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Structure and Composition of a Climax Mixed Mesophytic Forest System in Laurel County, Kentucky

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ABSTRACT

Rock Creek Gorge in Laurel County, Kentucky, is a deep, narrow gorge dominated by *Tsuga canadensis*, *Oxydendrum arboreum*, *Betula lenta*, and *Liriodendron tulipifera*, with *Rhododendron maximum* dominating the understory. Analysis of the forest showed the community to be stable and climax. The dominant tree species dominated sapling and seedling size classes. Slight variation was noted between vegetation on east- and west-facing slopes with hemlock having a lower density on west-facing slopes. The study site, composed of 76.5 ha, is estimated to support 329 trees/ha with an average basal area of 23.3 m²/ha.

INTRODUCTION

Much information has been gathered on the forests of the eastern United States in general, but little information can be found on the forests of the Commonwealth of Kentucky specifically. Rock Creek in Laurel County, Kentucky, was designated as a Natural Area by the U.S. Forest Service in 1939. It became a natural landmark registered by the U.S. Department of the Interior in 1975 providing a reference to a small portion of Kentucky's original vegetation. No extensive compositional studies of the area have been made although Braun (1950) cited Rock Creek as an example of gorge vegetation in hemlock mixed mesophytic forests. In her study, a random sample of

117 trees was taken to determine the composition of the gorge. Winstead and Nicely (1976) sampled the tree flora using the random pairs method but did not make any analysis of size classes of the woody vegetation.

The total natural landmark covers approximately 312 ha (770.64 acres) within the Daniel Boone National Forest adjacent to the Rockcastle River. The area of this study is a deep gorge. Map coordinates and a sketch of the area are included in Winstead and Nicely (1976). Discussions with field workers of the U.S. Forest Service indicated that logging activities in the Rock Creek Gorge took place only at the mouth of the gorge prior to 1938. An absence of stumps, logging trails, and the physical features of extremely steep slopes covered with immense boulders indicates that there has been very little disturbance by man

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within the boundaries of the area studied in this report.

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MATERIALS AND METHODS

Field work for determination of forest structure and composition was conducted between May and September 1975. To provide analysis of trees, saplings, and seedlings, 3 circular plots were established at each of 10 different sites within the gorge. Five sites were placed on either side

of the gorge bisected by Rock Creek. Sites were placed approximately 400 m apart in the upper three-fourths of the gorge so that all sample points were well away from the open end of the gorge and any area that might have been disturbed by logging activity. The concentric circular plots had diameters of 39.9, 28.22, and 19.95 m that provided areas of 0.125, 0.062, and 0.031 ha, respectively. All trees of 10 cm or greater diameter breast height (dbh) were measured and recorded in the 0.125-ha plots. Saplings, designated as woody plant species less than 10 cm dbh and greater than 50 cm in height, were counted and recorded in the 0.062-ha plots. Seedlings, woody plant species less than 50 cm in height, were noted and recorded in the 0.031-ha plots.

Due to the denseness of *Rhododendron* and *Kalmia*, 3-m diameter plots were used to count the stems above ground. Those plots and the sapling plots were then projected to 1 ha and analyzed together.

Data collected in the above manner provided for analysis of total numbers, relative

TABLE 1.—NUMBER (N), RELATIVE DENSITY (RD), RELATIVE DOMINANCE (RDo), RELATIVE FREQUENCY (RF), AND IMPORTANCE VALUE (IV) OF TREES SAMPLED IN SUM OF CIRCULAR PLOTS (1.25 HA) IN ROCK CREEK GORGE, LAUREL COUNTY, KENTUCKY

Species	N	RD	RDo	RF	IV
<i>Tsuga canadensis</i>	87	0.2106	0.4571	0.1052	0.7729
<i>Oxydendrum arboreum</i>	59	0.1428	0.0612	0.1052	0.3092
<i>Betula lenta</i>	46	0.1113	0.0908	0.1052	0.3073
<i>Liriodendron tulipifera</i>	32	0.0774	0.0797	0.0736	0.2307
<i>Ilex opaca</i>	34	0.0823	0.0248	0.1052	0.2123
<i>Acer rubrum</i>	28	0.0677	0.0493	0.0736	0.1906
<i>Magnolia macrophylla</i>	26	0.0629	0.0220	0.0947	0.1796
<i>Fagus grandifolia</i>	25	0.0605	0.0348	0.0736	0.1689
<i>Quercus rubra</i>	19	0.0460	0.0361	0.0526	0.1347
<i>Quercus alba</i>	12	0.0290	0.0396	0.0421	0.1107
<i>Quercus prinus</i>	10	0.0242	0.0256	0.0315	0.0813
<i>Nyssa sylvatica</i>	8	0.0193	0.0155	0.0315	0.0663
<i>Cornus florida</i>	6	0.0145	0.0025	0.0421	0.0591
<i>Pinus taeda</i>	5	0.0121	0.0256	0.0105	0.0482
<i>Pinus virginiana</i>	5	0.0121	0.0165	0.0105	0.0391
<i>Magnolia acuminata</i>	5	0.0121	0.0060	0.0210	0.0391
<i>Carya glabra</i>	4	0.0096	0.0050	0.0105	0.0251
<i>Aesculus octrandra</i>	1	0.0024	0.0045	0.0105	0.0174
Totals	412	0.9968	0.9966	0.9991	2.9925

density, and relative frequency of the various species in each size class. Diameter measurements of trees provided information for determination of relative dominance and basal area values. An importance value was then calculated for trees by totaling the values for relative density, relative frequency, and relative dominance. Only relative density and relative frequency were calculated for saplings and seedlings. Those values were summed to find the importance of the saplings and seedlings in their respective layers in the gorge.

Soil samples were taken at the center of each site at depths of 0–5 and 5–10 cm. Soil texture analysis followed the technique developed by Bouyocous (1936) using soil hydrometers. Determinations of pH, nitrate nitrogen, phosphorus, and potassium were made utilizing a standard LaMotte soil testing kit.

RESULTS

In Rock Creek Gorge, 18 tree species with individuals 10 cm or greater in diameter were present in the 1.25 ha sampled. Ranked according to importance values (Table 1), the 4 dominant species were: *Tsuga canadensis*, 0.7729; *Oxydendrum arboreum*, 0.3092; *Betula lenta*, 0.3073; and

TABLE 2.—NUMBERS OF TREES PER HECTARE AND BASAL AREAS (M²/HA) FROM SELECTED POSITIONS WITHIN ROCK CREEK GORGE COMPARED WITH THE EARLIER STUDY OF WINSTEAD AND NICELY (1976)

Location	Trees/ha	m ² /ha
Total gorge	329.6	23.3
East-facing slope	300.8	26.7
West-facing slope	358.2	19.9
Four plots closest to earlier study	368.0	26.4
Earlier study total	672.8	47.5

Liriodendron tulipifera, 0.2307. *Ilex opaca* had a higher number, relative frequency, and relative density than *L. tulipifera*, but a much smaller relative dominance.

A total of 412 trees having a total basal area of 29.1 m² was recorded in the 1.25-ha sampling area. On a per hectare basis, there were 329.6 trees, and the basal area was 23.3 m² (Table 2). The mean diameter at breast height of the trees sampled was 24.7 cm.

Twelve species were found on the cooler and wetter east-facing slope in 5 sites that totaled 0.625 ha. The 4 most dominant species were the same as those for the total gorge. The importance values were: *T. canadensis*, 0.9032; *O. arboreum*, 0.3053; *B.*

TABLE 3.—NUMBER (N), RELATIVE DENSITY (RD), RELATIVE DOMINANCE (RDo), RELATIVE FREQUENCY (RF), AND IMPORTANCE VALUE (IV) OF TREES SAMPLED IN SUM OF CIRCULAR PLOTS (0.625 HA) ON THE EAST-FACING SLOPE OF ROCK CREEK GORGE, LAUREL COUNTY, KENTUCKY

Species	N	RD	RDo	RF	IV
<i>Tsuga canadensis</i>	44	0.2340	0.5473	0.1219	0.9032
<i>Betula lenta</i>	24	0.1276	0.1227	0.1219	0.3722
<i>Acer rubrum</i>	22	0.1170	0.0796	0.1219	0.3185
<i>Oxydendrum arboreum</i>	25	0.1329	0.0505	0.1219	0.3053
<i>Liriodendron tulipifera</i>	22	0.1170	0.0995	0.0975	0.3140
<i>Magnolia macrophylla</i>	19	0.1010	0.0328	0.1219	0.2557
<i>Ilex opaca</i>	19	0.1010	0.0211	0.1219	0.2440
<i>Fagus grandifolia</i>	7	0.0372	0.0091	0.0731	0.1194
<i>Magnolia acuminata</i>	3	0.0159	0.0060	0.0243	0.0462
<i>Quercus alba</i>	1	0.0053	0.0259	0.0243	0.0555
<i>Quercus rubra</i>	1	0.0053	0.0046	0.0243	0.0342
<i>Cornus florida</i>	1	0.0053	0.0004	0.0243	0.0300
Totals	188	0.9995	0.9995	0.9992	2.9982

TABLE 4.—NUMBER (N), RELATIVE DENSITY (RD), RELATIVE DOMINANCE (RDo), RELATIVE FREQUENCY (RF), AND IMPORTANCE VALUE (IV) OF TREES SAMPLED IN THE SUM OF CIRCULAR PLOTS (0.625 HA) ON THE WEST-FACING SLOPE OF ROCK CREEK GORGE, LAUREL COUNTY, KENTUCKY

Species	N	RD	RDo	RF	IV
<i>Tsuga canadensis</i>	43	0.1911	0.3361	0.0869	0.6141
<i>Oxydendrum arboreum</i>	34	0.1511	0.1129	0.0869	0.3509
<i>Fagus grandifolia</i>	18	0.0800	0.0693	0.0869	0.2362
<i>Quercus rubra</i>	18	0.0800	0.0839	0.0695	0.2334
<i>Betula lenta</i>	22	0.0977	0.0480	0.0869	0.2326
<i>Ilex opaca</i>	15	0.0666	0.0297	0.0869	0.1832
<i>Quercus alba</i>	11	0.0488	0.0581	0.0521	0.1590
<i>Quercus prinus</i>	10	0.0444	0.0600	0.0521	0.1565
<i>Liriodendron tulipifera</i>	10	0.0444	0.0531	0.0521	0.1496
<i>Nyssa sylvatica</i>	8	0.0355	0.0363	0.0521	0.1239
<i>Magnolia macrophylla</i>	7	0.0311	0.0075	0.0695	0.1081
<i>Pinus taeda</i>	5	0.0222	0.0603	0.0173	0.0998
<i>Acer rubrum</i>	6	0.0260	0.0088	0.0521	0.0869
<i>Cornus florida</i>	5	0.0222	0.0052	0.0521	0.0795
<i>Pinus virginiana</i>	5	0.0222	0.0388	0.0173	0.0783
<i>Carya glabra</i>	4	0.0177	0.0117	0.0173	0.0467
<i>Magnolia acuminata</i>	2	0.0088	0.0060	0.0173	0.0321
<i>Aesculus octandra</i>	1	0.0044	0.0107	0.0173	0.0324
Totals	224	0.9942	1.0364	0.9726	3.0032

lenta, 0.3722; and *L. tulipifera*, 0.3140 (Table 3). There was a total of 188 trees having an average dbh of 26.04 cm and a basal area of 16.7 m²; on a per hectare basis, the trees totaled 300.8, and the basal area was 26.7 m². The largest trees of the gorge were *T. canadensis*, and all were on the east-facing slope. Those 8 trees ranged in diameter from 77.70 to 95.76 cm.

On the drier, west-facing slope, all 18 tree species were present (Table 4). The 6 species restricted to that slope were *Quercus prinus*, *Nyssa sylvatica*, *Pinus tsuga*, *Pinus virginiana*, *Carya glabra*, and *Aesculus octandra*. Of the 4 dominant species, *Tsuga canadensis* and *Oxydendrum arboreum* still ranked first with importance values of 0.6141 and 0.3509, respectively, and were followed by *Fagus grandifolia*, 0.2362, and *Quercus rubra*, 0.2334. *Betula lenta* had a higher relative density than either, but its importance value was only 0.2326. There was a greater number of trees as well as species than on the east-facing slope. The west-facing slope had

224 trees, but the average dbh was only 22.66 cm and the basal area was 12.4 m² for the 0.625 ha, or a basal area of 19.9 m² and 358.24 trees/ha.

Although not sampled within any of the test plots, 2 additional species, a single large specimen of *Liquidambar styraciflua* and 3 individuals of *Cercis canadensis*, were seen during the field work.

Saplings and shrubs were sampled over a total area of 0.625 ha for the 10 sites. Sixteen species of trees and 4 species of shrubs were found. All species were ranked according to relative density (RD) plus relative frequency (RF) (Table 5). *Tsuga canadensis* (0.1112), *I. opaca* (0.0882), and *F. grandifolia* (0.0882) were the most important trees. *Rhododendron maximum* was the most important shrub as well as the most important woody plant of the understory with a RD + RF value of 0.9432. *Kalmia latifolia* also had a value higher than any sapling, but was found only on the drier, west-facing slope. A few *Castanea dentata* were found, all infected with the

TABLE 5.—NUMBER (N), RELATIVE DENSITY (RD), AND RELATIVE FREQUENCY (RF) OF SAPLING AND SHRUB SPECIES PER HECTARE IN ROCK CREEK GORGE, LAUREL COUNTY, KENTUCKY

Species	N	RD	RF	RD + RF
<i>Rhododendron maximum</i>	184,000	0.8553	0.0879	0.9432
<i>Kalmia latifolia</i>	30,000	0.1394	0.0329	0.1723
<i>Tsuga canadensis</i>	312	0.0014	0.1098	0.1112
<i>Magnolia macrophylla</i>	56	0.0002	0.0549	0.0551
<i>Ilex opaca</i>	74	0.0003	0.0879	0.0882
<i>Fagus grandifolia</i>	72	0.0003	0.0879	0.0882
<i>Oxydendrum arboreum</i>	95	0.0004	0.0769	0.0773
<i>Acer rubrum</i>	112	0.0005	0.0659	0.0664
<i>Betula lenta</i>	42	0.0002	0.0549	0.0551
<i>Liriodendron tulipifera</i>	27	0.0001	0.0549	0.0550
<i>Cornus florida</i>	21	0.0001	0.0549	0.0550
<i>Clethra acuminata</i>	67	0.0003	0.0439	0.0442
<i>Stewartia ovata</i>	37	0.0001	0.0329	0.0330
<i>Hamamelis virginiana</i>	19	T ¹	0.0329	0.0329
<i>Nyssa sylvatica</i>	8	T	0.0329	0.0329
<i>Quercus alba</i>	8	T	0.0219	0.0219
<i>Quercus rubra</i>	6	T	0.0219	0.0219
<i>Quercus prinus</i>	3	T	0.0219	0.0219
<i>Carya glabra</i>	3	T	0.0111	0.0111
<i>Castanea dentata</i>	2	T	0.0111	0.0111
Totals	215,924	0.9986	0.9993	1.9979

¹ T denotes a value of less than 0.0001.

chestnut blight, and none were over 1 m high. *Stewartia ovata*, a small tree in the understory, was also found in the gorge. The remaining tree species were all found

in the canopy and subcanopy. The 2 species of *Pinus* and *A. octandra*, found in the tree size class, were not found in the saplings. *Clethra acuminata* and *Hamamelis virgin-*

TABLE 6.—NUMBER (N), RELATIVE DENSITY (RD), AND RELATIVE FREQUENCY (RF) OF SAPLING AND SHRUB SPECIES PER HECTARE ON THE EAST-FACING SLOPE OF ROCK CREEK GORGE, LAUREL COUNTY, KENTUCKY

Species	N	RD	RF	RD + RF
<i>Rhododendron maximum</i>	127,574	0.9940	0.1219	1.1159
<i>Tsuga canadensis</i>	160	0.0012	0.1219	0.1231
<i>Ilex opaca</i>	77	0.0006	0.1219	0.1225
<i>Magnolia macrophylla</i>	80	0.0006	0.0976	0.0982
<i>Fagus grandifolia</i>	48	0.0003	0.0976	0.0979
<i>Clethra acuminata</i>	131	0.0010	0.0732	0.0742
<i>Oxydendrum arboreum</i>	105	0.0008	0.0732	0.0740
<i>Betula lenta</i>	67	0.0005	0.0732	0.0737
<i>Acer rubrum</i>	45	0.0003	0.0732	0.0735
<i>Cornus florida</i>	19	0.0001	0.0489	0.0490
<i>Liriodendron tulipifera</i>	13	0.0001	0.0489	0.0490
<i>Stewartia ovata</i>	10	T ¹	0.0244	0.0244
Totals	128,333	0.9995	0.9759	1.9754

¹ T denotes a value of less than 0.0001.

TABLE 7.—NUMBER (N), RELATIVE DENSITY (RD), AND RELATIVE FREQUENCY (RF) OF SAPLING AND SHRUB SPECIES PER HECTARE ON THE WEST-FACING SLOPE OF ROCK CREEK GORGE, LAUREL COUNTY, KENTUCKY

Species	N	RD	RF	RD + RF
<i>Rhododendron maximum</i>	57,000	0.6465	0.0588	0.7053
<i>Kalmia latifolia</i>	30,000	0.3403	0.0588	0.3991
<i>Tsuga canadensis</i>	467	0.0053	0.0980	0.1033
<i>Fagus grandifolia</i>	96	0.0011	0.0784	0.0795
<i>Oxydendrum arboreum</i>	83	0.0009	0.0784	0.0793
<i>Acer rubrum</i>	179	0.0020	0.0588	0.0608
<i>Ilex opaca</i>	70	0.0008	0.0588	0.0596
<i>Liriodendron tulipifera</i>	42	0.0005	0.0588	0.0593
<i>Hamamelis virginiana</i>	38	0.0004	0.0588	0.0592
<i>Magnolia macrophylla</i>	32	0.0004	0.0588	0.0592
<i>Cornus florida</i>	22	0.0003	0.0588	0.0591
<i>Nyssa sylvatica</i>	16	0.0002	0.0588	0.0590
<i>Quercus rubra</i>	13	0.0001	0.0392	0.0393
<i>Quercus prinus</i>	6	T ¹	0.0392	0.0392
<i>Quercus alba</i>	16	T	0.0222	0.0222
<i>Betula lenta</i>	16	T	0.0196	0.0196
<i>Carya glabra</i>	6	T	0.0196	0.0196
<i>Clethra acuminata</i>	3	T	0.0196	0.0196
<i>Castanea dentata</i>	3	T	0.0196	0.0196
Totals	88,108	0.9988	0.9630	1.9618

¹ T denotes a value of less than 0.0001.

iana were the other shrubs found in the gorge.

On the east-facing slope, the most important saplings and shrubs and their RD + RF values were *R. maximum*, 1.1159; *T. canadensis*, 0.1231; *I. opaca*, 0.1225; and *M. macrophyll*, 0.0982 (Table 6). On the west-facing slope, the 4 major saplings and shrubs and their RD + RF values were *R. maximum*, 0.7053; *K. latifolia*, 0.3391; *T. canadensis*, 0.1033; and *F. grandifolia*, 0.0794 (Table 7). *Oxydendrum arboreum* was also an important species with a value of 0.0793.

According to RD + RF values, the important seedlings in the gorge are *T. canadensis*, 0.3304; *Magnolia* spp., 0.3152; *Acer rubrum*, 0.2584; and *R. maximum*, 0.1911 (Table 8). On the east-facing slope, the predominant seedlings are *Magnolia* spp., 0.4395; *T. canadensis*, 0.3335; *A. rubrum*, 0.3022; and *I. opaca*, 0.2439 (Table 9); and on the west-facing slope are *T. canadensis*, 0.3291; *Magnolia* spp., 0.2306; *A. rubrum*,

0.2289; and *R. maximum*, 0.1588 (Table 10). *Kalmia latifolia*, 0.1542, also has a high importance.

No major differences could be found in the texture of the soil samples between the east- and west-facing slopes. Also, little differences were noted between 0-cm and 5-cm samples. The soil texture tests showed the soil to contain an average of 63.11 per cent sand. The average percentage of silt was 17.51 and clay was 13.72.

The pH levels ranged from 3.8 to 4.4, and statistical analysis indicated a highly significant difference (.001 level) between the 3.8 pH of the east-facing slope and the 4.2 of the west-facing slope.

Phosphorus was high in all 16 samples ranging from 168 to 224 kg/ha. Potassium was generally low. The LaMotte soil test measures potassium only for levels of 112 kg/ha or greater. In all but 2 samples the potassium levels were below that limit. At 1 site, the level reached 112 kg/ha in the 5-cm sample. The only difference noted at

TABLE 8.—NUMBER (N), RELATIVE DENSITY (RD), AND RELATIVE FREQUENCY (RF) OF SEEDLINGS SAMPLED IN THE SUM OF CIRCULAR PLOTS (0.312 ha) IN ROCK CREEK GORGE, LAUREL COUNTY, KENTUCKY

Species	N	RD	RF	RD + RF
<i>Tsuga canadensis</i>	59	0.2092	0.1212	0.3304
<i>Magnolia</i> spp.	59	0.2092	0.1060	0.3152
<i>Acer rubrum</i>	43	0.1524	0.1060	0.2584
<i>Rhododendron maximum</i>	24	0.0851	0.1060	0.1911
<i>Ilex opaca</i>	16	0.0567	0.1212	0.1779
<i>Fagus grandifolia</i>	16	0.0567	0.0454	0.1021
<i>Quercus rubrum</i>	7	0.0248	0.0757	0.1005
<i>Hamamelis virginiana</i>	10	0.0354	0.0606	0.0960
<i>Kalmia latifolia</i>	13	0.0460	0.0454	0.0914
<i>Oxydendrum arboreum</i>	6	0.0212	0.0454	0.0666
<i>Clethra acuminata</i>	5	0.0177	0.0454	0.0631
<i>Nyssa sylvatica</i>	9	0.0319	0.0303	0.0622
<i>Stewartia ovata</i>	7	0.0248	0.0303	0.0551
<i>Liriodendron tulipifera</i>	2	0.0071	0.0303	0.0374
<i>Betula lenta</i>	3	0.0106	0.0151	0.0257
<i>Quercus prinus</i>	2	0.0071	0.0151	0.0222
<i>Sassafras albidum</i>	1	0.0035	0.0151	0.0186
Totals	282	0.9994	1.0145	2.0139

that site from the others was the presence of *P. taeda*, *P. virginiana*, *A. octandra*, and *C. glabra*. In the 0-cm sample of another site, the potassium level measured 173 kg/ha. No species difference occurred at this site. Nitrogen levels were less than 11.2 kg/ha except at 2 sites where the levels were between 11.2 and 22.4 kg/ha.

DISCUSSION

Upon analysis of the data, the forest community was shown to be a stable system. When the 10 most important species of each size class are compared, the data show the forest to be replenishing itself with the same species (Table 11). Eight

TABLE 9.—NUMBER (N), RELATIVE DENSITY (RD), AND RELATIVE FREQUENCY (RF) OF SEEDLINGS SAMPLED IN THE SUM OF CIRCULAR PLOTS (0.156 ha) ON THE EAST-FACING SLOPE IN ROCK CREEK GORGE, LAUREL COUNTY, KENTUCKY

Species	N	RD	RF	RD + RF
<i>Magnolia</i> spp.	34	0.2656	0.1739	0.4395
<i>Tsuga canadensis</i>	26	0.2031	0.1304	0.3335
<i>Acer rubrum</i>	22	0.1718	0.1304	0.3022
<i>Ilex opaca</i>	9	0.0700	0.1739	0.2439
<i>Rhododendron maximum</i>	14	0.1093	0.1304	0.2397
<i>Fagus grandifolia</i>	2	0.0156	0.0869	0.1025
<i>Quercus rubra</i>	5	0.0390	0.0434	0.0824
<i>Clethra acuminata</i>	5	0.0390	0.0434	0.0824
<i>Stewartia ovata</i>	4	0.0312	0.0434	0.0746
<i>Hamamelis virginiana</i>	4	0.0312	0.0434	0.0746
Totals	125	0.9758	0.9995	1.9753

TABLE 10.—NUMBER (N), RELATIVE DENSITY (RD), AND RELATIVE FREQUENCY (RF) OF SEEDLINGS SAMPLED IN THE SUM OF CIRCULAR PLOTS (0.156 ha) ON THE WEST-FACING SLOPE IN ROCK CREEK GORGE, LAUREL COUNTY, KENTUCKY

Species	N	RD	RF	RD + RF
<i>Tsuga canadensis</i>	33	0.2101	0.1190	0.3291
<i>Magnolia</i> spp.	25	0.1592	0.0714	0.2306
<i>Acer rubrum</i>	21	0.1337	0.0952	0.2289
<i>Rhododendron maximum</i>	10	0.0636	0.0952	0.1588
<i>Kalmia latifolia</i>	13	0.0828	0.0714	0.1542
<i>Ilex opaca</i>	7	0.0445	0.0952	0.1397
<i>Fagus grandifolia</i>	14	0.0891	0.0238	0.1129
<i>Oxydendrum arboreum</i>	6	0.0382	0.0714	0.1096
<i>Hamamelis virginiana</i>	6	0.0382	0.0714	0.1096
<i>Nyssa sylvatica</i>	9	0.0573	0.0476	0.1049
<i>Stewartia ovata</i>	3	0.0191	0.0476	0.0067
<i>Liriodendron tulipifera</i>	2	0.0127	0.0476	0.0603
<i>Betula lenta</i>	3	0.0191	0.0238	0.0429
<i>Quercus rubrum</i>	2	0.0127	0.0238	0.0365
<i>Quercus prinus</i>	2	0.0127	0.0238	0.0365
<i>Sassafras albidum</i>	1	0.0063	0.0238	0.0301
Totals	157	0.9993	0.9520	1.9513

of the first 10 saplings are also among the first 10 trees in importance value, although the order differs. The 2 species that are different in the sapling class are *Cornus florida* and *Stewartia ovata*, usually small trees confined to the subcanopy and understory levels, although *C. florida* was found in the tree class within the gorge. In the seedling class, 8 of the first 10 species were

again the same as the trees although the order was not the same. The presence of *Stewartia ovata* in the seedlings makes 9 out of 10 seedlings and saplings the same. In all size classes, *Tsuga* was the most important tree.
Coniferous trees usually are found in a more acid soil than hardwood species, partially because conifers can tolerate more

TABLE 11.—ORDERS OF IMPORTANCE OF TREES¹, SAPLINGS², AND SEEDLINGS³ OF THE 10 MAJOR TREE SPECIES WITHIN ROCK CREEK GORGE, LAUREL COUNTY, KENTUCKY

Trees	Saplings	Seedlings
<i>Tsuga canadensis</i>	<i>Tsuga canadensis</i>	<i>Tsuga canadensis</i>
<i>Oxydendrum arboreum</i>	<i>Magnolia macrophylla</i>	<i>Magnolia</i> spp.
<i>Betula lenta</i>	<i>Ilex opaca</i>	<i>Acer rubrum</i>
<i>Ilex opaca</i>	<i>Fagus grandifolia</i>	<i>Fagus grandifolia</i>
<i>Liriodendron tulipifera</i>	<i>Oxydendrum arboreum</i>	<i>Quercus rubra</i>
<i>Acer rubrum</i>	<i>Acer rubrum</i>	<i>Ilex opaca</i>
<i>Magnolia macrophylla</i>	<i>Betula lenta</i>	<i>Oxydendrum arboreum</i>
<i>Fagus grandifolia</i>	<i>Liriodendron tulipifera</i>	<i>Nyssa sylvatica</i>
<i>Quercus rubra</i>	<i>Cornus florida</i>	<i>Stewartia ovata</i>
<i>Quercus alba</i>	<i>Stewartia ovata</i>	<i>Betula lenta</i>

¹ Trees with diameter of 10 cm dbh or greater.
² Saplings having a diameter of less than 10 cm dbh and a height of 50 cm or greater.
³ Seedlings—woody tree and shrub species having a height less than 50 cm.

TABLE 12.—TREE SPECIES REPORTED IN 3 STUDIES OF THE ROCK CREEK GORGE, LAUREL COUNTY, KENTUCKY

Present study 412 trees	Braun (1950) 117 trees	Winstead and Nicely (1976) 100 trees
<i>Tsuga canadensis</i>	<i>Tsuga canadensis</i>	<i>Tsuga canadensis</i>
<i>Oxydendrum arboreum</i>	<i>Fagus grandifolia</i>	<i>Liriodendron tulipifera</i>
<i>Betula lenta</i>	<i>Liriodendron tulipifera</i>	<i>Betula lenta</i>
<i>Liriodendron tulipifera</i>	<i>Acer rubrum</i>	<i>Acer rubrum</i>
<i>Ilex opaca</i>	<i>Quercus rubra</i>	<i>Quercus rubra</i>
<i>Acer rubrum</i>	<i>Betula lenta</i>	<i>Ilex opaca</i>
<i>Magnolia macrophylla</i>	<i>Ilex opaca</i>	<i>Nyssa sylvatica</i>
<i>Fagus grandifolia</i>	<i>Castanea dentata</i>	<i>Prunus serotina</i>
<i>Quercus rubra</i>	<i>Nyssa sylvatica</i>	<i>Fagus grandifolia</i>
<i>Quercus alba</i>	<i>Quercus montana</i> ¹	<i>Quercus alba</i>
<i>Quercus prinus</i> ¹	<i>Oxydendrum arboreum</i>	<i>Magnolia macrophylla</i>
<i>Nyssa sylvatica</i>	<i>Magnolia macrophylla</i>	<i>Carpinus caroliniana</i>
<i>Cornus florida</i>		<i>Cornus florida</i>
<i>Pinus taeda</i>		
<i>Pinus virginiana</i>		
<i>Carya ovata</i>		
<i>Aesculus octandra</i>		
<i>Magnolia acuminata</i>		

¹ Same species according to Radford et al. (1968).

acid soils and partially because of their presence. In sandy soils, such as that in the gorge, cations are easily leached and replaced by hydrogen ions. Also, plant litter from certain species, especially those of Pinaceae, yield acidic material when they decompose (Daubenmire 1959). In the soil of the gorge, there was a highly significant difference between the pH of the east-facing and west-facing slopes. The pH was lowest on the east-facing slope (3.8), and the only conifer present (*Tsuga canadensis*) had the highest relative dominance (0.5473). On the west-facing slope, the pH was 4.4, and 3 species of conifers collectively had a relative dominance of 0.4352, while the hardwoods had a relative dominance of 0.5639.

Other studies involving Rock Creek Gorge were done with different techniques and smaller samples. In the study by Braun (1950), 117 trees were randomly sampled and recorded. Winstead and Nicely (1976) used 2 750-m transect lines to sample 100 trees using a random pairs method. The 3 studies show a difference in the data collected (Table 12). In a comparison of

number of species, Braun found 12, 11 of which were the same as in the present study. The other single species reported by Braun, but absent in the present analysis, was *Castanea dentata* which has been eliminated by chestnut blight. Dead, fallen chestnut trees still remain in the gorge. Winstead and Nicely (1976) found 13 species of trees within the gorge. Eleven of those species were found in the present study; *Prunus serotina* and *Carpinus caroliniana* were not found.

Basal areas of the present study were compared with those reported by Winstead and Nicely (1976) (Table 2). The 2 techniques gave different results. An analysis of the 4 plots nearest the earlier study showed 368 trees/ha with a basal area of 26.4 m². Those figures are higher than for the total gorge (329.6 trees with 23.3 m²/ha basal area). The numbers are less than those in the preliminary study that had 672.3 trees/ha with a basal area of 47.5 m². The data show a pattern of decreasing numbers with increasing size of the area sampled.

The basal area data from Rock Creek

Gorge do not match the predicted value of 30 m²/ha as proposed by Held and Winstead (1975) being an indication of climax status in mesic forest systems. Their proposal was developed by comparing basal area data from various studies of forests primarily in Kentucky and Indiana. Those forest ecosystems were not confined to such a narrow gorge as Rock Creek; thus, the physiography of the area might be limiting in some way to tree growth.

Braun (1950) found that the pattern of vegetation in Rock Creek Gorge with hemlock dominant accompanied by dense thickets of *Rhododendron* was typical of the narrowest gorges of the Cumberland Plateau. She also noted the greater importance of oak on the drier slopes. In Rock Creek, the importance value of the sum of the 3 species of oak on the west-facing slope was 0.5489, just below that of hemlock (0.6141). On the other slope, only 1 species of oak was present having a value of 0.0535, while that of hemlock was 0.9104.

Lilley Cornett Woods in Letcher County is a virgin area in southeastern Kentucky on the Cumberland Plateau (Martin 1975). The area contains several hemlock communities on lower northeastern and northwestern slopes. *Tsuga canadensis* accounted for 60 percent of the importance value and *Fagus grandifolia* was the only other important constituent. The northwestern slope had smaller trees with the highest density of 478 stems/ha; the northeastern slope had 321 stems/ha. The pattern is the same as that in Rock Creek Gorge. Also, as in Rock Creek, oak became a more important constituent on the northwestern slope. A greater number of tree species was present on the northwestern slope of Lilley Cornett Woods than in Rock Creek Gorge. Fifteen species were found on the northeastern slope and 18 on the northwestern slope compared with 12 on the eastern slope and 18 on the western slope in Rock Creek. Basal areas were higher in the woods than the gorge. Martin (1975) reported basal areas of 42.4 m²/ha on the northeastern slope and 22.4 m²/ha on the northwestern slope of Lilley Cornett Woods compared

with 26.7 m²/ha on the eastern and 19.9 m²/ha on the western in the gorge. That difference may be due to differences in methods. Martin used 12.4 cm dbh as the smallest tree size instead of the 10 cm dbh limit used in Rock Creek. In spite of that difference, the pattern is still the same. The greatest basal area is on the eastern slopes.

In Lilley Cornett Woods, beech was a more important constituent of the forest composition than in Rock Creek Gorge. Braun (1950) found the same to be true of wider gorges where beech occupied the valley floor. The pattern was present at Yahoo Falls in McCreary County, Kentucky, although that area is not covered by a virgin forest (Braun 1950).

No other virgin hemlock-mixed mesophytic forests have been studied in Kentucky. Areas of secondary growth with the same hemlock-mixed mesophytic forest are present in Red River Gorge, but to our knowledge no compositional studies have been done there. In 1973, Herman and See reported on secondary succession after a fire in the hemlock-mixed mesophytic forest of "Tight Holler" in Wolfe County. After 47 years, tulip poplar was dominant, and hemlock was present only in the shrub layer.

Rock Creek Gorge is a good site for more specific ecological studies of virgin vegetation. Also, the rim of the gorge is secondary growth with 1 plot that was clearcut in 1965 by the U.S. Forest Service. The plot has since been abandoned and is a possible site of the study of successional patterns of that area.

The present study gives a more complete picture of vegetational structure and community composition than would be expected to develop within similar gorge habitats in the Cumberland Plateau of Kentucky. Such information may be of considerable value in future plans of wilderness management and development of potential recreational sites. Another point of significance is that such a protected area as Rock Creek, once inventoried, provides a potential pool of genetic stock representing species that now or in the future might have great economic

value in reforestation, timber production, and wildlife management. It is also hoped the data presented here may provide baseline information for comparison with other climax forest systems within the central and eastern United States in relation to stability of forest ecosystems and species diversity.

LITERATURE CITED

- BRAUN, E. L. 1950. *Deciduous Forests of Eastern North America*. Hafner Publishing Co., New York, N.Y. 596 pp.
- BOUYOUCOS, G. J. 1936. Directions for making mechanical analysis of soils by the hydrometer method. *Soil Science* 42:225-229.
- DAUBENMIRE, R. F. 1969. *Plants and Environment*. John Wiley & Sons, Inc., New York, N.Y. 422 pp.
- HELD, M. E., AND J. E. WINSTEAD. 1975. Basal area and climax status in mesic forest systems. *Ann. Bot.* 39:1147-1148.
- HERMAN, T., AND M. G. SEE. 1973. Secondary succession following fire in "Tight Holler," Kentucky. *Castanea* 38:275-285.
- MARTIN, W. H. 1975. The Lilley Cornett Woods: A stable mixed mesophytic forest in Kentucky. *Bot. Gaz.* 136:171-183.
- RADFORD, A. E., H. E. AHLES, AND C. R. BELL. 1968. *Manual of the Vascular Flora of the Carolinas*. Univ. N. Carolina Press, Chapel Hill, N.C. 1183 pp.
- WINSTEAD, J. E., AND K. A. NICELY. 1976. A preliminary study of a virgin forest tract of the Cumberland Plateau in Laurel County, Kentucky. *Trans. Ky. Acad. Sci.* 37(1-2): 29-32.



Cameron, Margaret Ringland and Winstead, Joe E. 1978. "Structure and composition of a climax mixed mesophytic forest system in Laurel County, Kentucky." *Transactions of the Kentucky Academy of Science* 39(1-2), 1-11.

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