WHITE OAK COMMUNITIES IN THE GREAT VALLEY OF EAST TENNESSEE-- A VEGETATION COMPLEX

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ABSTRACT

The major regional vegetation feature in the Great Valley of East Tennessee is a complex of floristically diverse forest communities dominated by *Quercus alba* with upland oak and hickory species as major constituents and/or codominants.

Although several oak species are widely distributed throughout the southern Appalachians and the Great Valley, *Q. alba* has the highest ecological amplitude of any of the potential forest dominants in the Valley ecosystem.

In general, these communities dominate xeric to mesic habitats that form a large percentage of the land area. Vegetation that can be termed white oak-oak and/or white oak-hickory vegetation was undoubtedly more widespread in the past.

Other forests in the southern Appalachians can be correlated with these communities. *Castanea dentata* was a major component in many of these forests, but its removal has opened a niche which appears to have been filled by *Q. alba* or shared by other oak species.

INTRODUCTION

Although the Great Valley of East Tennessee is near the center of the Deciduous Forest Formation of eastern North America as defined by Braun (1950), little ecological research has been conducted in stable plant communities. Commercial forest acreage in the region, about 45 percent of total area, decreased by approximately two percent during the 1960's (Hedlund and Earles, 1971), and although timber volume is actually increasing (Murphy, 1972), the increase is accounted for in young, secondary stands. The older forests approaching steady state conditions are rapidly decreasing in acreage and will continue to do so particularly when projections suggest that hardwood cutting of saw timber ($\geq$ 27.5 cm. dbh) will exceed growth in the 1970's (Murphy, 1972).

With continued exploitation of these forests a knowledge of structure and function of these ecosystems becomes increasingly important for proper management of these renewable resources.

The objectives of this paper are to document and delimit composition and structure of contemporary stable forest communities dominated by Quercus alba and discuss their interaction with soil and site properties to other forest communities (or types) of the Southern Appalachians.

THE STUDY AREA

This study involves a six-county area in the central portion of the Ridge and Valley physiographic province in Tennessee (Fenneman, 1938), also known as the Great Valley of East Tennessee. This portion of the Great Valley, approximately 6400 km^2, lies between 36°00' and 36°30' north latitude and between 83°30' and 84°30' west longitude. Approximate elevation range is 225-420 m. above mean sea level. The major drainage system is the Tennessee River as it flows in a southwesterly direction.

The temperate continental, regional climate is significantly modified by the Appalachian Plateau on the west and Blue Ridge Mountains on the east. The dissected plateau to the northwest retards and weakens the force of cold winter air from northern high pressure systems. The Plateau causes warm, moist air from the Gulf of Mexico to rise and this change in air flow increases the frequency of afternoon thunderstorms that lower summer temperatures and reduce the number of extremely warm days in the valley. Mean annual temperature is 10°C with temperatures averaging 5°C or above all months of the year except January. Mean annual precipitation is 120 cm. and usually well distributed throughout the year. Average length of the growing season is 205 days (Knoxville, TN; U.S. Dept. Commerce, 1969).

The Great Valley is udderlain by a complex system of rock units that form the present parallel valleys and ridges trending northeast-southwest. These landforms have developed as a result of folding, thrust faulting and subsequent erosion of Paleozoic strata chiefly of Cambrian and Ordovician Age (Fenneman, 1938). According to Rogers (1953), the Rome Formation of lower Cambrian is the oldest formation and the highest local relief because of past thrust faulting and resistant sandstone beds which dominate the interbedded strata. Limestone and shale units of middle Cambrian (Conasauga group) occur across the valley of units dominated by limestone, shale or alternating beds of these. Limestones of this age contain little or no chert and weather to form low ridges and hills, and if shales dominate valleys are generally formed. Upper Cambrian and late Ordovician rocks are members of the Knox Group. These rocks are principally dolomitic, and residuum is characterized by chert. Undivided, this group occupies 33 to 40 percent of the Great Valley (Case, 1925). Middle Ordovician rocks are complex shale, limestone and sandstone rock units. The shales and sandstones are calcareous and resistant to weathering. The shales are associated wtth intricately dissected shale "knobs" and the sandstone forms prominent ridges and knobs that are surpassed in elevation only by areas underlain by the Rome Formation. Limestones of this age are essentially non-cherty and typically weather to easily eroded, fine-textured soils. Most of the soils have formed from residuum derived from the Paleozoic strata or from colluvium or alluvium derived from these strata and deposited in later periods of geologic time.

The Great Valley is delineated as the Appalachian Valley floristic region (Shanks, 1958), and its flora is generally known. A conservative estimate of 1000 vascular species in the region indicates a diverse flora and a wide range of environmental conditions. Two of the counties in the study area have a known tree flora of 67 species (Mann and Bierner, 1975). The region does not possess major barriers that isolate interbedding gene pools, and large areas of climatic, edaphic and topgraphic extremes do not exist that can limit distribution of most species.

General vegetation classifications have placed the Great Valley in an Oak-Chestnut Association (Weaver and Clements, 1938) or Forest Region (Braun, 1950). Death of Castanea dentata during this century renders these classifications obsolete. Placement of the Great Valley in the Appalachian Oak Forest by Kuchler (1964) is more indicative of contemporary potential physiognomy. Four forest types recognized by TVA emphasized the importance of pine species in the region; a Yellow-Pine-Hardwood forest type was recognized as the most widespread. An Upland Hardwood type characterized by oaks and hickories occupied mesic sites with Oak-Chestnut, Blackjack Oak-Hardwoods or Yellow-Pine types occupying the drier sites (TVA, 1941).

Previous vegetation studies in this region have usually considered vegetation of smaller areas (e.g., county-wide studies by Wolfe, 1956; West, 1970), or habitats expressing environmental and floristic extremes such as glades (Finn, 1968) or barrens (DeSelm et. al., 1969). Smith (1968) studies successional communities in the Great Valley but the nature of succession beyond 70 years was not determined. Oxendine (1971) studied shrub, vine and herb species in stands associated with this study. Understory communities were not delineated although strata were defined along a xeric to hydric gradient.

Modern man has long occupied the Great Valley with modest beginnings at least 8000 years ago (Lewis and Kneberg, 1958). Burial and temple mound cultures of eastern Indians apparently flourished here with remnants existing at the time of DeSoto in 1540. The Cherokee Indians were the dominant tribe in the Great Valley at the time of the arrival of the white man (Lewis and Kneberg, 1958). The impact on forests during the entire period of occupation by Indians was probably greatest in valley sites, on river islands and along flood plains according to early accounts collected by Williams (1928). The impact on vegetation by Indian cultures was minor compared to that of the Europeans. They quickly removed the Indians and succeeding generations exploited this forested region heavily in the 19th and 20th centuries. In spite of heavy useage, 45 percent of the land area is still forested although virtually all of the acreage can be characterized as young, even- and uneven-aged stands with a different species composition from the original forest.

METHODS

This study involved 58 old-growth forest stands ranging in area from 0.5-12 ha selected in Blount, Knox, Loudon, Monroe, Roane and Sevier counties in the middle portion of the Great Valley.

The criterion of stand selection was uneven-aged stands with apparent freedom from artificial disturbance over the past 40 years; this could not be absolute because of selective tree removal even in the oldest stands. A lower limit of one acre was placed on stand size. Stands were also selected by tree size and apparent age, associated geologic formation and soils. Old growth was based on presence of several trees with relatively large bole diameter ($\geq$ 47 cm), absence of closely-spaced trees of similar size and/or the absence of a continuous acreage of trees with the same diameter. An effort was made to find stands within each geologic parent material type with a representation of several aspects, slope forms and positions.

In each stand, concentric 400 m^2 temporary, circular plots were established at least 18 m from the forest edge; plot radii were adjusted for slope angle (Bryan, 1956). In all, 684 plots were established; the smallest stand of approximately 0.5 ha contained four plots and the largest of over 12 ha contained 27 plots. Stand homogeneity was considered in the sense that all stands were forested and that distribution of trees in a stand must appear as a function of chance rather than an intrinsic (natural or artificial) habitat factor. Stands were presumably associated with one soil-parent material unit and one slope aspect. In stands with different slope positions, forms and varying slope angles, homogeneity in the strictest sense could only be assumed within each position, form and associated slope angle.

On the plots, trees $\geq$ 12.5 cm dbh were counted by species and dbh recorded to the nearest 2.5 cm. Site characterisitics recorded at each plot slope form, were position, angle (percent) and aspect.

Thirty-four stands were selected for soil sample collection and soil profile description. Field and laboratory data from these sites were extrapolated to those similar in parent materials, soils, topographic forms, position, aspect and slope angle. In all, 95 pits were dug to a depth of 30-60 cm and cored to 105 cm or bedrock. Properties determined in the field were: thickness of A and B horizons, depth to bedrock or 105 cm (auger length), stone percent by volume for the profile, depth to gray and/or olive colors. Laboratory analyses included pH determination and textural analyses for the A and B_2 horizons. Textural estimates were made by the "feel" method (Soil Survey Staff, 1951), and compared with the hydrometer method of mechanical analysis (Day, 1956). From this textural information, water holding capacity was determined by horizon using the relationship between mean available water holding capacity and textural classes of Tennessee soils (Longwell, et. al., 1963). Centimeters of water/cm of soil were calculated by horizon thickness x the textural class determined for that horizon. Horizon values were summed and corrected for estimated percent stone for water-holding capacity of the solum.

FOREST COMMUNITIES IN THE GREAT VALLEY OF EAST TENNESSEE

Physical Features

Geologic topography units and soil series (76 total) associated with this particular study reflect regional geologic and edaphic complexity (Table 1).

TABLE 1. Major representatives of soil Great Groups, parent materials, topography, geologic mapping units and soil series in Great Valley of East Tennessee.

Unit No.	Dominant Soil Great Group and parent material	Topography	Associated geologic mapping units	Associated soil series
1	Eutrochrepts from calcareous shale	Knobs	Athens, Ottosee, Sevier shales	Dandridge, Whitesburg
2	Hapludalfs from limestone	Bluff and rock outcrop	Chickamauga, Lenoir limestone	Talbott, Colbert
3	Dystrochrepts from sandstone and shale	Prominent ridges	Rome Formation, interbedded sandstone and shales	Allen, Hayter, Jefferson, Lehew, Ramsey
4	Hapludults from shale	Rolling to flattened	Nolichucky, Pumpkin Valley shales	Barbourville, Bland, Leadvale, Litz, Muse, Sequoia
5	Paleudults from cherty dolomitic limestone	Ridges to rolling	Knox Group: Chepultepec, Copper Ridge, Kingsport, Longview, Mascot dolomites	Bolton, Clarksville, Dunmore, Fullerton, Greendale, Landisburg, Minvale
6	Paleudults from alluvium	Terraces; rolling to flat	Alluvium from limestone	Cumberland, Decatur, Emory, Etowah, Waynesboro
7	Rhodudults from calcareous sandstone	Knobs or ridges	Chapman Ridge sandstone	Alcoa, Nuebert, Steekee, Tellico
8	Haplaquepts from alluvium	Flat; present flood plain	Alluvium chiefly from limestone	Huntington, Lindside, Melvin
9	Paleudults from dolomitic limestone and limestone	Rolling	Maryville, Maynardville, Rutledge dolomite and limestone	Dewey, Hermitage
10	Haplaquents from alluvium	Flat; present flood plain	Alluvium from limestone, sandstone, or shale	Bruno, Hamblen, Staser

Ultisols and the suborder Udults, are most characteristic of the Great Valley. Approximately 30 percent of the area can be characterized by soils that belong to the Fullerton and Dunmore series derived from the Knox Group. Fullerton and closely related soils are typically deep, well-drained, acid soils with significant volumes of chert developing on broad, rounded hills and ridges. Generally, water availability is lowered in these deep, fine-textured soils in relation to the amount of chert present. Dunmore soils are deep and well-drained but possess less chert and more clay and they are usually associated with topographic features of less relief and slope angle. Approximatley 15 percent of the soils belong to the Sequoia and Dandridge series formed from non-calcareous shale and calcareous shale, respectively. Sequoia soils develop in residuum from easily weathered non-calcareous shale of the Conasauga group. These are moderately deep, acid soils with loam to silty clay loam A horizons and silty clay to clay B are associated with gradual slopes and low local relief. Dandridge soils are frequently shallow and commonly less than 60 cm in thickness, particularly when associated with the steep calcareous shale "knobs" in the eastern portion of the study area. Generally they are slightly acid soils with water holding capacity lowered by shallow sola, shale ragments in the sola and/or fine-textured subsurface horizons.

General Vegetation

The old growth forests represent an array of communities with widely varying composition and expression of dominance by tree species. In this study, the number of tree species (57) is comparable to other studies in the Great Valley and this physiographic province, with oaks and hickories comprising 30 percent of the species. In general, the upland species occupy a wide variety of sites with extensive geographic distribution in eastern North America.

Diversity is also recognized by the recognition of 76 forest communities in four major, conceptual vegetational complexes: the White Oak, Chestnut Oak, and Mixed Mesophytic and Tulip Poplar complexes. Within a complex, vegetation types and communities are constructed according to dominant, codominant species or taxonomic (generic) groups with communities recognized as variants of the complex as a whole because vegetation of similar composition is not confined to definite topographic, geologic and/or edaphic situations (Martin, 1971).

The composition and site relationships of the Chestnut Oak and Mixed Mesophytic Complexes have been reported (Martin and DeSelm, 1976), and they represent 35-40 percent of the old-growth forests. Chestnut oak communities are concentrated on middle and upper slopes of sandstone ridges of the Rome Formation while mixed mesophytic communities, dominated by Fagus grandifolia, occupy the protected slopes of the shale knobs in the eastern part of the aalley. Slope position and aspect are two major site variables that can be correlated with the presence of these communities. In addition, communities dominated by Liriodendron tulipifera, Pinus strobus and other pines, restricted upland hardwood and bottomland hardwood communities comprise approximately 25 percent of the old-growth forest (Martin, 1971).

Vegetation features common to all communities are density and basal area. Average density is 275 stems/ha with average ranges from 225-322 stems/ha. Average basal area is approximately 23.0 m^2/ha with averages ranging from 9.0-31.0 m^2/ha. On the uplands, density and basal area are highest on sites characterized by soils derived from non-cherty dolomitic limestone with no predictable correlation with topography. Low density and basal area are associated with poorly drained sites along present flood plains (Martin, 1971).

A complete discussion of all complexes, communities and statistical analyses is provided elsewhere (Martin, 1971). The remainder of this paper is devoted to examples of forest communities, landforms and soils dominated by Quercus alba and associated species. They represent the largest vegetational features in the valley that approach steady-state conditions.

THE WHITE OAK COMPLEX

Braun (1950) recognized the dominance of Q. alba in the Great Valley as a "unifying characteristic." She asserted that pure stands of the species rarely occurred in the original forests but it could dominate in all size classes in these communities. In the Ridge and Valley physiographic province of Virginia and Pennsylvania, she described numerous communities in which Q. alba was a dominant or codominant with various species, especially oaks. The vegetation complex recognized here indicates that similar communities also exist in this region and emphasizes the importance of Q. alba over a wide range of soil and topographic conditions. Its dominance in mesic climax and physiographic climax oak and oak-hickory forests in communities of large areal extent in the Oak-Hickory, Oak-Pine regions, and its common presence in the undifferentiated Mixed Mesophytic Forest Associated indicate a wide ecological amplitude. In the Great Valley, the uplands hardwood and oak-chestnut forests often recognized as the major forest types are dominated by oak species (TVA, 1941). Quercus alba is a major constituent of these forests, and this complex and its communities represent the major portion of these general types.

Examples of communities in the vegetational complex (Table 2) along with corresponding soil properties (Table 3) show the importance of Quercus alba (communities 1 and 2, Table 2) are not confined to any particular site. The greatest contribution by Q. alba to any community occurs on upper slopes of broad ridges underlain by non-cherty dolomitic or limestone (community 1) but these communities may also be at different slope positions on cherty dolomite sites (chiefly ridges), on high terraces and calcareous shale (Figure 1A, B, and C). Soil properties associated with communities discussed here are not radically different (Table 3). Deep soils with high water-holding capacity on northwest slope aspects certainly suggest mesic sites. The mesic nature of these sites is also accentuated with almost "pure" Q. alba and in the community on Knox dolomite (community 2), Q. alba is dominant on middle and lower leads (ridges) and in depressions (draws) (Figure 1A). The increased importance of such species as Q. rubra and Liriodendron tulipifera in the draws indicates substantial differences between draws and leads, but there is also an increased importance of hickories that are generally associated with more xeric habitats in this region (Braun, 1950; Martin and DeSelm, 1976).

Stable Q. alba forest types are recognized by the Society of American Foresters (S.A.F., 1954, type 53) but as scattered stands of limited acreage. In this region, communities clearly dominated by Q. alba are also localized, but they probably occupied a greater area in the original forest because the associated soils in topographic positions of present communities are widespread. Because of their accessibility and agricultural and timber potential, these areas were among the first cleared for homesites and cultivation. Extensive logging continues; since completion of field work for this study, several of the stands used to construct these communities have been selectively or clear-cut.

Quercus prinus is a major oak associated with Q. alba particularly on ridge sites characterized by cherty dolomitic limestone and Fullerton soils (community 3). This relationship extends to lower slopes of the sandstone ridges of the Rome Foramtion. Relative to white oak communities, total stand density is higher but basal area is considerably less. These differences are probably a function of topographic properties and soils with high chert content that promote slightly xeric conditions. Density, basal area and number of species are similar to chestnut oak-dominated communities. The presence ond contribution of Q. prinus does suggest more xeric conditions that are associated with communities dominated by Q. prinus in the southern Appalachians (Martin and DeSelm, 1976).

TABLE 2. Examples of forest communities of the White Oak Complex in the Great Valley of East Tennessee.

	Community (variant)[a]									
	1(2)	2(3)	3(7)	4(8)	5(11)	6(14)	7(17)	8 (19)	9(24)	10(25)
	Soil-Parent Material Unit[b]									
	5	2	2	4	2	3	1	4	2	3
	Slope Aspect									
	NW	NW	NW	NW	SW	SW	SW	NW	SW	NW
	Slope Position, form[c]									
	Ul	L,Ml	Ml	M,Ul	Ul	M,Ul	Ul	L,Ml	L,Ml	L,M,Ud
	Mean Density (stems/ha)									
	250.0	250.0	300.0	300.0	325.0	250.0	300.0	250.0	325.0	250.0
	Basal Area (m^2/ha)									
	27.0	28.0	23.0	25.3	23.0	18.0	28.0	23.0	21.0	21.0
	Total Number of Species									
	14	14	23	24	15	22	16	15	17	19
Species	Average Importance Value (IV=200)[d]									
Carya glabra	0.0	10.0	11.0	17.0	14.0	7.0	8.0	8.0	6.0	3.0
Carya ovata	0.0	0.0	1.0	0.0	0.0	0.0	0.0	40.0	0.0	0.0
Carya ovalis	3.0	0.0	0.0	11.0	2.0	3.0	0.0	3.0	0.0	12.0
Carya tomentosa	0.0	9.0	3.0	2.0	16.0	11.0	32.0	0.0	19.0	13.0
Juniperus virginiana	0.0	0.0	0.0	0.0	0.0	0.0	11.0	19.0	0.0	0.0
Liriodendron tulipifera	5.0	21.0	15.0	13.0	0.0	6.0	0.0	0.0	4.0	38.0
Nyssa sylvatica	6.0	22.0	9.0	8.0	2.0	3.0	2.0	0.0	6.0	4.0
Pinus echinata	2.0	11 0	0.0	5.0	23.0	9.0	2.0	0.0	49.0	0.0
Quercus alba	131.0	76.0	73.0	44.0	50.0	47.0	62.0	59.0	66.0	59.0
Quercus coccinea	0.0	0.0	14.0	0.0	8.0	26.0	2.0	0.0	3.0	9.0
Quercus falcata	11.0	0.0	2.0	0.0	13.0	16.0	20.0	0.0	7.0	7.0
Quercus muhlenbergii	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17.0	0.0	0.0
Quercus prinus	11.0	0.0	25.0	12.0	0.0	0.0	0.0	0.0	0.0	0.0
Quercus rubra	0.0	13.0	10.0	25.0	1.0	9.0	3.0	26.0	1.0	10.0
Quercus stellata	0.0	0.0	0.0	0.0	6.0	10.0	16.0	0.0	3.0	7.0
Quercus velutina	13.0	9.0	7.0	11.0	41.0	21.0	29.0	0.0	10.0	0.0

[a]Variant as in Tables 11-20; Martin, 1971
[b]Units in Table 1, column 1.
[c]L,M,U indicate lower, middle and upper slopes respectively, l,d indicate convex and concave (lead and draw) slope shape respectively.

[d]Relative Density + Relative Basal Area x 100 = Importance Value; major upland species with IV $\geq$ 10.0 in two or more communities are included.

TABLE 3. Average soil properties of communities of the White Oak Complex provided in Table 2.

	Community[a]									
	1	2	3	4	5	6	7	8	9	10
	Soil-Parent Material Unit									
	9	5	5	7	5	6	4	7	5	6
Soil Variables	Community Values									
Thickness of A_1 horizon (cm.)	5.0	7.5	2.5	5.0	2.5	5.0	5.0	0.0	2.5	12.5
Thickness of A_{2-3} horizon (cm.)	12.5	24.0	10.0	12.5	18.0	12.5	15.0	7.5	22.5	32.5
Depth to bedrock (cm.)	≥105.0	≥105.0	≥105.0	100.0	≥100.0	≥100.0	90.0	≥105.0	≥105.0	≥105.0
Depth to mottling (cm.)	≥105.0	≥105.0	95.0	100.0	≥105.0	≥105.0	90.0	≥105.0	82.5	≥105.0
Sand in A horizon (percent)	20.0	20.0	32.0	55.0	40.0	50.0	50.0	37.0	50.0	25.0
Silt in A horizon (percent)	60.0	60.0	45.0	32.0	45.0	30.0	30.0	40.0	25.0	60.0
Clay in A horizon (percent)	20.0	20.0	22.0	12.0	15.0	20.0	20.0	22.0	25.0	15.0
Sand in B horizon (percent)	15.0	10.0	17.0	37.0	17.0	40.0	15.0	22.0	12.0	30.0
Silt in B horizon (percent)	60.0	55.0	42.0	35.0	35.0	15.0	35.0	45.0	12.0	50.0
Clay in B horizon (percent)	25.0	35.0	41.0	27.0	47.0	45.0	50.0	32.0	76.0	40.0
Stone volume (percent)	0.0	15.0	22.0	7.0	17.0	15.0	5.0	0.0	40.0	40.0
Available water (cm./solum)	23.0	18.0	15.0	16.0	15.0	15.0	15.0	21.0	10.0	15.0
pH A	5.2	4.6	5.0	4.8	4.5	4.2	4.2	4.3	3.5	4.9
pH B	5.3	4.3	4.5	4.0	4.1	4.1	5.1	4.8	4.2	4.6
pH C (or 105 cm.)	5.3	4.2	4.2	4.0	4.3	4.2	6.8	5.5	4.0	4.2

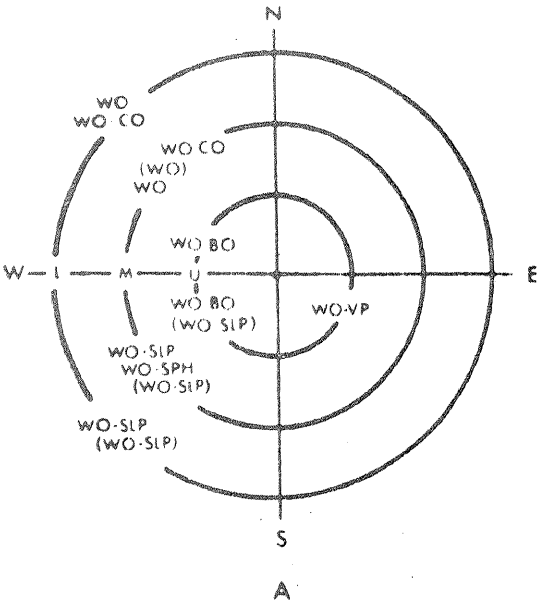
[a]Community as in Table 1

In the Ridge and Valley section of Virginia and Pennsylvania, Braun (1950) noted white oak-chestnut oak communities on lower north-facing slopes and on long slopes with low slope inclination compared with steep, upper slopes with scarlet oak-pine and/or chestnut oak communities. Castanea was a constituent of these communities but apparently not as a codominant. In this study, Castanea was a former constituent in the white oak-chestnut oak communities; whether or not it was the codominant is unknown. Quercus prinus is considered to be a species that commonly fills the niche opened by the death of Castanea (Woods and Shanks, 1957), but it is conceivable that Q. alba and Q. prinus partially share this ecological niche with other oaks (Stephenson, 1974).

White oak-northern red oak communities are associated with sandy-textured Tellico and colluvial soils derived from the calcareous Chapman Ridge sandstone (community 4). Increasing clay and silt content in the B horizon and low stone content enhance water availability, but steep, convex slopes associated with these soils and rock units reduce the water availability. These features indicate dry site conditions although the taxonomic diversity is highest in this community relative to other white oak-oak vegetation and species commonly associated with mesic sites, e.g., Acer saccharum, Fagus grandifolia, and Liquidambar styraciflua, contribute to the overstory in addition to the codominant, Q. rubra.

This localized community appears to represent the white oak-red oak hickory S.A.F. (1954) type 52, especially when contribution of Carya glabra is considered. Other researchers describing oak-hickory communities (or types) recognize the importance of communities dominated by Q. alba, Q. rubra, C. glabra associated with sandy-textured soils on steep slopes (Chapman, 1957; Lindsay, et. al., 1965; Ohman and Buell, 1968).

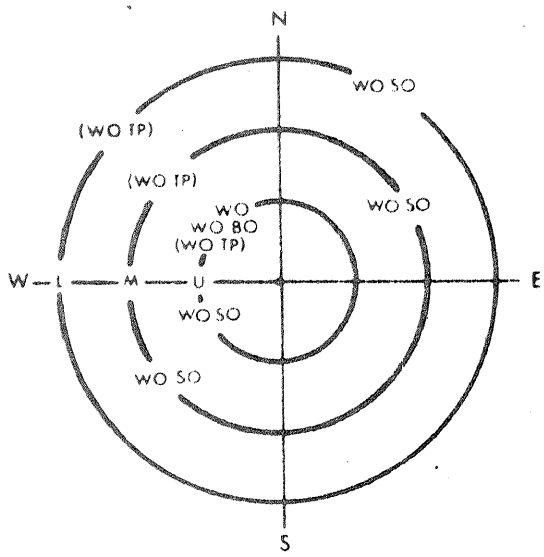
White oak-black oak communities (community 5) are found not only on upper southwest slopes associated with soils derived from cherty dolomitic limestone but also on upper northwest slopes and on upper exposed slopes of terraces (Figure 1A, B). It is well known that southwest slopes are hotter and drier than other aspects, and in the communities, aridity is accentuated by less protected, upper slope positions and a relatively high stone (commonly chert) content and high clay in the B horizon that lowers the water holding capacity.



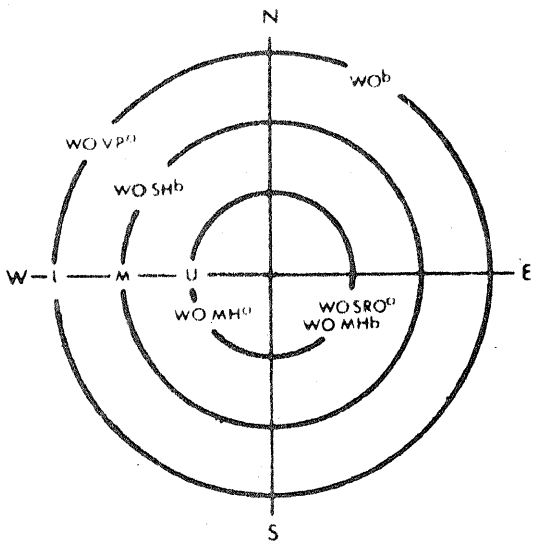
A

LEGEND

WO	-	Quercus alba
BO	-	Quercus velutina
CO	-	Quercus prinus
SO	-	Quercus coccinea
SRO	-	Quercus falcata
MH	-	Carya tomentosa
SH	-	Carya ovata
SPH		Carya ovalis
TP	-	Liriodendron tulipifera
SLP	-	Pinus echinata
VP	-	Pinus virginiana
L,M,U	-	Lower, middle, upper slopes
( )	-	Concave slope shapes



B



C

Figure 1A-C. Communities of the White Oak Complex in the Great Valley of East Tennessee. Communities associated with aspect, form and position on (A) Fullerton and associated soil series derived from cherty dolomitic limestones and limestones of the Knox group, (B) Decatur, Waynesboro and associated soil series derived from alluvium and (C) Sequoia and associated soil series derived from non-calcareous shales of the Conasauga group (a) and Dandridge and associated soils derived from calcareous Athens, Ottosee, and Sevier shales (b).

White oak-black oak communities are widely recognized across different climatic, edaphic, topographic and physiographic regions. In New England, the species share dominance on well-drained slopes (Rasche, 1958). In an unglaciated portion of Indiana, (McQueeny, 1950) and the inner, dissected Piedmont of Virginia (Braun, 1950), Quercus alba is the most widespread species and it shares dominance with Q. velutina on upper south, east, and north slopes. At all positions on north slope leads of the Ozark Plateau in Arkansas and Missouri, Braun (1950) describes white oak-black oak communities with different associated tree species e.g., Carya buckleyi and Castanea ozarkensis. In the Great Valley, prevailing limestone, dolomite and chert-producing bedrock of Cambrian and Ordovician age and the dominance of Q. alba and Q. velutina suggest a degree of vegetational similarity between these widely separated regions. White oak-black oak communities in the Asheville Basin, in the shale valleys of the Great Valley, and other areas in the Oak-Chestnut Forest Region were correlated with the Harrisburg peneplain (Braun, 1950). However, defined communities on the valley shale in this study (Figure 1C) do not exhibit this order of dominance. The common relationship between the two species suggests overlapping or similar site requirements at some point along a hypothetical environmental gradient. In this region, the relationship is associated with dry habitats of cherty dolomitic ridges that may have been initially dominated by Q. alba and Castanea dentata (Wolfe, 1957; Lipps, 1966).

On old terraces dominated by Waynesboro and Cumberland soils, Q. coccinea is second in importance to Q. alba on southwest middle and upper leads (community 6) with the relationship extending to similar slope positions on cooler and moister northeast slopes (Figure 1B). Important constituents throughout the community are Q. velutina, Q. falcata, C. tomentosa, and C. glabra. Low silt content in the solum, high sand content in the A horizon, presence of coarse fragments (rounded gravels) reduce water availability. However, middle and upper slopes of these terraces are characterized by low slope angle, less relief and broad convex leads. These sites enhance water retention and prevent rapid loss by seepage and/or runoff relative to habitats characterized by white oak-red oak and/or white oak-black oak communities with soil properties that favor better water and nutrient relationships.

The low basal area of 18 m^2/ha and presence of pines suggest past canopy openings that allowed invasion of shade intolerant oak species such as Quercus coccinea (Clark, 1970). Low basal area and density may also be a function of site. White oak-black oak communities on similar but cooler, moister slopes (Figure 1B) have the same average stand density but 50 percent more basal area, while the white oak-scarlet oak community on the northeast slope has a basal area of 16 m^2/ha (Martin, 1971). Q. coccinea, Q. stellata and the hickories are slow growing species that could produce low basal area values for the entire community.

White oak-scarlet oak communities on the broad leads and white oak-tulip poplar communities in the draws (Figure 1B) constitutes 75 percent of the terrace sample. The contribution of Q. coccinea to forest composition is at the optimum on these well-drained terrace sites and relative to other white oak-oak communities these sites appear intermediate in available (calculated) water. Quercus coccinea is also a significant component of white oak-black oak communities and in white oak-chestnut oak communities as water availability increases. As mentioned before, the species is commonly associated with xeric sites (e.g., Braun, 1950) but this is not necessarily true in this region (see Mixed Oak type; Chapman, 1957).

White oak-hickory communities are widespread but of lesser importance than white oak-oak communities. In a white oak-mockernut hickory community (community 7) on non-calcareous shale, major tree species include Carya glabra, Juniperus virginiana, Quercus falcata, Q. stellata and Q. velutina. A similar relationship exists on calcareous shale knobs (Figure 1C) and on sites underlain by non-cherty dolomite.

Sites of non-calcareous shale are usually valley positions characterized by Sequoia, Litz and associated soil series. In this study, these soils have a relatively high clay content and slow internal drainage in the B horizon indicated by gray mottling Practically all of these valley sites are cultivated, undergoing urban development, or occupied by young, second growth forests. Slope aspect is neither as important nor as well defined relative to ridge sites. Protection afforded by other land forms is minimal since valleys or low-lying ridges can be several km in width. The predominant control of forest development on these sites may be physical properties of soils as opposed to topographic features. Species that contribute significantly to total composition would be adapted to more poorly drained and poorly aerated conditions. However, the generalization cannot be made that white oak-hickory vegetation is confined to such habitats. These communities are associated with steep slopes of calcareous shale knobs, low-lying ridges and steeper slopes of calcareous sandstone sites. Although the hickories are slow growing, they probably have wider ecological amplitude than is usually recognized. The ecological importance of specific hickory species is too often overlooked by simply lumping all hickories as Carya spp., a practice that should be discouraged.

White oak-hickory vegetation was probably more widespread in the past although communities such as the white oak-sweet pignut hickory community on dolomite (Figure 1A) and the white oak-shagbark community on calcareous shale (Figure 1C) may reflect past disturbances because other vegetation has been recognized tatt appears older. For example, northwest mid-slope positions on calcareous shale are occupied by older and more widespread chestnut oak communities (Martin and DeSelm, 1976).

The white oak-mockernut kickory community is one of the best examples of general, conceptual oak-hickory forests. Oak-hickory communities recognized elsewhere usually emphasize importance of Carya glabra. In this study, white oak-pignut hickory communities are recognized but they form only a part of white oak-hickory forests Populations in different habitats in this region indicate differential selective pressure on and varying expression of codominance by these species.

Oak-hickory vegetation cannot be associated only with dry sites. White oak-shagbark hickory communities occupy lower and middle northwest slopes of calcareous sandstone units dominated by Tellico soils and middle northwest leads on the calcareous shale knobs (community 8). The presence of the codominant Carya ovata and increasing importance of Quercus rubra, constituents of mixed mesophytic forests in the Cumberlands (Braun, 1950), suggests mesic sites; the absence of oak species and C. tomentosa on drier, south-facing slopes also suggests relatively cool, moist environments on the northwest-facing slopes. Slope positions, aspect and calculated available water also indicate that characteris of these sites improve water relations, although availability is probably reduced on the relatively steep slopes. Contribution by Juniperus virginiana and Q. muhlenbergii suggests an improved base status relative to similar sites characterized by white oak-northern red oak communities (community 4), but pH values do not clearly support such relationships.

Some communities dominated by Q. alba and Pinus echinata appear to be long-standing and occur on middle and lower leads and extend into draws on low-lying, gently sloping ridges dominated by Fullerton soils and cherty dolomitic of the Knox Group (community 9, Figure 1A). Permanence of the community on the leads is suggested by presence of P. echinata in the understory but the species is absent in the understory of the sampled draws. The occurrence of pine as a major constituent on these sites is not expected in old growth communities, and white oak-shortleaf pine communities are seldom recognized in deciduous forest communities (cf. Safley, 1970 in second growth forests). The S.A.F. (1954) recognized a shortleaf pine-white oak cover type as a variant of the shortleaf pine-oak type 76 on well-drained, deeper soils of mesic sites; these communities could also be considered local variants. However, they may be stable on xeric sites (Braun, 1950) and in the southern edge of the Ridge and Valley where periodic ice storms apparently perpetuate other pines ad major constituents. (Lipps, 1966).

White oak-Virginia pine communities on cherty dolomite sites and on non-calcareous shale (Figures 1A and C) also appear to be old-growth. In comparison with communities in which P. echinata is a codominant, these are xeric sites with fewer species, more open canopy and lower productive potential. The permanence of these communities is usually questionable. The community on the non-calcareous shale (Figure 1C; a valley site) has low density and high basal area with pine in the understory and the community on the upper slope of a dolomite ridge (Figure 1A) has not been logged in 75 years (Martin, 1971).

One community dominated by Quercus alba and Liriodendron tulipifera is recognized and confined to the depressions of terraces and Emory soils (community 10; Figure 1B). Slope position and aspect indicate a mesic habitat supporting mesophytes such as the codominant Liriodendron, Q. rubra, Liquidambar styraciflua and Carya cordiformis. The latter two species are particularly restricted to mesic sites such as north aspects and/or coves in the Cumberland Mountains (Braun, 1950) and in other areas indicative of moist, fertile conditions (Auten, 1945; Caplenor, 1968; Clark and Losche, 1969).

In the Ridge and Valley section of Virginia, Braun (1950) observed that Q. alba was usually the dominant tree on mesic slopes and that Liriodendron was an important constituent. The more mesic valley flats were characterized by representatives of mixed mesophytic forests while white oak-tulip poplar communities dominated the gentle lower mountain slopes. Q. velutina was considered the third most important constituent on these mountains slopes. Communities dominated by Q. alba and Liriodendron may be common in this physiographic province but site and taxonomic differences exist which do not permit prediction of pattern and/or location.

SUMMARY AND CONCLUSIONS

In the Great Valley of East Tennessee diverse geologic units, soil and topography result in numerous micro- and macroenvironments that influence the development of a diverse vegetation. Ridge and valley topography and indirect effects of slope aspect, angle, shape (form), and position are major environmental factors and a constant consideration in analyzing plant community and soil development. Stone volume and soil texture are soil properties that seem most important as they affect vegetation by modifying water and nutrient availability. Soil chemical properties need to be analyzed in more detail to determine their relation to species distribution and community composition.

When old-growth forests alone are considered from the vegetational matrix of this long-inhabited region, variation in forest composition is quite complex. The major species exerting the greatest effect in community development and composition are the widespread oaks and, to a lesser degree, the hickories. Communities dominated by Q. alba are the most widely distributed, but there is considerable variation in codominants, species richness and tree size and number. In general, these communities dominate sub-xeric to mesic habitats that form a large percentage of the land area: soils and slopes associated with dolomitic limestone and limestone of low-lying hills and ridges; hills and valleys of moderate relief characterized by non-calcareous shales; areas with deposits of alluvium on terraces of old, abandoned flood plains. Forests dominated by this oak and oak and hickory codominants were undoubtedly more widespread in the past.

Communities of the White Oak Complex can be correlated with recognized commercial types and forest communities elsewhere in this physiographic province and the southern Appalachians. In many communities, *Castanea dentata* was a former major constituent, particularly on drier sites. It may have been a common codominant with *Quercus alba* or the leading dominant in some areas. Its removal by blight in the 1930's temporarily disrupted forest composition, but this opened niche was rapidly filled by representatives from the diverse, attendant gene pools. It appears that *Q. alba* has occupied this niche or partitioned the niche with species such as *Q. prinus*. In the central portion of the Great Valley (at the very least) removal of *Q. alba* would probably be equally or more disruptive to contemporary forest ecosystems.

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