Some Observations on the Tree Strata of an Oak-Hickory Woods[1]

J. D. Barton, Jr., Purdue University

In 1951, Northern Illinois State Teachers College acquired a sixty-six acre tract of land to be preserved as an outdoor laboratory for the natural sciences and for teacher training. This study was made to determine the composition of the tree strata of the higher topographic positions of the area, some of the reasons for the variations present, and to gain some knowledge of the climax relationships of this part of the midwest.

The area studied is located in the N. W. ¼ of Sec. 33, T. 24 N., R. 10 E. of the Fourth Principal Meridian, in Ogle County, Illinois. It lies within the Till Plains section of the Central Lowlands Province, called the Rock River Hill Country by Leighton (5). Relief may be as great as 155 feet in a half mile. The hill tops are covered with a thin mantle of Illinoian glacial till. Platteville limestone of Ordovician age makes up the bedrock of the region (1, 3, 5). The climate is continental; temperature ranges from 100°F. to —10°F. The mean annual precipitation is thirty-four inches (1, 3).

Methods

Twenty-two 10 x 10 meter quadrats were subjectively placed to fall at the higher topographic positions. Within these higher positions they were placed at fifty or one hundred pace intervals depending upon the size of the ridge. About ten acres are included in the higher topographic positions thus resulting in approximately a five per cent survey. The largest ridge top in the area was omitted because of introduced vegetation around various buildings.

Discussion of Results

A compilation of the data collected by means of the quadrat method appears in Table I. It can be seen that one species had the highest index in all three phases of critical tree measurement. This species, *Quercus alba*, covered 0.222441 per cent of the total area sampled, occurred in 95.4 per cent of the quadrats, and averaged 3.409 individuals per quadrat. The numbers quoted refer to basal area, frequency, and density in that order. From Table I, it is seen that *Quercus rubra* and *Carya ovata* ranked high in basal area, frequency, and density. This is an indication of co-dominance.

Quercus velutina had a comparatively high index of basal area and a low index of frequency and of density. This indicates that although there were only a few members of the species present, they were large. *Quercus rubra* had a high frequency and density, but a low basal area. This indicates a large number of small trees that can compete with the shrub strata, but rarely grow to maturity.

---

1. This paper is based on a Master's qualifying paper deposited in the library, Northern Illinois State Teachers College. The author wishes to thank Dr. Robert A. Bullington who directed the research.

Prunus serotina had high frequency and density indices and medium basal area. These facts are not significant in themselves, but when combined with observation of the association, it is seen that *Prunus serotina* grows to maturity, but not usually in large numbers.

The above facts combined with the field observations of the investigator lead him to conclude that the hill-top stratum in this area is dominantly oak-hickory *(Quercus alba, Quercus rubra—Carya ovata)* interspersed with black cherry. In the following discussion, the hill-top tree stratum will be related to topographic position. This analysis supplies further information relative to the climax relationship of this area.

Table II indicates that the largest number of species reaching optimum development occurred at the lowest topographic position, on the slope of the hill, a well-drained spot. This could be interpreted as indicative of the most mesarch environment. This is further substantiated by the fact that *Quercus rubra*, a tree that grows well in moist soil, reached its optimum development at the same topographic position. Even though *Quercus rubra* reached an optimum development at this elevation, it was not dominant, but co-dominant with *Quercus alba*. It can be said that dominant trees share the ground with other trees, but in such a situation they are not as frequent as they may be in another environment where they are the dominant species.

One species, *Quercus alba*, showed a decrease in density and an increase in basal area with an increase in elevation. *Quercus alba* reached its maximum size at the highest topographic position. *Quercus velutina*, at its maximum development in this area, occurred only as a minor-dominant on the more xerarch hilltops.

From the facts presented above, and the observations made in the field, it is the opinion of this author that *Quercus alba* is the dominant tree of the higher topographic positions in the area studied. Other species share this dominance as co-dominants or minor-dominants under certain conditions. At the lowest topographic positions, *Quercus alba* is dominant, with *Quercus rubra* co-dominant. *Quercus velutina, Carya ovata*, and *Prunus serotina* are three minor-dominants. *Quercus alba, Carya ovata*, and *Quercus rubra* are co-dominant at the medium topographic positions. At the highest topographic positions, *Quercus alba* is dominant, with *Prunus serotina* and *Carya ovata* as co-dominants. At this position, *Quercus velutina* and *Carya cordiformis* are minor-dominants.

Quercus alba, Carya ovata, and *Quercus velutina* are dominant trees because of their ability to succeed on well-drained land. The limestone bedrock with its thin mantle of glacial till offers the dry environment which these trees favor. *Quercus velutina* probably preceded *Quercus alba* on these dry (xerarch) exposed hills and are then responsible for the more mesarch conditions which now exist. The increase in density and basal area for *Carya cordiformis* is probably due to the presence of prairie openings at the highest topographic positions.

The lower elevations, being subject to less erosion, and sometimes collecting part of the material eroded from the higher land, especially colloidal material, would therefore have a thicker mantle of soil material. This thick material would be capable of holding more moisture and would

TABLE I

Species	Basal Area[1]	Frequency[2]	Density[3]
Quercus rubra	0.0486916	59.50	1.769
Quercus velutina	0.0124496	22.72	0.409
Quercus alba	0.2224410	95.40	3.409
Carya ovata	0.0361177	72.70	1.636
Carya cordiformis	0.0009675	45.40	1.500
Quercus macrocarpa	0.0014203	4.54	0.272
Fraxinus americana	0.0005514	2.72	0.590
Tilia americana	0.0068475	31.81	0.545
Ostrya virginiana	0.0023425	31.81	0.590
Acer negundo	0.0005247	18.10	0.409
Juglans nigra	0.0074760	31.80	0.409
Celtis occidentalis	0.0006955	27.21	0.500
Ulmus fulva	0.0029030	50.00	0.725
Prunus serotina	0.0060424	59.00	2.000
Acer saccharum	0.0000230	4.54	0.045

Basal area: Expressed in percent of square meters ($\pi r^2/2200$)
Frequency: Per cent of quadrats in which species occurs (N/22 x 100)
Density: Average number per quadrat (X/22)

TABLE II

	Position I[1]		Position II[2]		Position III[3]	
Species	Den.	B. A.	Den.	B. A.	Den.	B. A.
Quercus velutina	0.1	0.061275	0.9	0.007251	0.25	0.005685
Quercus rubra	2.3	0.108865	2.2	0.060096	0.75	0.095566
Quercus alba	3.5	0.020713	2.2	0.224793	3.50	0.404699
Quercus macrocarpa			0.9	0.004469		
Carya ovata	1.6	0.060394	1.7	0.045178	1.50	0.018775
Carya cordiformis	0.7	0.000525	1.1	0.000783	2.60	0.002882
Prunus serotina	4.1	0.148563	1.2	0.005657	1.00	0.030243
Ostrya virginiana	0.3	0.001247	0.9	0.003972	0.10	0.001666
Ulmus fulva	0.5	0.005558	0.7	0.004238	0.70	0.001733
Fraxinus sp.			1.7	0.001032	0.10	0.000464
Celtis occidentalis	0.7	0.002172	0.1	0.000157	0.10	0.000013
Tilia americana	1.0	0.015909	0.2	0.000608	0.40	0.011456
Juglans nigra	0.2	0.000129	0.9	0.024269	0.30	0.000517
Acer negundo	0.5	0.000290			0.60	0.002369

Density and basal area compared with topographic position.
Position I: Characterized by accumulation of erosional and colloidal materials.
Position II: Slope of the hill immediately below crest.
Position III: Crest of the hill.

support a different type of vegetation. *Quercus rubra* can survive the moist soil conditions, and in this area reaches its optimum development at the lower elevations.

In Tables I and II there are listed many minor species of trees. Some of these species, such as *Ostrya virginiana* and *Juglans nigra* are characteristically found in oak-hickory communities. They rarely become part of the dominants, but *Juglans nigra* may form small societies in particularly favorable locations. *Ostrya virginiana* is often found in association with the oak-hickory community as part of the tall shrub or sapling strata under the canopy. Accessory trees forming a part of these strata are *Celtis occidentalis* and *Ulmus fulva*. These usually die out before their size warrants them a place in the canopy strata. In a clearing or open area they will pave the way for the oaks, or momentarily occupy the place of some large tree that has succumbed to disease, lightning, or old age.

Summary

The results of the quadrat method showed *Quercus alba* to be the dominant tree species at all physiographic positions studied. At the lower positions, *Quercus alba* was found to share this dominance with *Quercus rubra*. *Carya ovata* and *Prunus serotina* occur as minor-dominants. At the intermediate positions, *Quercus alba* shares dominance with *Quercus rubra* and *Carya ovata*. At the highest positions, *Quercus alba* is dominant, with *Prunus serotina* and *Carya ovata* occurring as co-dominants. At all elevations sampled, accessory species may occur in the canopy, but do not constitute enough of the community to be considered dominant.

Literature Cited

1. BRETZ, J. HARLEN. 1923. Geology and mineral resources of the Kings quadrangle, extract C. from bulletin 43. State of Illinois, Department of Registration and Education, Urbana. p. 205-304.
2. GATES, F. C. 1949. Field manual of plant ecology. McGraw-Hill Book Company, New York. 137 pp.
3. KNAPPEN, RUSSELL S. 1926. Geology and mineral resources of the Dixon quadrangle, bulletin 49. State of Illinois Department of Registration and Education, Urbana. 141 pp.
4. OOSTING, H. J. 1948. The study of plant communities. W. H. Freeman and Company, San Francisco. 389 pp.
5. RAASCH, GILBERT O. 1952. Oregon area guide leaflet. State of Illinois, Department of Registration and Education, Urbana. 20 pp.