The Distribution of *Fagus grandifolia* in Hutcheson Memorial Forest, New Jersey

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Introduction

American beech, *Fagus grandfolia,* has an extensive geographical distribution, ranging from the Gaspe region west across southern Canada to Michigan and Wisconsin, south to eastern Texas and northwestern Florida. In the Mixed Mesophytic Forest Region, the center of distribution for the Eastern Deciduous Forest, beech is a major compositional dominant in association with sugar maple, basswood, tuliptree, oaks, and hemlock. In this region beech is relatively unrestricted by environment, occurring on rich uplands, lower and mid-slopes irrespective of exposure, as well as in ravines and valley floors (Braun, 1935; 1940; 1942). Away from this center, beech becomes increasingly restricted to the most favorable sites. It occurs extensively in the Beech-Maple Forests of the Lakes States, but here the south-facing slopes and ridges are populated by oaks and hickories (Potzger and McCormick, 1956; Cain, 1935). In the Oak-Hickory Region and areas of the former Oak-Chestnut Forest it becomes confined to ravines and low moist slopes (Braun, 1950; Niering, 1953; Raup, 1937). Within the South-east Evergreen Forest beech is found extensively in hammocks, low flats, and mesic slopes (Quarterman and Keever, 1962; Braun, 1950). It also appears as an associate within the Hemlock-White Pine-Northern Hardwoods Region of the Appalachians and New England (Nichols, 1935) but drops out in the Boreal Forest.

This wide range is apparently made possible by the existence of three "biotypes," described by Wendell H. Camp, which enable this species to adapt to a wide variety of habitats. One genic base, the White Beech, is found in nearly pure form in the lowlands from northern Florida northward into Maryland; Red Beech occurs on uplands and the Appalachian slopes northward into the Hemlock-Northern Hardwoods where it grades into the Gray Beech as balsam fir and red spruce become important at the edge of Boreal Forest. The beech of the Mixed Mesophytic and Beech-Maple Forest is a genetic blend of the three types, which accounts for the wide habitat distribution of the species in these areas (Camp, 1950).

The limiting factors in the distribution seem to be deficient soil moisture to the west and length of growing season to the north (Ward, 1956). At the range limits reproduction is predominantly vegetative by root sprouts; little viable mast is produced (Ward, 1961). Sprouting occurs throughout the range of beech, but as the seed production becomes limited, the relative importance of sprouting in propagation increases (Russell, 1953).

The purpose of this study was to determine and explain the distribution of the beech in Hutcheson Memorial Forest in New Jersey, where Red Beech approaches its southern limit, and to ascertain the relative importance of seed versus sprout reproduction.

Description of Study Area

Hutcheson Memorial Forest is a 65 acre tract of oak-hickory forest located on the Piedmont of New Jersey near East Millstone (40° 30' N, 70° 34' W). Surrounded now by cultivated land and by fields in various stages of secondary succession, this tract is a remnant of a once extensive oak-hickory forest covering most of the Piedmont. The trees now range up to and over 300 years in age. The forest is preserved as a natural area, and represents the closest approximation to a "virgin" forest on the Piedmont (Monk, 1957). The tract has been variously referred to as a close approximation to climax (Bard, 1952) and as "Mature oak forest" (Buell, 1957). However, because of the importance of sugar maple and white ash in the understory, and the paucity of young oaks and hickories, Monk (1961) suggests that the forest should not be called climax.

The vegetation of the forest is well-stratified with a distinct overstory of white oak (*Quercus alba*) in association with black oak (*Q. velutina*), red oak (*Q. rubra*), and white ash (*Fraxinus americana*); an understory composed principally of dogwood (*Cornus florida*), and occasional saplings of canopy species; a well-defined shrub layer dominated by *Viburnum acerifolium* and *V. dentatum*; and a scattered herbaceous layer.

Essentially undisturbed by man since colonization, the principal forms of disturbance in the area have been natural phenomena. Prior to Dutch settlement in 1701, the area was burned periodically by Indians (Buell, et al. 1954). Natural disturbances have included wind, ice-storms, and lightning. Drought has also been important in the development of the forest; a period of drought in 1957 impeded the growth of the trees and caused the death of some of the older individuals (Buell, Buell, Small, and Monk, 1961; Small, 1961).

The forest is underlain by weathered Triassic shale of the Brunswick Formation. The forest soils developed from the red shales are classified as Norton loams (Monk, 1961).

The mean annual temperature of the region is 54.4°F. Micro-climatic studies have shown the extremes for one year in the forest to be -37°F. minimum and 96°F. maximum (Sparkes and Buell, 1955).

Procedure

The present distribution of beech in the forest was determined by locating the position of each tree and plotting it on a map. The forest has been divided into hectares with red stakes permanently marking the corners and yellow stakes designating the centers. The distance in feet and the compass direction of each tree from the nearest stake was recorded. In clonal situations the largest, presumed parent beech tree was located with reference to the nearest stake, and the parent tree then used as the reference point for smaller peripheral trees. The dbh of all stems over one inch dbh was measured, and the heights estimated for stems under one inch dbh. During the initial location of trees all stems were considered individuals except where several stems emerged from a single point due to browsing; these were designated as a clump.

The root system of each stem was exposed to a

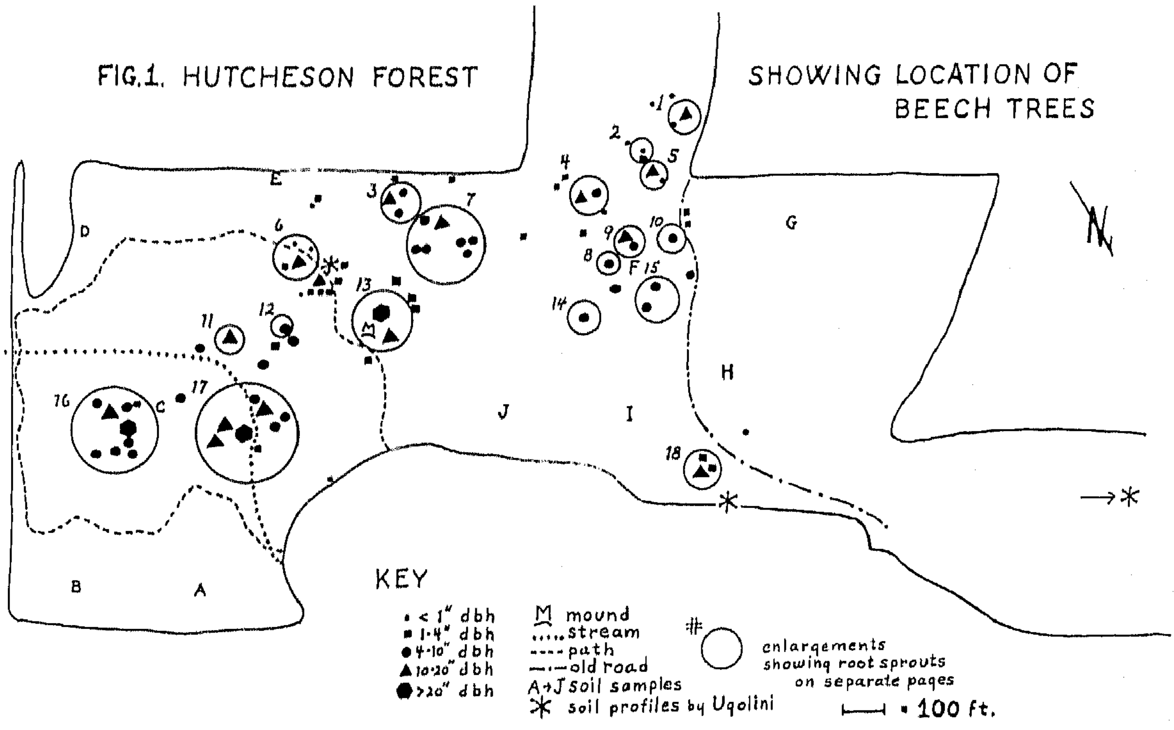


FIG. 1. HUTCHESON FOREST SHOWING LOCATION OF BEECH TREES

depth of six inches to determine the nature of origin for the stem and, where possible, to trace sprout roots to the parent.

Cores were taken in all trees with a dbh of 4-10 in. and in four 10-20 in. trees using a 12 inch increment borer. The largest tree was cored with a 15 inch borer. These cores were treated with a saturated solution of phloroglucinol in 95% ethyl alcohol for one minute, drained, and washed with 50% HCl. This treatment stains the lignin of the vessels and tracheids making clearer identification of spring and summer wood possible. Age determinations were then made by counting the annual rings.

During September and October beech nuts were collected around the clones. Five hundred nuts were tested for per-cent germination using standard testing procedures. Two wood flats were filled with sterilized sand and divided into ten sections. Twenty-five nuts were put into each section. The flats were kept moist at 4°C. in the cold room for three months (November 18, 1964 to February 12, 1965), then transferred to the greenhouse where they were subjected to fluctuating temperatures (64°F. to 81°F.) for two months (February 14, 1965 to April 16, 1965). The temperatures were recorded using maximum-minimum thermometers. The number of nuts which germinated were recorded and the per-cent germination calculated. In addition, the viability of 54 nuts was tested using tetrazolium chloride. Living embroyos stain red while dead embryos remain cream-white.

Soil samples were taken at each of 10 stations (Fig. 1) at a depth of six inches using a soil auger.

TABLE I. *Population of beech trees in Hutcheson Forest by size classes. The number of sprouts associated with each tree are indicated. The underscored number indicates the number of trees in each size class which are sprouts of larger trees.*

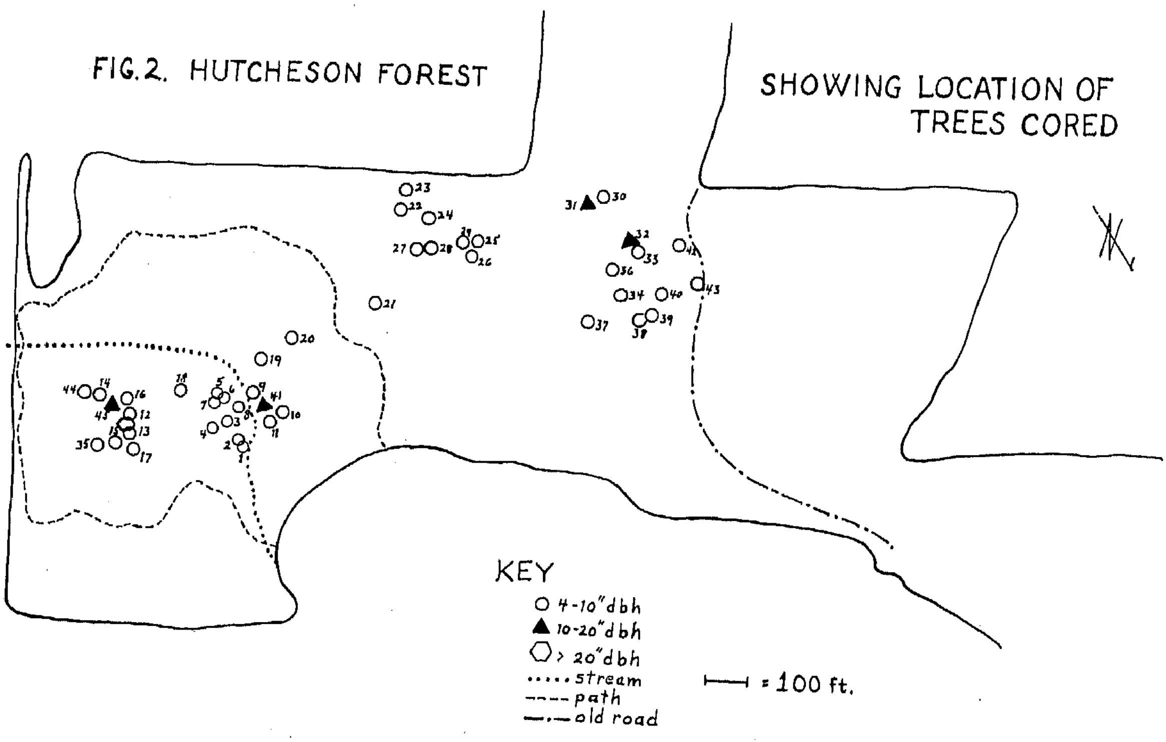
S.C. = size class; Tr = Tree; Sp = Sprouts.

S.C.	20"dbh #Tr	20"dbh Sp/Tr	10-20"dbh #Tr	10-20"dbh Sp/Tr	4-10"dbh #Tr	4-10"dbh Sp/Tr	1-4"dbh #Tr	1-4"dbh Sp/Tr	1"dbh #Tr	1"dbh Sp/Tr
	3	1-9	15	1-4	42	2-6	77	1-2	262	0
		1-26		3-6		5-2				
							21		**226**	
		1-6		2-5		2-3				
				1-19		2-5				
	0			1-2		22.0				
				3-1		1-14				
				1-0		3-1				
				1-3		1-9				
				1-27						
			0		**4**					
				1-13						
Total # Sp.		14		7		1		.01		0
Av. #		41		99		63		2		0

The samples were air-dried for 48 hours and soaked in sodium hexametaphosphate to disperse the clay particles. And silt and clay fractions were then determined using the Bouyoucos (1951) hydrometer method.

Results

Beech in Hutcheson Forest is restricted to the eastern and central section of the forest where it occurs as a wide band running east-west (Fig. 1). An



old roadway marks the western limit of the beech. Only three stems were found west of this line: a seedling which died during the summer, and two young saplings which occur at the very edge of the road.

Three hundred and ninety-nine stems were found, counting the browse clumps as one individual. Considering the size class distribution there are three trees over 20 inches in dbh: 15 ranging from 10-20 in. dbh; 42, 4-10 in. dbh; 76, 1-4 in. dbh; and 262 less than one inch dbh (Table 1). Chi square tests testing deviation from random distribution show statistically significant clumping of the population as a whole (x2= 2613; d.f = 99; P = .05), and in the three smaller size classes (x2 = 980; d.f. = 99; P = .01 The 10-20 in. size class is evenly distributed with a tendency towards clumping, and the three largest trees, while evenly spaced, are all located at the eastern edge of the area occupied by beech.

TABLE 2. *Age and dbh of the 45 trees cored. The number of sprouts associated with each stem are indicated. The number in the right hand column gives the number of each tree as it appears in Fig. 2. The asterisk indicates those 10-20 in. dbh trees which were cored. The figures in the Adj. age column give the ages of the trees adjusted for the 24 in. below the level of the core. Numbers 36, 39, 40 were eliminated as the annual rings could not be identified.*

# Ann. Rings	Adj. age	# Sprouts	dbh	Tree #
34	42	0	4.1"	42
35	43	0	5.6"	44
38	46	0	5.4"	10
39	47	0	5.7"	17
40	48	0	4.5"	23
40	48	0	4.8"	43
41	49	0	4.1"	16
41	49	0	5.5"	8
41	49	9	5.9"	9
43	51	0	6.9"	14
43	51	0	6.5"	25
44	52	0	5.4"	15
44	52	2	4.5"	27
45	53	0	6.8"	35
48	56	0	5.7"	19
48	56	3	4.8"	38
49	57	0	4.1"	20
49	57	0	4.9"	2
50	58	2	6 9"	4
50	58	11	6.3"	28
51	59	0	4.2"	12
52	60	0	5.7"	18
55	63	3	7.4"	22
58	66	0	7.2"	11
62	70	0	4.4"	3
62	70	1	8.4"	34
65	73	0	7.0"	1
66	74	5	9.1"	30
66	74	0	8 5"	13
67	75	6	7.2"	42
67	75	4	11.2"*	45
69	77	1	4.6"	6
72	80	2	7.5"	29
72	80	1	4.6"	21
74	82	6	8 0"	33
76	84	4	6 7"	5
77	85	2	10.7"*	32
84	92	5	10 2"*	31
90	98	0	7 0"	7

The ages of the trees below are incomplete due to rot in the center, or missing center.

# Ann. Rings	Adj. age	# Sprouts	dbh	Tree #
35+	43+	2	4.1"	26
47+	56+	27	11.9"*	41
95+	103+	0	8.5"	37

The range in dbh is paralleled, though not uniformally, by a wide range in ages. The youngest seedling found was five years old, the oldest tree 150 years.

Sprouts under five years may be present but ages were not determined. Cores of the 4-10 in. class trees indicate that this most widely dispersed group ranges evenly in age from 43 years to about 100 years (Table 2).Examination of five stems indicates that most of the stems under three inches dbh range from about 12 to 39 years in age.

Sixty-five per-cent of the stems (251) were found to be root sprouts. Figure 3 part 1-18 shows the relationship between root sprouts and parent trees, and also between seedlings and the parent trees. Two hundred and twenty six of the root sprouts (90%) were under one inch dbh, 21 were 1-4 in. dbh, and five were 4-10 in. dbh. Further examination shows that 90% of all the smallest-sized stems are sprouts; only 36 seedlings under one inch dbh were located. In contrast, only 27% of the 1-4 in. trees are of sprout origin, and 11% of the 4-10 in. stems. None of the stems in the two largest size classes can be considered sprouts (Fig. 4).

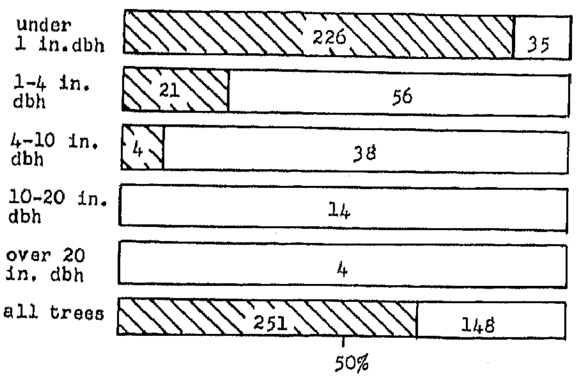


Fig. 4. The percentage of trees in the five size classes which are of sprout and seed origin. The black bar represents the per-cent sprouts, the white, the seedlings. The total number of each type is indicated in the bar graph.

The numbers following the figure number correspond to the circled areas numbered in Fig. 1.

The germination tests proved negative. Of the 500 nuts tested, none had germinated at the end of nine weeks. Only four of the 54 nuts tested with tetrazolium showed any living embryonic tissue.

The results from the soil samples indicate that the clay fraction ranges from 30% along the stream to 14% at station I (Fig. 1) (Table 3). The beech occurs on soils ranging from 30% to 28% clay in the A horizon. Across the roadway, west of the beech limit, the clay fraction drops to 20% and 19%; east of the area occupied by beech, it drops to 16% and 18%; to the north, 14% and 22%; and to the south, 20% and 24%.

TABLE 3. *Composition of soil of the ten samples taken. See Fig. 1 for the locations of these areas.*

Point where soil sample was taken	% Sand	% Silt	% Clay
A	30	52	18
B	22	62	16
C*	32	38	30
D	22	58	20
E	20	56	24
F*	24	48	28
G	28	52	20
H	28	53	19
I	28	58	14
J	22	56	22

* *Indicates those samples which were taken in areas occupied by beech.*

TABLE 4. *Clay fractions in A, B, and C horizons taken from Ugolini, 1964. See Figure 1 for the location of the three soil profiles.*

Horizon	East	West	Far West
A	30.58	12.80	11.81
B	27.79	16.66	16.21
C	37.75	19.46	23.21

Discussion

The distribution of beech in Hutcheson Forest essentially confirms the findings of Frei's floristic survey (1963) and Monk's vegetational study (1961). The pattern of a single restricted band running east-west through the forest is very striking. Moisture gradients are generally recognized as the most important determinant of beech distribution. For not only is the geographical range determined in part by moisture, but the occurrence within the range is often limited to restricted moisture regimes. With the exception of the White Beech, the species requires good drainage, but with a fairly high water table (Potzger and Keller, 1952; Gleason, 1924). It rarely becomes established in soils with excessive or very poor drainage. Characteristically, in Hutcheson Forest, the beech is located on soils denoted by Ugolini (1964) as imperfectly to well drained, and is conspicuously absent on the poorly drained soils in the western part of the forest. Forty-eight per-cent (29) of the trees in the three largest size classes are located within 200 feet of the stream which bisects the eastern end of the forest.

A related but more specific correlation exists between the presence of beech and the clay fraction of the soil. Where beech is present in the forest, the clay fraction is relatively high (28% or more); the largest fraction of clay (30%) was found near the stream (Fig. 1 Point C) where the greatest concentration of the large beeches is found. Beyond the area occupied by beech the amount of clay in the A horizon drops sharply in all directions (Table 2) particularly to the north, east and west. To the south the drop is not as sharp, but as one goes south from the limit of the beech the percentage of clay steadily decreases (24% at E, 20% at D). Due to the relatively young age of the beech in the forest and to the infrequent establishment of seedlings, it is unlikely that beech has populated all the soil on which it is potentially capable of occurring, yet the correlation between the present distribution of beech and the clay present in the soil is certainly striking. Results obtained in this study closely correlate with the fractions obtained by Ugolini using the pipette method (Table 4). His data show about twice as much clay in the A and B horizons at the eastern end of the forest where beech occurs as at the west end where beech is essentially absent.

The relationship between beech and clay has been noted by Quick (1923) in southern Michigan where beech occurs twice as frequently on clayey soils as on sandy soils. Gates (1912) working in the beech-maple forests of northern Michigan also observed that beech was more important on clays than sands.

The present data also reveal a paucity of small trees of seed origin; only 36 saplings under one inch dbh were found. Other than one 16 inch tall stem, none were found less than six feet in height. This can be closely correlated with the condition of the mast being produced in the forest. Frei recorded the absence of beech in flower or fruit during her survey in 1960. In the current study, although mast was produced, none of the nuts collected and tested germinated. The viability tests and observations indicate that most of the nuts produced are empty or have only partial embryos, as has been noted in Wisconsin (Ward, 1961). Much of what viable seed is produced is likely consumed by rodents.

It is relevant to note that two-thirds of the nuts collected were produced by a single tree at the edge of the stream; the other one-third were collected in small quantities from many of the other large trees.

One year's study of seed production is certainly not conclusive, for beech is known to produce large seed crops once only every three to four years (Cain, 1935; Williams, 1936). However, as the seed produced in the center of the beech range has a high germination potential, the failure of seed to germinate here, in conjunction with the paucity of small seedlings, does indicate a very limited ability of the species, here, to produce seed capable of germinating. In Wisconsin and Michigan this condition has been attributed to insufficient moisture (Ward, 1961; Benninghoff and Gebben, 1959). In the southern part of these states viable beech mast is rarely found, while in the cooler, moister northern sections viable mast is found in large quantities. Likewise, in the southern part reproduction is predominantly by sprouts, in the northern sections by seed.

Obviously viable seed is occasionally produced, but only a few seedlings become established at scattered intervals. The evenly ranged ages of the 4-10 in. class trees give further testimony to this. Of the forty-two stems, in only one case were three trees the same age, in eleven cases two were the same.

The humus layer in Hutcheson Forest is a mull type with the organic material grading indistinctly into the mineral soil. Ward (1961) found it possible to correlate the establishment of beech seedlings with the type of humus present. Where seedlings are abundant, the humus tends toward a mor type; while in stands with a mull humus seedlings are infrequent. It is believed that the mor type of humus is more moist

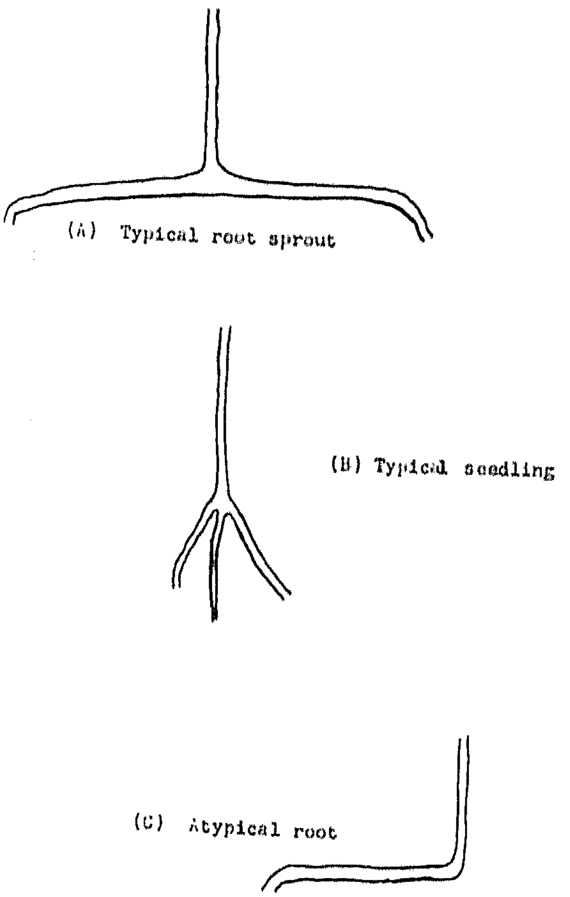


Fig. 5. Types of root development found in Hutcheson Memorial Forest.

and less compacted, thereby providing more favorable conditions for the germination and early survival of beech seedlings. The presence of a mull humus in Hutcheson Forest compounds the problem of seedling establishment.

Because of low seedling production, the relative importance of sprouts as a means of reproduction is high: a minimum of 65% of all trees found are of sprout origin. The importance of sprouting is more clearly demonstrated in the smaller size classes; 85% of the stems under one inch dbh and 27% of the trees with a dbh of one to four inches were of sprout origin.

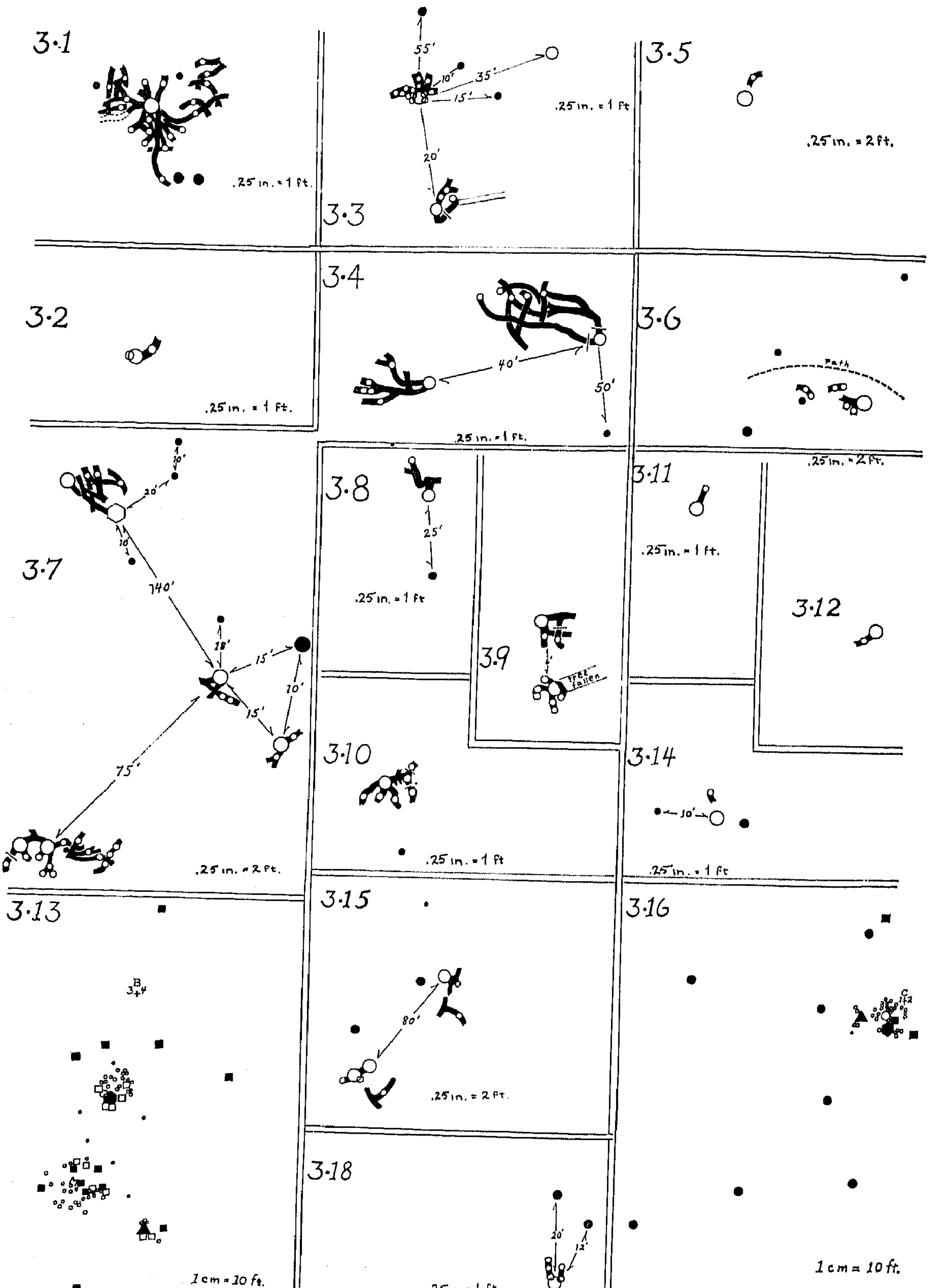
Sprouting was readily recognized in these smaller classes, but became increasingly difficult to recognize in the larger classes. Generally the root of a sprout is as large or larger than the diameter of the stem base and extends superficially for a foot or more to either side of the sprout before curving down into the soil. No feed roots or tap roots occur beneath the stem (Fig. 5a). In contrast, seedlings have a tap root with several lateral roots arising from the base of the stem (Fig. 5b). In a few cases the root had the appearance shown in Fig. 5c. Where the horizontal portion extended a foot or more, the stem was considered a sprout. However, in instances where the horizontal section was less than six inches, it was necessary to interpret the stem as a seedling.

It was often possible to actually trace the sprout-producing root back to the parent root or to a larger root clearly originating from an adjoining tree. However, when the roots extended below six inches or became entangled with other roots, this became impossible.

The greatest difficulties arose with the 4-10 in. and 10-20 in. class trees, where sprouts are sufficiently old to have produced secondary feed and support roots at the stem base thus masking the original sprout root. Furthermore, there was evidence of the disintegration of original sprout roots breaking former connections between stems. As a consequence many stems in these size classes had to be classified as being of seed origin for lack of positive evidence to the contrary.

No stems more than 15 feet from the parent tree could be conclusively identified as sprouts. Ward found no sprouts extending beyond 24 feet from the parent. As might be expected, the larger trees had the greater average number of root sprouts (Table 1). The one 1-4 in. dbh tree which possessed sprouts gave evidence of being itself of sprout origin, but the evidence was not conclusive. With this possible exception, no trees under 49 years of age possessed sprouts.

Work with *Populus*, another frequently sprouting species, indicates that sprouting is a phenomenon similar to axillary branching in stems, and is correlative with apical dominance. Farmer (1952) found that damage to the phloem, interrupting the flow of auxins downward, or outward in the roots, resulted in the production of sprouts beyond the point of injury. If the interruption occurs low on the stem, sprouts will develop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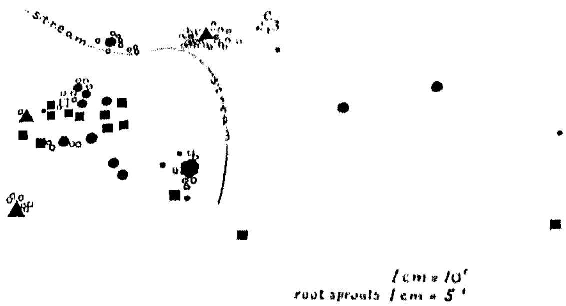

Fig. 3.1- 3.12, 3.14, 3.15, 3.18. The white circles indicate stems which are connected by roots to other stems. The connecting roots are shown in black. The black circles represent stems originating from seed which occur in association with the other trees depicted in the diagrams. The scale given on each diagram refers to the root sprouts. Associated trees are to the same scale except when otherw'se indicated.

Fig. 3.13, 3.16, 3.17. Due to the large numbers of stems involved, it was impossible to indicate root connecttions. The white circles and squares indicate sprouts; the black, seed originated stems. The large circles represent 4 - 10 in. dbh trees; squares, 1 - 4 in. dbh trees; and small circles, trees under 1 in. dbh.

at the stem base; if the interruption occurs in the root, sprouts will develop on the root just beyond the injury.

While actual experimental data are lacking for beech, observations from this study indicate that the same phenomenon may be operational in this species. A high percentage of the roots possessing sprouts were superficial roots subject to abrasion from animals, falling timbers, people, etc. (Fig. 3.1, 3.7, 3.15, 3.16, 3.17, 3.18). Roots bearing five sprouts, shown in Fig. 3.4, were partially under a windthrow, and were perhaps initiated as a result of injury to the root caused by the windthrow. In addition two stems possessing sprouts are themselves windthrows (Fig. 3.3, 3.9). One instance was found in which a tree whose trunk is infested on one side by a fungus had developed numerous sprouts (Fig. 3.3). On the damaged side there are 13 clumps of sprouts, some emanating from the base of the trunk, others from surface roots. On the undamaged side there are no sprouts. Ward (1961), also noted the presence of sprouts where roots had been damaged, in this case due to root-grafting. The occurrence of grafting was noted in the present study, but no attempt was made to correlate this with presence of sprouts.

Calculation of the tree ages was most difficult. The cores were taken at a height of 24 inches as recommended by Douglass (1929) in order to avoid possible root influence. Adjustment was therefore necessary to account for the 24 inches below the core. The 16 inch tall, five year old seedling provided the basis for the correction figure of eight: five years to attain the 16 inches and three for the additional eight inches. A single stem is insufficient datum for calculating a correction factor, but as the only available source of data, it did provide a guide.

In addition, the annual rings, even when stained were not consistently clear, and the possibility of false rings made counting difficult. However, assuming the correction figure is satisfactory, most of the ages can be considered accurate to within three to five years, with several only to within eight to ten years. A few are, at best, only estimates.

Three still-living beech windthrows were found in the forest, two in the 4-10 in. dbh class, a third in the 1-4 in. dbh class. Reiners (1965) in a study of windthrows in the eastern end of the forest found only one beech; this fell sometime after 1955. One mound formed by a beech windthrow (Buell, personal communication) which has been removed was located (Fig. 3.13). Twenty-nine young sprouts formerly associated with this tree surround the mound in the ring pattern characteristic of clones. No other rings of beech sprouts occur in the forest to indicate the existence of large beech prior to the present population. Thus it seems likely that the three trees now over 20 in. dbh together, perhaps, with the two windthrows mentioned above are the beeches which originated the beech population in Hutcheson Forest. As beech is highly sensitive to fire, it is probable that the species was unable to invade the forest until the cessation of periodic burning (1711) following Dutch colonization in 1701.

Conclusions

Several conclusions can be drawn from the data provided in the study. First, beech in Hutcheson Forest is currently reproducing predominantly by root sprouts. Little viable mast is being produced with the result that seedlings are scarce. The data would further indicate that this phenomenon is not new in the forest; only occasional seedlings have been produced, one or two at a time, for the last ninety to one hundred years.

There is considerable evidence in Hutcheson Forest to support the theory that root sprouting is similar in nature to axillary branching in stems, and that sprouts are rarely produced by trees under fifty years old.

The distribution of beech in the forest can be correlated with the clay fraction in the soil.

Finally, the largest beeches present in Hutcheson Forest are probably the beech trees which originated the beech population in the forest.

Summary

Distribution of the beech was studied in Hutcheson Forest in New Jersey where red beech approaches its southern limit.

The location of all beech stems was plotted, and dbh's recorded. Three hundred and ninety-nine stems were found of which the oldest was 150 years old and the youngest seedling, five years.

The beech is restricted to the eastern and central section of the forest. This distrbution can be correlated with the amount of clay present in the soil; beech is present where the clay fracton is high, and absent or rare where the clay content is low.

Seeds were tested for viability and per-cent germination. None of the seeds tested germinated, and only 8 out of 54 seeds showed the presence of living embryonic tissue.

Trees in the 4-10 in. dbh size class were cored and age determinations made counting annual rings. The stems range evenly in age from 42 years to around 100 years.

Examination of roots indicated that 65% of all the stems are derived from sprouts. 90% of the trees under one inch dbh are of sprout origin.

The paucity of viable mast and young seedlings indicates that beech reproduction in Hutcheson is predominantly by root sprouts as has been found in other areas where beech approaches its geographical limits.

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ANNUAL MEETING*

Abstracts of Papers

ARCHEOLOGY

(In cooperation with the Archaeological Society of New Jersey.)

The Rediscovery of a New Jersey Colonial Road Using Archival and Archaeological Evidence

Recently the road designated by the State Highway Department as Route 10, was rebuilt at a cost of approximately one million dollars per mile. This road was built on the bed of the Newark Mount Pleasant Turnpike, which in turn roughly followed a Colonial road which existed as early as 1700. There seems to be further evidence to support a supposition that the Colonial road had its origins in an even earlier Indian trail that ran along part, at least, of the present route.

Prior to 1800 roads were generally used without charge to the traveler, but such roads were often circuitous and poorly constructed. With the advent of the nineteenth century, turnpike roads became popular; they provided a more direct route for the many wagons carrying supplies to the larger towns. A fee was charged for the use of such roads, payable at toll gates, and a long spear or pike was placed across these toll-gates to insure proper payment of the tolls. When the fee was paid the pike was turned to allow the wagon or horseman to pass, hence, the name "turnpike."

The turnpike and road that is the subject of this paper first came to the attention of history in 1666 when the settlers of Newark realized that the Indians employed a rough, but well defined, trail leading through what are now East Orange, Orange and West Orange in a generally westerly direction over the mountains to Wippanong. The Indian name Monusing was adopted by the colonists and the road became known as the Monusing Path. This same Monusing Path became commercially necessary when an iron forge was established in Wippanong about 1700. The pigs of iron were then ferried across

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