The chi-square level of significance of $\geq .500$ probably reflects the infrequent occurrence of this tree. Gleason (1952) and Fernald (1950) describe the habitats of overcup oak as wet woods, bottomlands, and swamps, the same types of conditions in which it occurs in the study area.

Overcup oak is commonly found with willow oak, American elm, green ash, sugarberry, red maple, sweet gum, and persimmon. On the Northwest Highland Rim it was associated with Acer rubrum, Ulmus rubra, Nyssa sylvatica, Acer saccharinum L., Acer Negundo L., Populus deltoides Marsh., Platanus occidentalis L., Quercus Michauxii, Quercus palustris, Quercus Phellos, Quercus macrocarpa, and Salix nigra Marsh.

Quercus macrocarpa - Bur oak was another uncommon species on the Northwest Highland Rim. The data for bur oak are the same in all respects, even to the calculated chi-square level of significance, as those for Quercus lyrata.

Quercus Michauxii - Found only twice in the sampling, swamp chestnut oak was apparently an uncommon tree in the study area. It is a tree of mesic habitats, more specifically of inundated bottoms, streambanks, and swamps (Fernald, 1950) and wet and poorly drained soils (Braun, 1961). I have

observed this tree to be more common than the sampling indicated, especially along streambanks and on very moist soils. The chi-square level of significance of $\geq$ .100 presumably reflects the infrequent occurrence of this tree.

Swamp chestnut oak is commonly associated with cherrybark, white, and Shumard oaks, black gum, and shagbark, mockernut, and bitternut hickories. In the study area the associates included Acer Negundo, Acer saccharinum, Carya laciniosa (Michx.) Loud., Liquidambar Styraciflua, Nyssa sylvatica, Populus deltoides, Platanus occidentalis, Quercus macrocarpa, Salix nigra, and Ulmus rubra.

Quercus Muehlenbergii - Although chinkapin oak occurs in several habitats, its abundance on the limestone bluffs is quite conspicuous (Fig. 4). The chi-square level of significance of $\geq$ .995 for this distribution suggests an affinity for calcareous soils. Sargent (1933), Fernald (1950), and Braun (1961) describe chinkapin oak as a calciphile, occurring most frequently on limestone soils and outcrops. The data presented herein coincide with those descriptions.

Trees commonly associated with chinkapin oak are white and black oaks, sugar maple, hickories, ashes, black walnut, and tulip poplar. Those associates found in the study area were Acer saccharum, Fraxinus americana L., Jumiperus virginiana L., Ostrya virginiana (Mill.) K. Koch, and Carya ovata.

Quercus nigra - Though not encountered in the sampling, water oak was found in the study area. This find consti-

tutes a range extension. The single individual was found on a streambank. Trees commonly associated with water oak are sweet gum, willow oak, American elm, white ash, green ash, white oak, black gum, American beech, and sugarberry.

Quercus palustris - Pin oak occurs infrequently in the study area, only two stems being encountered in the sampling. Those sampled were found on the upland flatlands and had an insignificant chi-square level of $\geq .500$. This species is also occasionally found on bottomlands. These observations correspond to the findings of Braun (1961), who lists pin oak as being most abundant on flats, and Harlow and Harrar (1958), who list bottomlands and poorly drained clay flats as the preferred sites.

Commonly cited as associates are red maple, sweet gum, green ash, elms, box elder, hackberry, and bur, overcup, willow, and swamp chestnut oaks. Within the study area the associates were the same as those of Quercus lyrata.

Quercus Phellos - Another infrequently encountered species was willow oak. Although only three stems were included in the sampling, all three were found on the same habitat. This produced a significant chi-square level of $\geq .990$. The occurrence of willow oak on the upland flatlands is in accord with the bottomlands and poorly drained loamy or clay flats listed as preferred sites by Harlow and Harrar (1958) and the swamps and moist soils listed by Gleason (1952).

Trees cited as common associates of willow oak are sweet gum, swamp chestnut and cherrybark oaks, sugarberry,

American elm, green ash, and overcup oak. The associates as found in my study area were Acer rubrum, Ulmus rubra, Nyssa sylvatica, Liquidambar Styraciflua, Quercus palustris, Quercus lyrata, and Quercus velutina.

Quercus Prinus - Exhibiting the narrowest range of moisture tolerance, chestnut oak was found exclusively on the xeric ridges (Fig. 2). The chi-square level of significance of $\geq .995$ reflects this narrow range. Harlow and Harrar (1958) describe the habitat of chestnut oak as dry soils and rocky ridges and Fernald (1950) describes it as dry or rocky woods, bluffs, and crests. These descriptions are similar to the results of this study. However, Braun (1961), Sargent (1933), and Brock (1969) report that chestnut oak is occasionally found on mesic sites and streambanks, a situation I have not observed.

Frequently listed as associates of chestnut oak are scarlet, black, and white oaks, black gum, sweet gum, and red maple. Associates noted on the Northwest Highland Rim were Carya glabra, Carya tomentosa, Nyssa sylvatica, Oxydendrum arboreum, Quercus alba, Quercus coccinea, Quercus stellata, Quercus velutina, and Quercus marilandica.

Quercus rubra - Northern red oak is similar to Quercus alba in terms of its wide range of tolerance (Fig. 4), but is not so abundant. A chi-square level of significance of $\geq .975$ was calculated for this distribution. Thus, northern red oak appears to favor moderately moist and alkaline habitats. Its habitats are described as moist or dry soils by

Gleason (1952) and as a variety by Braun (1961), both statements being applicable to my study area. Though I found it most frequently on the limestone bluffs and northerly facing slopes, northern red oak occurred in all habitats except the upland flatlands.

As would be expected, from its wide distribution, northern red oak has numerous associates. Those commonly cited are ashes, black cherry, elm, hickories, maples, other oaks, sycamore, hackberry, black walnut, butternut, box elder, cottonwood, black gum, sweet gum, and honey and black locusts. Associates encountered in the study area were Quercus alba, Quercus Muehlenbergii, Carya glabra, Nyssa sylvatica, Acer saccharum, Carya ovata, Carya ovalis, Fraxinus americana, Liriodendron Tulipifera, and Quercus velutina.

Quercus Shumardii var. Shumardii - Shumard oak was found only once in the sampling and subjective observations affirm the paucity of this tree in the study area. A chi-square level of significance of $\geq .100$ indicated that the habitat preferenda of this tree cannot be determined. The moderately dry habitat on which Shumard oak was found in the sampling, a southerly facing slope, does not coincide with the habitats cited by Sargent (1933), Fernald (1950), and Gleason (1952), who all listed relatively moist habitats. Since Shumard oak was found on a southerly facing slope, its associates would be assumed to be the same as those of Quercus alba and Quercus velutina. Trees generally cited as associates of Shumard oak are black gum, white ash, shagbark,

shellbark, and bitternut hickories, cherrybark and swamp chestnut oaks, all trees of moderately moist habitats.

Quercus Shumardii var. Schneckii - As was Shumard oak, Schneck oak was encountered rather infrequently, but apparently is the more common of the two. Although Schneck oak was most often seen on streambanks, the chi-square level of significance of $\geq .500$ does not permit conclusions with respect to site preferenda. Nevertheless, these available data agree with the lowlands and bottomlands habitats described by Gleason (1952), Sargent (1933), and Fernald (1950).

Common associates cited for Schneck oak are the same as those for Shumard oak. Within the study area, trees most often found with Schneck oak were Carya cordiformis, Celtis laevigata Willd., Celtis occidentalis, Ulmus rubra, Acer Negundo, Acer saccharinum, Carya laciniosa, Platanus occidentalis, Populus deltoides, and Salix nigra.

Quercus stellata - A tree of dry upland woods and sterile soils (Gleason, 1952; Fernald, 1950), post oak was found as a dominant on two of the drier habitats: xeric ridges and the southerly facing slopes (Fig. 2). Post oak was found in one other habitat in the sampling, a northerly facing slope, and the chi-square level of significance, $\geq .995$, suggests a preference for the drier sites. However, Quercus stellata has been reported from moist sites (Svenson, 1941), and I found several instances of such an occurrence within my study area.

Trees most frequently listed as associates of post oak are black, blackjack, southern red, white, scarlet, chestnut, shingle, and chinkapin oaks, various hickories, black gum, sourwood, red maple, winged elm, hackberry, and dogwood. Associates most often observed in my area were Carya glabra, Quercus alba, Carya tomentosa, Oxydendrum arboreum, Quercus falcata var. falcata, Quercus marilandica, and Quercus Prinus.

Quercus velutina - Due to a similar distribution over the habitats sampled, black oak appears to have much the same habitat preferenda as Quercus alba (Fig. 1). Its predominant occurrence on the drier sites (chi-square level of significance of $\geq .995$) corresponds to the habitats described by Fernald (1950), Gleason (1952), and Braun (1961).

A list of those trees commonly associated with black oak includes various hickories, and post, scarlet, southern red, blackjack, chestnut, white, and northern red oaks. In the study area, its associates were most commonly Carya glabra, Quercus alba, Nyssa sylvatica, Oxydendrum arboreum, Quercus marilandica, Quercus rubra, Carya tomentosa, Quercus coccinea, Quercus falcata var. falcata, and Quercus Prinus. On the wetter habitats, black oak was found associated with Liquidambar Styraciflua, Nyssa sylvatica, Acer rubrum, Ulmus rubra, and Liriodendron Tulipifera.

X Quercus Fernowii - This hybrid was not encountered in my sampling and only one tree was found in the study area. It was on an upland flatland habitat and was associated with Quercus alba, Quercus palustris, Quercus falcata var. pagodaefolia, Nyssa sylvatica, Liquidambar Styraciflua, and Ulmus

X Quercus leana - Lea's oak was found at one site on the Northwest Highland Rim. The habitat was apparently upland flatland. Trees noted in the vicinity were Quercus Phellos, Quercus imbricaria, Quercus velutina and various hickories.

X Quercus mutabilis - This oak was found growing along a roadside at the base of a slope, under moderately dry conditions. The vegetation of the slope consisted mostly of oaks and hickories.

Finally, a general description of Fagaceae of the Northwest Highland Rim may be derived by combining the data from the seven communities. This procedure makes the invalid assumption that all communities occupy an equal area in the study area. The communities of the limestone bluffs, upland flatlands, and streambanks, and possibly the xeric ridges, have seemingly smaller areas than do the other communities. Nevertheless, this description may be valuable, if one remembers that it is a subjective evaluation and that it is derived only from the data accumulated through the sampling methods.

Table XI presents for each species of Fagaceae which occurred in the sampling, its importance value, number of stems, and per cent of all stems sampled. The totals calculated from these data reveal that 30.5 per cent of the total number of stems and 33.3 per cent of the total importance value of the forests sampled were represented by Fagaceae. These figures far surpass those of any other family of trees

TABLE XI : Importance Values, Numbers of Stems, and Per Cent Total Stems of Fagaceae of the Northwest Highland Rim

Species	I. V.	Stems	% Stems
Quercus alba	24.6	106	7.57
Q. velutina	15.8	62	4.43
Fagus grandifolia	13.6	46	3.28
Quercus stellata	9.7	51	3.64
Q. Prinus	9.5	44	3.14
Q. rubra	5.3	23	1.64
Q. Muehlenbergii	4.7	25	1.78
Q. marilandica	2.8	16	1.14
Q. coccinea	2.6	13	.92
Q. falcata var. falcata	2.4	10	.71
Q. falcata var. pagodaefolia	2.0	8	.57
Q. Shumardii var. Schneckii	1.9	5	.35
Q. Phellos	1.3	3	.21
X Q. fontana	1.2	6	.35
Q. imbricaria	.6	3	.21
Q. palustris	.5	2	.14
Q. Michauxii	.4	2	.14
Q. lyrata	.3	1	.07
Q. Shumardii var. Shumardii	.3	1	.07
Q. macrocarpa	.2	1	.07
	99.8	428	

encountered. The Juglandaceae accounted for 10.3 per cent (I. V. = 30.8) of the total importance value and 12.4 per cent (n = 174) of the total stems; the Aceraceae accounted for 12.3 per cent (I. V. = 37.0) of the total importance value and 12.3 per cent (n = 172) of the total stems; and the Ulmaceae accounted for 9.8 per cent (I. V. = 29.4) of the total importance value and 9.6 per cent (n = 135) of the total stems.

Based on these figures, the forest of the Northwest Highland Rim may be termed an Oak-Maple-Hickory Forest. This conclusion agrees with Braun's (1950) conclusion that the Western Mesophytic Forest Region is approaching Oak-Hickory Forest in its western portions, of which the Northwest Highland Rim is part.

Appendix II depicts all species found in the random pairs sampling and presents each species and its importance value on each of the seven habitats.

CHAPTER IV

DISCUSSION

The results of this study have produced, besides more precise data on the affinities of Fagaceae, three range extensions, data supporting conclusions of other authors, and descriptions of several hybrids occurring within the study area. Also, comparison with previous works reveals certain discrepancies which are analyzed subjectively.

The range extensions involve three oaks, Quercus falcata var. pagodaefolia, Quercus nigra, and Quercus Shumardii var. Schneckii. Cherrybark oak, Quercus falcata var. pagodaefolia, was previously unreported from Montgomery County, Tennessee although specimens questionably (but correctly) labeled so were in the Austin Peay State University Herbarium. Quercus nigra, water oak, was reported for the first time from Stewart County, Tennessee. A specimen of water oak was filed in the A. P. S. U. Herbarium but was incorrectly identified as a hybrid. Schneck oak, Quercus Shumardii var. Schneckii was also previously unreported from Montgomery County, Tennessee, although specimens were on file in the A. P. S. U. Herbarium.

Several questions concerning the taxonomic treatment of Fagaceae, more especially of Quercus, remain. The first involves Quercus alba var. latiloba Sarg., recognized by Rehder (1940) and Sargent (1933), which differs from var. alba in having leaves with shallower sinuses and broader lobes and

a somewhat smaller acorn. Most authors reduce var. latiloba to the status of a forma. I agree with this reduction, based on the frequent variability of acorn size and on finding leaves of both types on the same tree. The variations may result from habitat differences, such as the amount of insolation a tree receives.

In the case of Quercus coccinea, the var. tuberculata appears to be quite common on the Northwest Highland Rim. All specimens of Quercus coccinea which I have found with fruits have the tuberculate scales on the cups. This is apparently not caused by ecological differences since trees with this fruit type have been found on dry ridges and in moist ravines.

Another question arises concerning the treatment of the varieties of Quercus falcata. Three of these supposed varieties occur in the study area: var. falcata; var. triloba; and var. pagodaefolia. Ware (1967), after extensive study of Quercus falcata and its varieties, concluded that the var. triloba should be reduced to synonomy with the var. falcata and that the var. pagodaefolia should be given species status, a conclusion that Trelease (1924) had previously made. I agree with Ware on both counts. First, the leaves ascribed to the var. triloba are commonly found on trees with typical leaves, usually near the bottom of the crown. Secondly, not only are the leaf, bur, fruit, and bark characters of var. pagodaefolia different from these of var. falcata, but the sampling in this study reveals that these varieties occupy

different habitats. Ware also cites lack of evidence of crosses between the two as indication of their distinctness. Thus, Quercus falcata var. pagodaefolia Ell. should more appropriately be called Quercus pagoda Raf.

The finding of hybrid oaks may or may not be significant. Irgens-Moller (1955) states that the frequency of hybridization in natural populations is low, that hybrid swarms are rare, and that hybridization occurs more commonly between allopatric than sympatric species. C. H. Muller (1941) expresses the opinion that many reports of hybrids are actually formae produced by sporting, stump sprouts, ecological stress, or may be races produced at the periphery of a species range. Therefore, it is reasonable to question the identification of hybrids.

Four apparent hybrids were found in the study area, each distinct from either of the assumed parents. I feel that the possibility of these hybrids being races near range boundaries is not great as each occurs well within the range of both parents. Since the trees were mature, relatively large (having dbh's over 15 cm), and usually fruit-bearing, the possibility of their being stump sprouts is discounted. Ecological stress could be a factor, but in most cases (X Quercus mutabilis excepted) both parents were found growing normally near the hybrid. Finally, sporting is discounted as the cause due to the uniformity of the characters of the hybrids.

The determination of the hybrids is based on several sources. The X Quercus leana found compares favorably with

specimens at the herbaria of Miami University, the University of Tennessee, and Austin Peay State University as well as being in accord with a description by Dyal (1936). My specimen of X Quercus Fernowii does not appear to be the same as herbarium specimens at the University of Tennessee and Austin Peay State University, but does compare in all respects with descriptions given by Trelease (1924) and Braun (1961). The X Quercus fontana found is similar in most respects to that described by Laughlin (1967), differences existing in fruit and bud size. These differences may derive from the fruits and buds described by Laughlin having been more mature than those I collected. Characters of the X Quercus mutabilis collected are intermediate between those of the assumed parents, though being more like those of Quercus Shumardii. The specimen found seems to be this hybrid based on Palmer's (1948) description. However, he states that it is impossible to determine which variety of Quercus Shumardii is the parent.

Four studies of forest vegetation have been conducted in the vicinity of the Northwest Highland Rim. In 1939, Frick published the results of a study of the slope vegetation at the boundary of the Highland Rim and the Central Basin. This site is located approximately 25 miles southeast of the region I studied. The slopes Frick studied are mostly of southern exposure and are regarded as inliers of the Highland Rim. The species of Fagaceae found by Frick (1939) are very similar to those reported in this paper. Frick recorded

nine species of Fagaceae on these slopes, all of which, with the exception of Quercus Prinus, were on the southerly facing slopes I sampled. The major differences occur in the order of dominance of the species. Frick (1939) listed Quercus velutina, Quercus Muehlenbergii, Quercus alba, Quercus Prinus, and Fagus grandifolia as the dominant members of Fagaceae. On similar slopes of the Northwest Highland Rim the list reads Quercus alba, Quercus velutina, Quercus stellata, Quercus falcata var. falcata, and Quercus Muehlenbergii. These data depict the slopes of the Northwest Highland Rim as being drier than similar slopes in the Central Basin and suggest that Quercus Prinus becomes more restricted in habitat as one approaches the western boundary of its range.

Clebsch (1957) published a list of woody plants occurring in Montgomery and Stewart Counties, Tennessee. His list of Fagaceae included all those I found except Quercus falcata var. pagodaefolia, Quercus nigra, and the hybrids. Also, Clebsch (1957) failed to report Quercus Prinus in Montgomery County. His brief ecological notes agree with my results with one exception; Quercus coccinea, which he cites as occurring on upland flats. In my research, Quercus coccinea was never found on upland flats and only one individual was observed growing in mesic conditions, that in a ravine.

Brock (1969), in a study of the Stewart State Forest, listed twelve species of Fagaceae and made brief comments on the distribution of each. Several of his conclusions are in disagreement with mine. Brock stated that Quercus velutina occurs rarely in Stewart State Forest. Both by sampling and

observation I have found Quercus velutina to be a rather common tree in this forest. Brock noted that Quercus rubra was absent from moist slopes, a habitat in which I found this tree to occur regularly. Finally, Brock stated that Quercus Prinus is common in ravines. My observations suggest that Brock misidentified Quercus Michauxii, which he failed to include in his list and which inhabits ravines, as Quercus Prinus; a common mistake.

Also in 1969, Duncan and Ellis published an account of the forests of Montgomery County, Tennessee. This paper not only cited species, but listed six subjectively delimited forest communities. The species list included three oaks which had never been recorded in Montgomery County: Quercus bicolor, Quercus nigra, and X Quercus Hawkinsiae. Since voucher specimens were not collected, the status of these species in Montgomery County is still doubtful. Also, Duncan and Ellis (1969) failed to distinguish Quercus falcata var. pagodaefolia and Quercus Shumardii var. Schneckii in their identifications.

Duncan and Ellis (1969) found both Quercus rubra and Quercus falcata var. falcata to be much more common than I did. This may be tentatively explained in two ways: Quercus Shumardii var. Shumardii, Quercus Shumardii var. Schneckii, and Quercus velutina, all of which I found to be more abundant than Duncan and Ellis indicated, are often mistakenly identified as Quercus rubra. Their data for Quercus falcata var. falcata probably includes both var. falcata and var. pago-

daefolia. Also, Quercus falcata var. falcata appears to be quite common along roadsides and in open areas but is rather infrequent in mature forest stands. Since my data is based on mature stands and that of Duncan and Ellis is based on all woodlands regardless of age, this may account for the difference.

Of the six communities Duncan and Ellis (1969) discussed, only three are comparable to the communities recognized in the present study. Their Post oak-Black oak community of drier ridges and poorer sites is similar to the White oak-Black oak-Post oak community described in Chapter III. The bottomlands community which they described is very similar to the Black gum-Sweet gum-Red maple community of the upland flatlands which I sampled, and the streambank communities of both studies are quite similar.

The other three communities which Duncan and Ellis (1969) described were not observed by me. No true Beech-Maple Forest is known to occur south of the area of Wisconsin glaciation (Braun, 1950) and those communities in which American beech dominated in my study area were co-dominated by white oak, tulip poplar, and red elm. In describing their Red cedar-Hardwood community, Duncan and Ellis made no mention of chinkapin oak and white ash, which I found to co-dominate with red cedar, but listed northern red and white oaks and mockernut and shellbark hickories as co-dominants, species which I found to occupy minor positions in the red cedar communities. I observed no community which could be labeled White oak-Northern red oak-Hickory.

Final consideration of the ecological results has led to the conclusion that Fagaceae as a group favors the drier habitats of the Northwest Highland Rim. Some species of Fagaceae (Quercus alba, Quercus falcata var. falcata, Quercus Muehlenbergii, Quercus rubra, and Quercus velutina) have a wide distribution but prefer the moderately moist to extremely dry habitats. Others (Quercus coccinea, X Quercus fontana, Quercus marilandica, Quercus Prinus, and Quercus stellata) have a narrow distribution, being found almost exclusively on the xeric and moderately xeric areas. The remainder of the Fagaceae (Fagus grandifolia, Quercus falcata var. pagodaefolia, Quercus imbricaria, Quercus lyrata, Quercus macrocarpa, Quercus Michauxii, Quercus palustris, Quercus Phellos, Quercus Shumardii var. Shumardii, and Quercus Shumardii var. Schneckii) inhabit the moderately moist to extremely wet sites with only Fagus grandifolia exhibiting any significant degree of community dominance.

In numbers of taxa, the species and varieties which are restricted to the more moist habitats equal those which occur primarily on the drier sites. The difference in number of stems over the study area however, is quite large, there being a total of 280 stems on the limestone bluffs, xeric ridges, and southerly facing slopes, a total of 78 stems on the the northerly facing slopes, and a total of 60 stems on the ravines, upland flatlands, and streambanks. Thus, the frequency of Fagaceae decreases as one moves from xeric to mesic along the moisture gradient.

There are two reasons which may explain the relative importance of the various species of Fagaceae. The Northwest Highland Rim is very near the range periphery of all of the mesic species except Fagus grandifolia, Quercus Shumardii var. Shumardii, and Quercus Shumardii var. Schneckii. Conversely, the study area is well within the range of all of the xeric species except Quercus Muehlenbergii and Quercus Prinus. A species generally exhibits an abundance gradient across its range, being most abundant near the center and least abundant near the periphery (Braun-Blanquet, 1932). Adaptedness is another factor which appears to be affecting the importance of the Fagaceae. Those species which inhabit the drier areas are apparently better adapted to their particular habitat than are those species inhabiting the wetter areas.

CHAPTER V

SUMMARY

A study of Fagaceae of the Northwest Highland Rim was undertaken to determine both the taxonomic and ecological status of the family. The study consisted of field observations and collections plus random pairs sampling of seven habitats. These habitats were delimited by subjectively evaluated moisture conditions. In order from most xeric to most mesic, these habitats are limestone bluffs, xeric ridges, slopes of mostly southern exposure, slopes of mostly northern exposure, ravines, upland flatlands, and streambanks.

Taxonomic investigation of Fagaceae of the study area revealed the presence of three genera, Castanea, Fagus, and Quercus. Of these, Quercus contains the greatest number of forms, 23 of the 25 forms found. The list includes one species each of Castanea and Fagus, and 17 species, two varieties, and four hybrids of Quercus. Range extensions are reported for one species, Quercus nigra, and two varieties, Quercus falcata var. pagodaefolia and Quercus Shumardii var. Schneckii. The status of Quercus falcata var. pagodaefolia has been questioned and I agree with previous works indicating that it should be given species status. The hybrids were found as individual trees with the exception of X Quercus fontana which was rather common on the xeric ridges.

Ecological investigations revealed distinct communities on each of the seven habitats. These communities were named according to the three species with the greatest importance value and are; Red cedar-White ash-Chinkapin oak community of limestone bluffs, Chestnut oak-White oak-Post oak community of xeric ridges, White oak-Black oak-Post oak community of southerly facing slopes, American beech-Tulip poplar-White oak community of northerly facing slopes, Red elm-Tulip poplar-American beech community of ravines, Black gum-Sweet gum-Red maple community of upland flatlands, and Box elder-Silver maple-Sycamore community of streambanks. The similarities of the communities were tested by a community coefficient which also was used to support conclusions concerning the moisture gradient.

Fagaceae were dominant elements on all but the two most mesic communities. The family attained its greatest dominance on the xeric ridges, southerly facing slopes, and northerly facing slopes. The species composition found depended on the habitat. Chi-square analysis suggests that the distribution of species is non-random and correlates with the moisture gradient. Major associates for each species were determined by field observation and frequency of joint occurrence on a sampling site.

By combining all data and calculating importance values for the Northwest Highland Rim, it was shown that Fagaceae is the dominant family and Quercus the dominant genus. Based on these data, the forest as a whole was found to be an Oak-Maple-Hickory Forest.

APPENDIX I

This appendix contains a brief description of the location of each of the 28 sampling sites utilized in this study. These are presented in order of habitat type from driest to wettest. Each of the four sites within a habitat type is labeled a, b, c, or d.

Limestone Bluffs
- a-right side of Hwy. 41A, just north of the Red River bridge.
- b-junction of Hwy. 48 and Hwy. 13; north of 13, west of 48.
- c-immediately west of the New Providence Recreation Area boat ramp.
- d-overlooking the Cumberland River, immediately south of New Providence Hill.

Xeric Ridges
- a-LBL, road to Ginger Bay camping area, one mile from junction with road to Clay Bay.
- b-LBL, road to Wallace's cemetery, .5 miles from junction with Blue Springs Road.
- c-LBL, .9 miles west of marker BM3.
- d-LBL, road to Bard's Dam, .5 miles from junction with Hwy. 49.

Southerly Facing Slopes
- a-A. P. S. U. farm, right side of entrance road, midway between gate and picnic area.
- b-Stewart State Forest, .7 miles south of sign marking northern entrance on Hwy. 49, to right of highway.
- c-LBL, .6 miles east of junction of Ft. Henry and Blue Springs Roads, left of road.
- d-Montgomery County, Wickham farm, approximately 100 yards behind log house at Wickham's Stone Park.

Northerly Facing Slopes
- a-Montgomery County, right side of Canaan Road, .3 miles west of junction of Canaan and Oak Ridge Roads.
- b-LBL, .1 miles south of marker 7N1 on Blue Springs Road, left of road.
- c-opposite of SFS b.
- d-opposite of SFS a.

Ravines

a-between NFS c and SFS b.
b-between NFS d and SFS a.
c-Montgomery County, Shiloh Road, .5 miles north of junction with Broom Road, right side of road.
d-LBL, junction of Hwy. 49 and Blue Springs Road.

Upland Flatlands

a-Montgomery County, Liberty Road, across from J. E. Water's farm.
b-one mile east on Sango Road, north of Hwy. 41A.
c-intersection of Hwy. 41A and McAdoo Creek Road, south of 41A, west of McAdoo Creek Road.
d-just south of Hwy. 79, immediately inside Stewart County line.

Streambanks

a-Montgomery County, to left of the boat ramp at Smith's Branch Recreation Area.
b-Montgomery County, north bank of Ringgold Creek, just east of Hwy. 41A.
c-both banks of Dyer's Creek, 1.5 miles east of Dover, behind Rebel Service Station.
d-Stewart County, 1.1 miles north of junction of Hwy. 49 and 149, east bank of Cross Creek.

APPENDIX II

TABLE XII : Species Found on the Northwest Highland Rim and Their Importance Values in Each of the Habitats

	Habitats and Importance Values						
Species	LB	XR	SFS	NFS	R	UF	SB
Acer Negundo L.					10.9		65.2
A. nigrum Michx. f.				1.7			
A. rubrum L.				1.1	4.4	42.5	
A. saccharinum L.							53.1
A. saccharum Marsh.	9.0	4.2	26.3	22.2	10.1	3.9	
Ailanthus altissima (Mill.) Swingle					6.7		
Asimina triloba (L.) Dunal					1.2		
Betula nigra L.							1.2
Carpinus caroliniana Walt.				1.1	9.4	6.1	
Carya cordiformis (Wang.) K. Koch				7.2	9.8		13.7
C. glabra (Mill.) Sweet		28.8	11.0	7.1		7.4	
C. laciniosa (Michx.) Loud.			1.3		8.5		2.4
C. ovalis (Wang.) Sarg.			12.7	17.3	9.5		
C. ovata (Mill.) K. Koch	9.0	1.9	7.6	3.0	6.5	2.5	
C. tomentosa Nutt.		10.2	20.2	6.7	1.6		
Celtis laevigata Willd.					9.7		5.5
C. occidentalis L.	1.7				1.3	4.1	16.9

TABLE XII : (continued)

Species	Habitats and Importance Values						
	LB	XR	SFS	NFS	R	UF	SB
Cercis canadensis L.	1.2			1.1	1.3		
Cornus florida L.	5.3	1.2	2.4	7.3	1.2	3.6	
Diospyros virginiana L.						3.1	
Fagus grandifolia Ehrh.			2.0	56.0	23.8	2.4	
Fraxinus americana L.	37.9		2.1	1.1	1.2		
F. pennsylvanica Marsh.				3.9		5.1	4.4
Gleditsia triacanthos L.	1.6				1.4		10.2
Juglans cinerea L.					1.9		1.4
J. nigra L.			1.3	2.9	13.9		8.9
Juniperus virginiana L.	125.7						
Liquidambar Styraciflua L.	2.0			2.3	9.3	62.5	
Liriodendron Tulipifera L.				27.6	29.3	2.3	
Maclura pomifera (Raf.) Schneid.	9.1						1.6
Morus alba L.							1.2
M. rubra L.					1.2	1.2	3.9
Nyssa sylvatica Marsh.		10.0	9.1	19.3	3.7	87.8	
Ostrya virginiana (Mill.) K. Koch	7.9		2.5	6.4			
Oxydendrum arboreum (L.) DC.		13.1	1.2				
Platanus occidentalis L.					20.9	5.2	38.7
Populus deltoides Marsh.					9.3		18.9
Prunus serotina Ehrh.	7.8			8.7	8.1		
Quercus alba L.	1.7	50.1	81.3	24.8	13.8	3.6	
Q. coccinea Muenchh.		19.3	1.6				
Q. falcata var. falcata Michx.	1.3		10.5	3.2		1.8	
Q. falcata var. pagodaefolia Ell.				9.3	2.1	1.2	

TABLE XII : (continued)

Species	Habitats and Importance Values						
	LB	XR	SFS	NFS	R	UF	SB
X Q. fontana Laughlin		8.0	1.6				
Q. imbricaria Michx.				1.3	1.3		1.4
Q. lyrata Walt.						1.8	
Q. macrocarpa Michx.							1.2
Q. marilandica Muenchh.		20.6	1.3				
Q. Michauxii Nutt.				1.5			1.5
Q. Muehlenbergii Engelm.	29.1		4.9	3.4	2.7		
Q. palustris Muenchh.						3.2	
Q. Phellos						7.8	
Q. Prinus		77.3					
Q. rubra	13.6	1.8	3.8	12.1	6.3		2.3
Q. Shumardii var. Shumardii Buckl.			1.5				
Q. Shumardii var. Schneckii (Britt.) Sarg.	3.2				5.2		4.8
Q. stellata Wang.		40.3	30.3	1.2			
Q. velutina Lam.		13.3	59.4	23.2		13.3	
Salix nigra Marsh.							6.8
Sassafras albidum (Nutt.) Ness.			2.5	10.0	1.2		
Ulmus alata Michx.	28.8		3.1	1.3		4.6	
U. americana L.			2.1			1.7	
U. rubra Muhl.	4.1			6.0	55.4	15.1	33.8
U. spp.*						6.4	

* Ulmus alata, U. serotina Sarg., and/or U. Thomasi Sarg.

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