FOREST COMMUNITIES OF DISSECTED UPLANDS IN THE GREAT VALLEY OF EAST TENNESSEE

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ABSTRACT

Upland sites in the Ridge and Valley physiographic province of Tennessee are occupied by several distinct forest communities which reflect the geologic, edaphic and topographic complexity of the region. Communities dominated by Quercus prinus L. occupy some of the driest upland sites, such as the top of prominent ridge systems. Quercus alba L. is usually a dominant on open slopes in the most dissected areas but is most widespread on rolling topography. In certain upland areas, forests on steep slopes with shallow soils are dominated by Fagus grandifolia Ehrh. and/or other species of the mixed mesophytic forest.

Soil and topographic properties appear to strongly influence this array of communities. Communities can be recognized on the basis of slope aspect, position and form and physical properties of associated soils. In this study, stepwise multiple regression is also used to relate individual tree species to selected soil-site parameters. Generally, the chestnut oak and mixed mesophytic communities recognized in this study have a high floristic similarity with other southern Appalachian forests having the same dominants. Similarities are highest in comparisons that consider the Cumberland Mountains and Plateau. Internal constancy is lower in the Valley mixed mesophytic forests than in chestnut oak forests because of more variable site conditions.

INTRODUCTION

The once-continuous, stable deciduous forest that covered the Southern Appalachians exists today as remnants. In the Great Valley of east Tennessee, the few existing remnants are in danger of disappearing as logging, agricultural expansion, and urban sprawl continue with few

checks. As a part of our understanding of ecosystems, it is essential that these remnants be investigated, since this natural vegetation can be used to identify biological response to environmental conditions where human influence has been minimal.

The objectives of this paper are to 1) describe two major components - chestnut oak and mixed mesophytic forest - of old-growth upland forest communities associated with dissected landscapes in the Great Valley of East Tennessee, 2) relate composition to soil and site properties, and 3) assess the relationship of these communities to similar vegetation in the Southern Appalachians.

THE STUDY AREA

The Great Valley in East Tennessee (Ridge and Valley physiographic province) occupies a central position in the Southern Appalachians and in the Eastern Deciduous Forest. The study area is a six-county unit in the central portion of the Great Valley, approximately 6400 km^2 in area. Geographically, it lies between 36°00' and 36°30' north latitude and between 83°30' and 84°30' west longitude. Approximate elevation ranges from 225 - 420 m above mean sea level.

Climate is temperate continental with a mean annual temperature of approximately 15°C, a mean annual precipitation of approximately 1200 mm, and an average growing season of about 205 days. Regional climate is modified by the proximity of the Cumberland Mountains and Plateau on the north and west, respectively, and the Smoky Mountains on the east as they affect air flow.

The Great Valley is a complex, furrowed system of parallel ridges and valleys trending northeast and southwest. Folding, faulting, thrusting, and erosion of the Paleozoic strata has produced landforms with complex structure and variable lithology.

The dominant sedimentary rock types are cherty dolomitic limestones, dolomitic limestones, and non-dolomitic sandstones; calcareous and non-calcareous shales; and siltstones. In the study area, the exposed strata represent a geologic time period from early Cambrian to middle Ordovician. Most of the soils have formed from residuum, colluvium or alluvium derived directly or indirectly from these Paleozoic rocks. The 76 soil series recognized in the counties of the study area accentuate the substrata complexity. One county alone has 36 series, with over 100 phases. Most upland soils are members of the Ultisol and Inceptisol soil orders; Ultisols and the suborder Udults are the most characteristic.

The study area is floristically rich and provides habitats for over 1000 vascular taxa (a conservative estimate); two of the counties in the study area have a known tree flora of 67 species (Mann and Bierner 1975). Most of the tree species of the uplands are widely distributed locally,

in the southern Appalachians and in the Eastern Deciduous Forest. Oak and hickory are the major taxonomic dominants in the region and the complexity of the oak taxa has long been recognized. Braun(1950) placed most of the physiographic province in the Oak-Chestnut Forest Region and noted the dominance of Quercus alba L. in forests of the Great Valley. A vegetational complex of white oak communities is the predominant old-growth forest in the study area. They comprise an estimated 40 percent of these forests and a substantial portion of second-growth stands (Martin 1971).

Indians have long occupied the Great Valley but the arrival of the Europeans in the 18th century initiated the extensive and intensive logging for homes and industry that continues to this day. Despite heavy utilization, forests are still wide-spread and presently occupy approximately 45 percent of the land area. This percentage has remained constant in the face of timber demands because of rapid regrowth following cutting, and the development of forest on abandoned agricultural land. The most extensive forest is on the dissected uplands where pastures and agriculture fields are not as productive as in valleys.

METHODS

Old-growth forest stands ranging in area from 0.4 to 12 ha were selected in Blount, Knox, Loudon, Monroe, Roane and Sevier counties in the middle portion of the Great Valley of East Tennessee.

Uneven-aged stands selected for study were free of artificial disturbance during the past 40 years. Absence of disturbance could not always be a certainty because selective tree removal (including removal of dead chestnut) has often occurred in the oldest stands. Selection was based on the presence of several trees with relatively large bole diameter (≥ 45 cm dbh) and the absence of even-aged groups of trees of similar height and diameter. An attempt was made to locate stands in association with each geologic-parent material type and on different slope aspects, slope forms and slope positions. Individual stands were generally associated with one soil-parent material unit; however, if more than one was present, samples were obtained from each unit.

In each stand, circular 0.04 ha plots were established at least 20 m from the forest edge; plot radii were adjusted for slope angle. In each plot, all trees ≥12.5 cm dbh were counted by species and dbh recorded to the nearest 2.5 cm. These data were used to calculate relative density and basal area. These two values were summed and multiplied by 100 to provide an importance value (IV = 0-200).

At each plot, slope characteristics recorded were form, position, angle, and aspect. In selected stands that represented each soil-parent material unit, soil data including thickness of A_1, A_2 +A_3 and B horizons, depth to bedrock or 105 cm (auger length), stone volume for the

profile, and depth to mottling (gray or olive colors) were recorded. Soil samples were collected for pH determination and textural estimates of A, B, and C horizons. Textural estimates of A and B horizons were made by the "feel" method and compared with samples analyzed by the hydrometer method (Day 1956). If there was significant variation between the two methods, all textural estimates for that soil series were adjusted using hydrometer data. From the texture data, water holding capacity of all soil profiles was calculated from information provided by Longwell, et al. (1963); the percentage of total soil volume occupied by coarse fragments was subtracted during calculation.

From topographic maps, additional site data were estimated. Two of these estimates that appear in regression equations herein were site relief (range 0-100 m) and size of the topographic unit. The latter value is an area measurement of the major landscape unit with which the forest stand was associated.

Simple linear regression and multiple step-wise regression programs at the University of Tennessee Computing Center were used to relate vegetational characteristics (i.e., total basal area and density, and IV of major overstory tree species) to soil and site parameters. Simple linear correlations were performed by BMD02D with item deletion, and multiple, step-wise regression analysis was conducted with step-wise regression program, BMD02R modified for item deletion. After graphed data suggested non-linear relationships between vegetational and soil-site variables, data transformations were made which included logarithmetic, inverse, and squared terms; program BMD02D was used in this analysis.

RESULTS AND DISCUSSION

The dissected uplands of the Great Valley reflect the geologic and edaphic complexity that is typical of the whole ridge and valley system (Table 1). With the exception of some sites underlain by cherty dolomitic limestone dominated by the Knox Group, all of these upland units have prominent relief.

Calcareous shale (or "slate") "knobs" are located in the easternmost edge of the Valley as distinct features following the trend of the other ridge systems. The predominant Dandridge soils of these knobs are shallow to bedrock, while soils of the Whitesburg series have developed in the deeper colluvium on lower slopes and in draws.

Rome Formation ridges are long, parallel northeast-southwest ridges that are most numerous in northwest and western parts of the valley. Their "comby" appearance is due to an undulating ridge line reflecting the differential erosion of the more easily-weathered shale in the gaps and the resistant sandstone of the crests. Residual soils that occupy the ridge crests and upper slopes are usually shallow soils of the Lehew and Ramsey series. Deeper colluvial soils, the Jefferson, Allen, and Hayter series, develop on the lower slopes and in the draws.

The ridges and rolling uplands underlain by cherty dolomitic limestone (especially the Knox Group) occupy 33-40 percent of the region (Case 1925). The Knox Group occurs between the higher Rome ridges and its highly weathered, reddish, cherty soils of the Fullerton and Clarksville series are easily recognized as dominant soils of forested and agricultural land. Calcareous sandstone rock units (also called knobs) are evident in the eastern portion of the valley and south of Knoxville with red soils that are several meters thick, and virtually free of coarse fragments.

Table 1. Major representatives of soil Great Groups, parent materials, topography, geologic mapping units, and soil series on dissected uplands 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	Dystrochrepts from sandstone and shale	Prominent ridges	Rome Formation, interbedded sandstone and shales	Allen, Hayter Jefferson, Lehew, Ramsey
3	Paleudults from cherty dolomitic limestone	Ridges to rolling	Knox Group: Chepultepec, Copper Ridge, Kingsport, Longview, Mascot dolomites	Bolton, Clarksville, Dunmore, Fullerton, Greendale, Landisburg, Minvale
4	Rhodudults from calcareous sandstone	Knobs or ridges	Chapman Ridge sandstone	Alcoa, Neubert, Steekee, Tellico

Chestnut Oak Communities

Although white oak communities predominate in the old-growth forests of the Great Valley, large segments of upland forest are dominated by other species and vary significantly in composition from white oak forests. Two of these vegetation components are chestnut and mixed mesophytic forest communities, the subjects of this paper. These results are condensed from Martin (1971) with the chestnut oak communities compiled

from 16 community variants and the four mixed mesophytic communities compiled from 11 variants.

Chestnut oak communities are most evident on middle and upper north and southeast-facing slopes on ridges associated with the Rome Formation, on lower elevation ridges underlain by cherty dolomitic limestone of the Knox Group, on the calcareous shale knobs, and on the ridge areas underlain by calcareous sandstone (Table 2). As a permanent forest type in the Great Valley, they are probably second in areal extent to the white oak communities. Among all chestnut oak communities, average density is 296.0 stems/ha and average basal area is 23.0 m^2/ha. Overstory tree species in the communities number 10 to 28.

Rome Formation sites have the greatest concentration of chestnut oak communities. Also, dominance by Quercus prinus L. is greatest on these sites with IV ranging between 30 and 50.

Recognition of three major chestnut oak communities (communities 1-3, Table 2) is based on the relative contributions by other species among sites with similar soils and parent material. In all three communities, the most common associated species are Quercus velutina Lam., Liriodendron tulipifera L., Q. alba and Pinus echinata Mill. Hickory species collectively have an IV of less than 20.

Considerable variation in composition may exist on sites of similar aspects. For example, stands in draws on southeast slopes (community 1) have a high dominance of Q. prinus while the community on leads (community 2) has a substantially higher proportion of Q. velutina and Q. alba. Similarly, on all slope positions on the leads, Q. velutina is second in importance followed by Q. alba and other oak, pine and hickory species (community 2), while the total contribution to IV by these three groups declines on the draw sites (community 3). Liriodendron tulipifera is more important in the draws regardless of aspect although Q. velutina and Q. alba are still important in number and size relative to most of the remaining overstory species.

Chestnut oak communities associated entirely with middle and upper lead positions on north slopes (communities 4-6, Table 2) differ from those communities on the Rome ridges chiefly through an increased proportion of hickory and a decline in oak richness.

Hickory IV is at least 20 in all of these communities. On calcareous shale sites, Carya glabra (Mill.) Sweet and Carya carolinae-septentrionalis (Ashe) Engl. & Graebn. account for more than 20 percent of total IV. Carya glabra, second in importance to Q. prinus, is the most common hickory throughout the Great Valley, while the knob areas were the only sites in this study where C. carolinae-septentrionalis was recorded. On the upper slopes of ridges characterized by calcareous sandstone bedrock and Tellico soils (community 5), Carya ovalis (Wangenh.) Sarg. and C. glabra contribute almost 40 percent of the total IV and may be considered co-dominants with Q. prinus.

Table 2. Major chestnut oak communities in the Great Valley of East Tennessee.

	Community Number					
	1	2	3	4	5	6
	Soil-Parent Material Unit 1/					
	2	2	2	3	1	4
	Slope Aspect					
	NE;SE	NW;SE	NW;NNE	NW	NNE	NW
	Slope Position, Form 2/					
	M,Ul;L,M,Ud	L,M,Ul	M,Ud	M,Ul	M,Ul	Ul
	Mean Density (stems;ha)					
	250.0	325.0	275.0	375.0	325.0	250.0
	Mean Basal Area (m^2/ha)					
	18.0	23.0	23.0	25.0	21.0	28.0
	Total Number of Species					
	28.0	24.0	19.0	20.0	25.0	10.0
Species	Average Importance Value (IV = 200)					
Quercus prinus	94.0	65.0	76.0	66.0	56.0	60.0
Liriodendron tulipifera	18.0	8.1	31.0	20.0	18.0	14.0
Quercus alba	8.0	16.3	8.0	23.0	17.0	20.0
Carya glabra	6.0	4.3	9.0	8.0	26.0	34.0
Quercus velutina	7.0	28.2	23.0	7.0	3.0	0.0
Quercus rubra	6.0	7.9	4.0	16.0	13.0	10.0
Carya ovalis	2.0	3.0	2.0	6.0	1.0	41.0
Nyssa sylvatica	8.0	5.2	8.0	15.0	0.0	0.0
Pinus virginiana	4.0	6.2	4.0	3.0	18.0	0.0
Pinus echinata	6.0	17.8	4.0	2.0	1.0	0.0
Oxydendrum arboreum	4.0	4.2	6.0	10.0	0.0	0.0
Carya tomentosa	5.0	11.6	3.4	4.0	0.0	0.0
Quercus stellata	6.0	9.8	2.0	0.0	2.0	0.0
Carya ovata	0.5	0.0	0.0	3.0	9.0	0.0
Carya carolinae 3/	0.0	0.0	0.0	0.0	16.0	0.0
Quercus muehlenbergii	0.0	0.0	0.0	0.0	0.0	13.0
Robinia pseudoacacia	1.0	0.0	0.0	0.0	7.0	3.0
Miscellaneous 4/	24.5	12.4	19.6	17.0	13.0	5.0
	200.0	200.0	200.0	200.0	200.0	200.0

1/ Units as in Table 1.
2/ Slope position: L, lower; M, middle; U, upper; 1, lead; d, draw.
3/ *Carya carolinae-septentrionalis*.
4/ Species with IV ≤ 5.0 in any community; community number given in parenthesis: *Acer rubrum* (1,4,5); *Acer saccharum* (2,4,5); *Aesculus octandra* (2); *Carya cordiformis* (1,5); *Cornus florida* (1,2,4,6); *Fagus grandifolia* (1,4,5); *Fraxinus americana* (1,3,4,5,6); *Juglans nigra* (1,2,3,4,5); *Juniperus virginiana* (2,5); *Liquidambar styraciflua* (1,2); *Morus rubra* (3,5); *Pinus strobus* (1,2); *Quercus falcata* (1,2); *Quercus marilandica* (1,2); *Sassafras albidum* (1,2,3,4); *Tilia heterophylla* (3); *Ulmus alata* (5); *Ulmus americana* (1).

Quercus alba and Quercus rubra L. are major components in these chestnut-oak communities; Quercus coccinea Muench., Q. velutina, Quercus falcata Michx., Quercus stellata Wangenh., and Quercus marilandica Muenchh. are much less important or may be absent entirely. Quercus muhlenbergii Engelm., an important oak species in one community (6), is absent in the others and appears to be infrequent in other old growth forests except in limestone valleys of the Great Valley.

Most soils associated with chestnut oak communities have deep to moderately deep, well-drained sola; exceptions are those soils of the Dandridge series derived from calcareous shale (Table 3). With the exception of the Tellico soils derived from calcareous sandstones, stone content is high in all soils, thus reducing water availability even though soil depth and texture may be quite favorable for water retention (as in the deep, silt loam-textured Fullerton and Clarksville soils derived from cherty dolomitic limestone). Soils (Ramsey, Jefferson) derived from non-calcareous sandstone of the Rome Formation are more coarse-textured throughout than other soils. In all soils, clay content increases in the B horizon leading to the development of a silt loam to clay subsoil. This type of development is expected and, with the exception of the high clay subsoil derived from calcareous sandstone, water availability would probably be improved significantly if texture alone determined the amount and availability of soil moisture. All soils are acid throughout and this chemical property indicates relatively low base status among the chestnut oak communities.

The shallow sola derived from the calcareous shale also have high stone content and these two properties lead to the lowest water availability in any of the communities. Potential availability is reduced further by the steep, 60 percent slopes. On these sites, these properties that reduce soil moisture are counterbalanced by downslope seepage, frequent north aspect and usual near proximity of opposite ridges (protection).

Mixed Mesophytic Communities

On areas occupied by chestnut oak and white oak communities, upslope oak contribution may decline significantly on lower slopes where the forests are dominated by Fagus grandifolia Ehrh. or characterized by several important species. In either case, we have considered them representative communities of mixed mesophytic forest in the Great Valley (Table 4). These communities are more limited in distribution than chestnut oak forests, and now form an estimated 10-15 percent of contemporary forests in the region.

Fewer ($\bar{x}$ = 260 stems/ha) and smaller ($\bar{x}$ = 18 m^2/ha) trees are at present associated with these forests compared to chestnut oak and white oak communities. The total number of overstory species is slightly less in these communities than in those dominated by oaks (smaller sample size) and there are considerable shifts in vegetational composition.

Table 3. Average soil properties of chestnut oak communities.

	Community Number 1/					
	1	2	3	4	5	6
	Soil-Parent Material Unit 2/					
	2	2	2	3	1	4
Soil Variables	Community Values					
Thickness of A_1 horizon (cm)	4.0	4.0	3.0	2.0	0.0	2.5
Thickness of $A_2 + A_3$ horizon (cm)	12.0	21.0	16.0	12.5	5.0	5.0
Depth to bedrock (cm)	98.0	83.0	≥105.0	≥105.0	47.5	≥105.0
Depth to mottling (cm)	98.0	80.0	≥105.0	≥100.0	47.5	≥105.0
Sand in A horizon (%)	40.0	44.0	47.0	22.0	37.0	30.0
Silt in A horizon (%)	41.0	39.0	41.0	53.0	43.0	55.0
Clay in A horizon (%)	19.0	14.0	12.0	23.0	19.0	15.0
Sand in B horizon (%)	32.0	29.0	23.0	14.0	25.0	15.0
Silt in B horizon (%)	46.0	46.0	57.0	46.0	51.0	15.0
Clay in B horizon (%)	22.0	25.0	21.0	38.0	23.0	70.0
Stone volume (%)	34.0	42.0	45.0	24.0	45.0	0.0
Available water (cm)	13.0	13.0	12.0	15.0	5.0	17.0
pHA	5.4	5.0	5.4	5.1	4.3	4.1
pHB	4.3	5.1	5.6	--	4.2	4.2
pHC (or at 105 cm)	5.1	5.2	5.6	4.4	3.9	4.2

1/ Community Number as in Table 2.

2/ Unit as in Table 1.

Communities clearly dominated by *F. grandifolia* (communities 1, 2) appear to be associated entirely with the shale knobs portion of the Great Valley in north-facing draws and on lower and middle leads (Martin 1971).

In these knob communities, several oak species occur in the overstory, but *Q. alba* and *Q. rubra* are most important. Species that were occasionally represented in the oak communities, *F. grandifolia* and *Acer saccharum* Marsh., are important here and contribute significantly to total IV. Hickory is also common although *Carya tomentosa* (Michx. F.) Loud. and/or *C. ovalis* are more important than *C. glabra*. In the oak and mixed mesophytic communities, the contribution by hickory to IV is mostly by density rather than basal area (Martin 1971).

Table 4. Mixed mesophytic forest communities in the Great Valley of East Tennessee.

	Community Number			
	1	2	3	4
	Soil-Parent Material Unit 1/			
	1	1	2	3
	Slope Aspect			
	NW	SE	NW	NW
	Slope Position, Form 2/			
	L1;L,M,Ud	L,M1	L,M1	L1,d
	Mean Density (stems/ha)			
	225.0	250.0	275.0	375.0
	Mean Basal Area (m^2/ha)			
	18.4	11.5	20.7	23.0
	Total Number of Species			
	26.0	15.0	13.0	23.0
Species	Average Importance Value (IV = 200)			
Fagus grandifolia	67.0	71.0	26.0	9.0
Quercus alba	22.0	45.0	20.0	6.0
Acer saccharum	16.0	14.0	26.0	35.0
Tilia heterophylla	0.6	0.0	25.0	17.0
Quercus prinus	4.0	0.0	34.0	8.0
Quercus rubra	21.0	7.0	4.0	12.0
Carya ovata	4.0	0.0	18.0	22.0
Aesculus octandra	4.0	0.0	23.0	10.0
Carya tomentosa	13.0	21.0	0.0	0.0
Liriodendron tulipifera	9.0	4.0	3.0	11.0
Carya ovalis	0.0	16.0	3.0	4.0
Carya glabra	7.0	2.0	0.0	15.0
Platanus occidentalis	1.0	0.0	0.0	18.0
Fraxinus americana	0.0	0.0	9.0	5.0
Pinus virginiana	11.0	2.0	0.0	0.0
Juglans nigra	0.7	0.0	6.0	6.0
Carya cordiformis	0.6	0.0	0.0	5.0
Pinus echinata	7.0	0.0	0.0	0.0
Acer rubrum	1.0	5.0	3.0	0.0
Ulmus americana	0.4	0.0	0.0	5.0
Miscellaneous 3/	10.7	13.0	0.0	12.0
	200.0	200.0	200.0	200.0

1/ Units as in Table 1.
2/ Slope position: L, lower; M, middle; U, upper; 1, lead; d, draw.
3/ Species with IV ≤ 5.0 in any community; community number given in parenthesis: Betula allegheniensis (4); Carpinus caroliniana (4); Liquidambar styraciflua (1,4); Morus rubra (1); Nyssa sylvatica (1,4); Oxydendrum arboreum (1,2,4); Prunus serotina (1); Quercus coccinea (2); Quercus muhlenbergii (1); Quercus stellata (1,2); Salix nigra (4); Sassafras albidum (2); Ulmus alata (1,2).

The mixed mesophytic forest "indicators", a mixture of hardwood mesophytic species including Aesculus octandra Marsh. and Tilia heterophylla Vent. are rare in the knob region, but elsewhere in the Great Valley these develop more commonly on lower slopes (communities 3 and 4). On the Rome (community 3), they exist as an alternative to chestnut oak and white oak forests communities on middle and lower slopes. Quercus prinus is an important member of these mixed mesophytic communities and becomes dominant on upper slopes. On these ridges, Q. alba is well-represented as an important member throughout the overstory regardless of soil or site characteristics.

The difference in composition between the mixed mesophytic communities of the lower slope and the oak communities can be simply described. Of the 18 mesophytes listed by Braun (1950) as widespread components of the mixed mesophytic forest, 11 contribute at least 5.0 to total IV of valley mixed mesophytic communities, but only three, Q. alba, Q. rubra and L. tulipifera, are present to that level of importance in the oak-dominated communities.

Communities on north-facing cherty dolomitic limestone ridges (community 4) are similar in species composition to the mixed mesophytic forests recognized in the other environments. Reduced importance of F. grandifolia is obvious, but the total contribution by other mesophytic taxa remains high. The community seems to occupy a limited area on this major upland feature of the Great Valley. Other draw sites associated with different aspects and slope positions are characterized by Q. alba and L. tulipifera (Martin 1971).

In the knobs area (communities 1, 2), the amount of available soil water is difficult to predict on mixed mesophytic community sites due to varying soil depth, percentage of coarse fragments, and soil texture (Table 5). The steep slopes have promoted the accumulation of more colluvium in draws than on lower slopes, thus resulting in sola with a higher percentage of small-sized particles. These steep slopes have also promoted surface runoff and rapid internal drainage which lowers the actual amount of water available, but the amount of water lost in this manner from these communities may be replaced in part by seepage, and, on lower slopes, drainage from upslope.

If long periods of available soil moisture are a requirement for establishment and survival of these mesophytes, then other environmental factors besides soil properties must be considered in the case of the mixed mesophytic community on the lower slopes of Rome ridges (community 3). Although the soils are deep and fine-textured, the high percentage of coarse fragments greatly reduces the amount of water retained. Presumably slope position, aspect, and topographic protection decrease moisture stress. The slopes are generally steep (>60 percent).

Soils associated with mixed mesophytic communities on the cherty dolomitic limestone sites (community 4) show few differences from those of chestnut oak communities. The lower acidity of these soils reflects

the parent material differences and litter from the latter community. Differences in soil properties are not as great as differences in other site characteristics between the two communities.

Table 5. Average soil properties of mixed mesophytic forest communities.

	Community Number 1/			
	1	2	3	4
	Soil-Parent Material Units 2/			
	1	1	2	3
Soil Variables	Community Values			
Thickness of A_1 horizon (cm)	1.5	0.0	7.5	2.5
Thickness of $A_2 + A_3$ horizon (cm)	7.0	7.5	30.0	6.0
Depth to bedrock (cm)	55.0	≥105.0	≥105.0	≥105.0
Depth to mottling (cm)	51.0	≥105.0	≥105.0	≥105.0
Sand in A horizon (%)	18.0	35.0	20.0	17.0
Silt in A horizon (%)	56.0	40.0	55.0	53.0
Clay in A horizon (%)	22.0	25.0	25.0	31.0
Sand in B horizon (%)	17.0	15.0	15.0	9.0
Silt in B horizon (%)	44.0	52.0	65.0	53.0
Clay in B horizon (%)	39.0	32.0	20.0	38.0
Stone volume (%)	19.0	15.0	60.0	29.0
Available water (cm)	9.0	17.0	8.0	16.0
pHA	5.5	3.6	4.3	6.7
pHB	4.7	4.3	5.5	6.0
pHC (or at 105 cm)	5.0	4.1	5.5	6.4

1/ Communities as in Table 4.
2/ Units as in Table 1.

Community Similarity and Diversity

Chestnut oak and mixed mesophytic forests are recognized as major vegetation units throughout the Southern Appalachians, and it is also recognized that overstory composition varies widely between these communities. A floristic comparison of regional representatives of chestnut oak and mixed mesophytic communities with collective Valley samples provides insight into this vegetational complexity (Table 6). In general, chestnut oak communities of other areas show less similarity to Valley communities relative to mixed mesophytic representatives. This suggests that these chestnut oak forests have low predictability with regard to composition although such forests are associated with dry, infertile, exposed sites that presumably select against many forest species. The higher values of similarity among mixed mesophytic communities argues for compositional consistency within these forests as believed by Braun (1950). It is interesting to note that the limited samples from other

Valley locations show the lowest similarity in both communities. In addition to accentuating vegetation variability, these differences in Valley forests may also suggest that significant floristic shifts occur within a few km of latitude.

Table 6. Indices of similarity between communities of dissected uplands of Great Valley of East Tennessee and those of other Southern Appalachian sites.

Region, State, Researchers	Similarity Percentages 1/	
	Chestnut Oak	Mixed Mesophytic
Ridge and Valley		
Georgia (Lipps 1966)	16.0	--
Virginia (Braun 1950)	--	25.0
Virginia (Stephenson 1974)	23.0	--
Cumberland Plateau		
Kentucky (Martin 1975)	50.0	54.0
Tennessee (Caplenor 1965)	19.0	41.0
Cumberland Mountains		
Kentucky (Braun 1950)	34.0	51.0
Tennessee (Martin 1966)	38.0	68.0
Tennessee (Cabrera 1969)	42.0	45.0
Tennessee/Kentucky (Safley 1970)	40.0	55.0
Blue Ridge Mountains and Foothills		
Tennessee (Chapman 1957)	21.0	31.0
Tennessee (Whittaker 1956)	34.0	37.0
Tennessee (Thomas 1966)	47.0	40.0

1/ Jaccard index: C/A + B - C x 100 where C = number of common species in the two communities, A and B = species only in Great Valley and the compared communities, respectively.

Similarity comparisons among Valley communities reported herein also show considerable variability with values ranging from 22-70 percent in the chestnut oak communities (Table 2) and 27-54 percent in the mixed mesophytic communities (Table 4). Both communities, then, show low compositional consistency in the Valley and in comparison with "similar" communities elsewhere in the Southern Appalachians. A major feature that influences this variability is undoubtedly caused by different edaphic, geologic, topographic and microenvironmental situations; less well-defined causal factors are the various long and short-term histories of these communities.

In addition to similarity evidence, high species richness in the overstory of chestnut oak and mixed mesophytic communities (Tables 2 and 4; mean number of species is 21 and 19 respectively) also implies high

species diversity. Calculation of Simpson's index of diversity (Simpson 1949) reveals that Valley chestnut oak and mixed mesophytic communities are equally diverse and even indicate higher levels of community diversity relative to similar vegetation that permits comparison (Table 7). The Cumberland Mountains and Plateau exhibit high diversity as viewed by Braun (1950), and she considered the all-deciduous mixed mesophytic communities and the sugar maple-basswood-buckeye association-segregates to be exemplary communities of this complexity (Braun 1950; Tables 1 and 2). Contemporary Great Valley communities on the dissected uplands are at least comparable to them and significantly more diverse (and less predictable) than the other vegetation outside of the Cumberlands in Kentucky. Beech (see footnote, Table 7) and chestnut oak segregates (Braun 1950; Tables 3 and 7, respectively) indicate far more dominance than Valley communities, although mixed mesophytic communities of the Valley are characterized by F. grandifolia. Since Braun's view of the chestnut oak community as a distinct vegetation feature of the Cumberlands was narrow in comparison with her concept of the all-deciduous mixed mesophytic community, it is not surprising that the two communities would show little similarity in diversity in that portion of deciduous forest. That the chestnut oak and mixed mesophytic communities of the Great Valley are equally diverse, and at least as diverse as neighboring communities in the Cumberlands and Blue Ridge foothills may seem unusual. However, the occurrence of these communities across a wide range of environmental conditions coupled with these diversity values lends support to the concept that environmental diversity promotes community and species diversity. In combination with stand history and existing information on environmental factors, these data provide insight into the degree of complexity of this portion of the Ridge and Valley province and the Southern Appalachians.

Multiple Regression Analysis

From simple correlation matrices between and among soil, site and vegetation measurements, IV values of major tree taxa were used as dependent variables in step-wise multiple regression analysis. Twelve single soil and site measurements were selected as independent variables. Seven soil and site features that show significant intercorrelation were included as interaction terms. In addition, the squared terms of each soil and site variable were tested; preliminary simple correlations indicated that logarithmetic and inverse terms were of little value. Three equations have been selected as examples predicting IV of the major forest dominants (Table 8). Variables that contribute less than 1 percent to total R^2 have been excluded from the equations.

The R^2 of the predictive equation of Q. alba shows that little variation has been accounted for by these variables. Available water and slope angle are the most important predictors in the equation and account for over 70 percent of total R^2. The equation illustrates the relationship between this taxon and deep soils especially on gentle topography. Somewhat similar results were seen by Smalley (1967) and Hannah (1968).

Table 7. Diversity values of chestnut oak and mixed mesophytic communities in selected Southern Appalachian locations.[1/]

Region, State, Researchers	Range in Simpson Index Values	
	Chestnut Oak	Mixed Mesophytic
Ridge and Valley		
Tennessee (Martin and DeSelm, this paper)	0.11 - 0.19	0.09 - 0.20
Cumberland Mountains and Plateau		
Kentucky (Braun 1950)	0.20 - 0.45	0.13 - 0.53 [2/]
Tennessee (Cabrera 1968)	0.67 - 0.80	-- --
Blue Ridge Foothills		
Tennessee (Thomas 1966)	0.87 --	-- --

1/ Simpson's index of diversity = $1 - \sum_{i=1}^{s} ({}_p i)^2$, where ${}_p i$ is relative density of a species in a community; values closer to 1.0 indicate greater dominance and less diversity.

2/ All values above 0.29 occur in the beech communities.

Table 8. Predictive multiple regression equations for importance values of three forest dominants in the Great Valley of East Tennessee.

Species	Regression equations [1/]
Quercus alba	Y = 69.22 + 0.666 AW - 0.316 SA - 0.335 pHC - 0.638 DR n = 377; R^2 = 0.10; $\bar{Y} \pm$ S.E.E. = 59.95 ± 38.14
Quercus prinus	Y = 100.13 + 1.034 SA + 1.128 TU - 0.376 SP - 1.156 pHA + 0.024 SP x A23 - 0.007 SA x As - 0.314 pHC n = 204; R^2 = 0.23; $\bar{Y} \pm$ S.E.E. = 76.18 ± 44.19
Fagus grandifolia	Y = 113.290 - 1.273 DR - 0.737 Bc + 0.311 SP - 0.163 R + 0.310 SA n = 102; R^2 = 0.35; $\bar{Y} \pm$ S.E.E. = 44.36 ± 31.69

1/ Abbreviations for independent variables (X_i): AW = available water; SA = slope angle; pHC = pH of C horizon; DR = depth to bedrock (or 105 cm); TU = topographic unit size (in km); SP = slope position; pHA = pH of A horizon; SP x A23 = slope position -A_2 + A_3 horizon thickness interaction; SA x As = slope angle-percent sand in A horizon interaction; Bc = percent clay in B horizon; R = relief.

Steep slope angles and large topographic units (major Valley ridge systems) account for most of the variation in the Q. prinus equation. The remaining variables contribute one percent to the total R^2. Although the equation does not clearly predict Q. prinus IV, it does suggest that environmental variation associated with topographic factors may be more influencial in determining density and stem size than are soil properties. This is of considerable interest since they are much more easily obtained than soil data. Direct relationships between upper slope positions and steeper slopes implies drier sites and inverse relationships between the species and higher pH implied association with areas of low base status. In southern Illinois, at the edge of the species' range, regression equations for Q. prinus accounted for 80 percent of the variation with similar independent variables (Myatt 1975).

The predictive equation developed for F. grandifolia IV has the highest R^2 value calculated for any selected overstory species. The negative relationship between IV and soil depth accounts for a significant portion of the total variation. Although this appears anomalous with the usual mesophytic designation of the species, this relationship occurs in the Great Valley where F. grandifolia dominance is best expressed on the variable depth soils in the shale knobs. The positive relationship to lower slope positions and steeper slope angles can also be related to those areas. The inverse relationship with relief lowers the reliability of the equation but is apparently an expression of the lower relief (low hills) of the knobs. The dependence of F. grandifolia growth on adequate soil moisture has been shown by Fritts (1960) but its propinquity for both shallow and deep soils reduces predictability (see also Safley 1970).

The correlation between F. grandifolia IV and shallow soils, steep, lower slopes may also be an indirect measure of its concentration on shale knob sites which are characterized by external site protection afforded by adjacent knobs. Similar conditions have been recognized elsewhere with regard to F. grandifolia concentration (Rasche 1958) and the decreased daily light duration and intensity, lower evapotranspiration and lower air and soil temperatures that would be associated with such protection may be sufficient environmental amelioration to allow persistence and dominance of mesophytes such as F. grandifolia.

SUMMARY AND CONCLUSIONS

In the Great Valley of East Tennessee, diverse geologic units, soils and topography result in development of numerous micro- and macroenvironments that influence the development of a diverse vegetation. Ridge and valley topography and the indirect effects of slope aspect, angle, form and position are constant considerations in analyzing plant community and soil development. The more resistant bedrock underlying the dissected uplands has interacted with climate and time to produce diverse topographic shapes and sizes and wide variation in soil properties.

In this paper, we have presented the chestnut oak and mixed mesophytic forest communities that appear to be chiefly associated with those land-forms with the greatest relief and dissection. These two community-types are widely distributed in the southern Appalachians (Braun 1950) with chestnut oak communities found on dry, exposed sites, and mixed mesophytic communities occurring in moist, protected draws, coves, ravines, and lower slopes.

Based on vegetation analysis alone, slope position and aspect seem to be two topographic variables influencing the distribution of chestnut oak communities in the Great Valley. On south-facing slopes of Rome ridges, these forests cover the slopes on the leads and in the draws, but on north-facing aspects, the communities are confined to middle and upper slopes and replaced by white oak and mixed mesophytic communities on lower slopes.

Mixed mesophytic communities are more limited in distribution and old-growth communities appear to be concentrated in one portion of the Great Valley. According to Braun (1950), mixed mesophytic communities in the Ridge and Valley province are restricted to cool, moist sites of small areal extent with fewer species than similar communities in forests of the Cumberland and Great Smoky Mountains. She considered F. grandifolia as a universal constituent and specifically mentions its dominance in coves of Clinch and Powell Mountains north of the study area. Based upon this study, mixed mesophytic communities are characterized by F. grandifolia domination, limited in distribution, and they are particularly associated with Dandridge soils and topography of the calcareous shale sites (knobs). Aesculus octandra and T. heterophylla, indicator species of mixed mesophytic communities, are minor constituents when communities are considered as a whole, but may be important constituents in individual communities. Collectively, these communities are diverse but they do not show any greater diversity than the chestnut oak communities.

In general, the amount of variation in the IV of major species accounted for by multiple regression analysis is of low order. Other attempts to employ this method of statistical analysis in extensive studies have met with similar difficulty in predicting plant response. Several factors seem to operate singly or in association with others that may give rise to the high degree of unaccountable variation. Those species included here have considerable ecological amplitude and cursory review of their distribution in eastern North America indicates a wide geographic distribution with the Great Valley in or near the center of their range. Hence, their ability to occupy a wide variety of sites greatly reduces population-habitat predictability. Second, the use of uneven-aged stands introduces a high standard of error of estimate that can be seen in the analysis. Third, inherent variation among independent variables, particularly soil variables, is undoubtedly high, and the independent variables selected may have been too indirect in measuring cause-effect relationships; the direct measurement of such parameters as soil moisture interacting with slope features should reduce unaccountable variation and more attention should be directed toward such measurements.

The vegetational complexity of the Great Valley is well-illustrated by the high species diversity among these communities and their limited floristic similarity to other Southern Appalachian forests. These communities can and do occupy a wide range of sites. Predictions regarding their location and attempts to associate them within a limited number of environments must be made with caution. In addition to locally high site variability, the past settlement effects of man have reduced forest area and disease (chiefly chestnut blight) and selection logging in remaining stands has greatly modified forest composition. Diversity has been reduced by these factors but this disturbance has also allowed other taxa (those with intermediate to shade-intolerant site requirements) to increase in the canopy resulting in increased diversity. As forest habitats continue to decline it is essential that this array of vegetation-habitat features is recognized in Valley forest management plans, land-use proposals, and the development of strategies to preserve and conserve natural areas.

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