THE BLACK ROCK FOREST

BULLETIN No. 7

HENRY H. TRYON, *Director*

BOTANICAL STUDIES IN THE BLACK ROCK FOREST

By

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PREFATORY NOTE

With the inception of silvicultural research on the Black Rock Forest there promptly became evident a need for the study of forest problems upon a perceptibly broader base than had previously been employed in this, and other regions. The publication of a series of monographs dealing with the biota and various related factors was planned. Dr. Hugh M. Raup of the Arnold Arboretum was invited to initiate such work in the summer of 1936. In this paper, the third of the series, effort has been made to bring to bear certain methods and viewpoints of the ecologic and floristic plant geographer. A number of lines of investigation of stimulating interest have been opened thereby. While certain of these methods and viewpoints differ sharply from those usually employed by the professional forester, they are offered in the way of suggestion for future study.

Henry H. Tryon, *Director.*

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INTRODUCTION

The major forest types in the Black Rock Forest were described by H. H. Tryon in 1930. His map and discussion were the result of a careful and painstaking cruise which was concerned primarily with the arborescent flora. The present writer's purpose has been to elaborate this description with studies of all of the vascular plants, and to re-examine the timber associations on a somewhat broader botanical basis. The forest types have been studied, therefore, not only as to local composition and distribution, but also in the light of their geographical affinities in the whole forest cover of northeastern North America. It will be noted that Tryon's classification of the major associations, although modified in some details, has not been greatly altered, and that the shrub and herbaceous floras have proved significant not so much in delineating the various timber types as in characterizing the region as a whole.

Attempts to account for the content and arrangement of the timber have led to some investigation of its probable relation to the pre-colonial forests, as well as to its current trends of development. Its obvious correlations with topographic features have suggested studies of the distribution of local climates and of glacial soils. The results of the geological studies are merely summarized in this paper, and will appear in detail in a forthcoming bulletin by Charles S. Denny.

During the course of the work considerable study of the local flora has been necessary. To give an adequate floristic basis for the following discussion of the vegetation, as well as for future botanical work in the Forest, a catalogue of plants is included in this paper.

ACKNOWLEDGMENTS

THE writer wishes to express his appreciation of the direct assistance and stimulating suggestion given by a number of persons during the field work and the preparation of the manuscript of this paper. Mr. H. H. Tryon, Director of the Black Rock Forest, and Mr. H. L. Mitchell, Assistant Director, have not only been of assistance in planning the project and criticizing the manuscript, but also they have supplied the most delightful and stimulating sort of companionship in the field. Most of the field work in 1937 was done in company with the geologist, Mr. Charles S. Denny whose searching inquiry into the glacial deposits of the area has opened attractive fields of investigation. Professor Kirk Bryan of Harvard University visited the area in the spring of 1937, and has been a constant source of inspiration. Both he and Mr. Denny have very kindly criticized the manuscript. Mr. A. C. Cline, Dr. P. R. Gast, and Mr. N. W. Hosley, all of the Harvard Forest, have been most helpful in criticizing the manuscript, and Prof. I. W. Bailey of Harvard has given some valued suggestions.

DESCRIPTION OF THE AREA

The Black Rock Forest is a tract of privately owned land, approximately 3200 acres in extent, lying just west of the Hudson River in Orange County, New York. It lies in the belt of rocky hills which extends in a southwest and northeast direction across the Hudson about 50 miles above New York City, and has been known since early Colonial times as the Hudson Highlands. This upland is part of the Reading Prong, a mass of crystalline rocks of the ancient Appalachian system which extends from New England southward through New Jersey. The area of the Forest is nearly all in some form of woodland, and has been under active silvicultural management for about ten years.

The northern edge of the Forest, at its lowest elevation, is about 450 feet above sea level, approximately the same as that of the broad, gently rolling Hudson lowland which extends northwestward to the Shawangunk Range. About one-third of the Forest's total area is on the northern slopes of the Highlands between elevations of 500 and 1200 feet. This part is mostly on the slopes of Mt. Misery, Honey Hill, Black Rock (Hill), and Sackett (Hill), and is drained chiefly by Canterbury and Black Rock Brooks. The slopes are in general quite steep with considerable stabilized sliderock, and the ravines are deep with sharp slopes and but small areas of flood plain along their courses.

To the southward is an elevated plateau-like region, mostly between 1200 and 1350 feet above the sea. It occupies between 55 and 60 per cent of the total area of the Forest, and extends entirely across it from northeast to southwest. The surface of the upland is rolling with occasional precipitous cliffs. A few higher hills stand out above the general level: Hill of Pines, 1400 ft.;

Rattlesnake (Hill), 1400 ft.; Black Rock (Hill), 1410 ft.; Spy Rock, 1461 ft. In nearly all cases the steepest slopes of these hills are on their south and west sides. This character is evident also on the smaller elevations in the high land lying about Arthur's and Tamarack Ponds, and westward to Sutherland Pond.

The southern portion of the Forest is marked by valleys carrying streams which drain to the southward. The largest of these is Cascade Brook in the southeast corner, where the lowest elevation reached within the Forest is about 800 feet in what is locally known as Glycerine Hollow. Mineral Spring Brook, at the southwest corner, flows through a valley at about 1100 feet; and other streams southeast of it, in Cat Hollow, are at similar levels. Most of these southward-flowing streams have broader valleys than those on the north; and the lower slopes of their valleys are more gentle and have larger areas of local flood plain deposits.

There are seven ponds in the Forest occupying a total of about 75 acres. On the original surface, however, there was only one which was permanent (Sutherland), though it is probable that the beaver had temporary ones of greater or less extent in several places, particularly in the southern valleys. The large swale through which Mineral Spring Brook now flows is the marsh which followed the drainage of an old beaver pond in this area. That this pond was not of long standing is indicated by the presence in it of the dead standing trunks of the forest trees which were killed by the original flooding. Other recent ponding has been done in the valley of Canterbury Brook just below Sphagnum Pond.

Sutherland Pond lies at an elevation of about 1246 feet and is about a third of a mile long and a third as wide. Its level has been modified in the last few years by beaver work at its southern end. The present shore line is obviously lower by a foot or more than it was within the last two or three years. The other six ponds are all

artificial and have been made within the past twenty years. Most of their shores are rocky; but a few marshy areas are found, notably on Jim's Pond, Aleck Meadow and the Upper Reservoir. The last two of these supply most of the water to the town of Cornwall in which the northern part of the Forest is situated. Consequently they have their levels considerably modified each year. In the dry summer of 1936 the Aleck Meadow Reservoir was nearly drained, and a large amount of water was drawn from the Upper Reservoir and Arthur's Pond.

Tamarack Pond is unique among the seven in having been made by flooding a spruce swamp. A considerable portion of the central mat of mosses and roots originally formed in the swamp appears to have floated up after the pond was formed to make a boggy island upon which most of the characteristic flora of the original swamp has been preserved.

The long period of exploitation in the Forest has left a maze of wood roads scattered throughout the area. A portion of these are now preserved as trails with suitable markings and positions on the map. By them nearly all parts of the Forest can be reached. Two public roads, now for the most part impassable, traverse the property. The old Continental Road was built during Revolutionary times and enters the Highlands by the valley of Canterbury Brook. It crosses the height of land near the head of Arthur's Pond and passes southward by the valley which contains Bog Meadow Pond. This pond lies just outside the Forest boundary on the southeast side. The old West Point Road is a continuation of the present Mountain Road which comes up from the village of Cornwall. It passes the Upper Reservoir and through a portion of the most easterly block of the Forest, crossing the height of land near the eastern end of the Carpenter Trail. It joins with the present Storm King Highway at the point where the latter connects with the Central Valley Road and the road to Highland Falls.

SOILS

THE character and distribution of the mineral soils of the Black Rock Forest have been determined first by the presence of the crystalline bed rock which forms the rugged Highlands region, and second by erosion, deposition, and weathering during and since the last advance of the Pleistocene ice. The predominating influence of the first of these is evident on every hand, while the relative importance of the Pleistocene influence has required considerable study for its evaluation.

The Hudson Highlands are composed largely of crystalline rocks: including granite, gneiss, schist, metamorphosed limestone and associated intrusives (Guidebook No. 9, XVI Internat. Geol. Congr., Washington, 1933). The rocks are highly variable in composition and mineralogically are extremely complex. Most of the bed rock in the Forest probably belongs to a formation called the "Storm King Granite," which is of pre-Cambrian age. Of greatest botanical significance are the facts (1) that this formation holds up high, steep hills composed of hard, predominantly siliceous materials which weather slowly into soil; and (2) that the continental glacier of Pleistocene time apparently removed all trace of the preglacial weathered soil from the uplands. Further, the resistant rocks of the Highlands are sharply contrasted with the Paleozoic or younger formations which lie in the lowlands both to the north and south. The sandstones and shales of which the latter are composed have yielded, by glacial and subsequent erosion and weathering, much finer, more compact soils. This is clearly shown by the large agricultural development on the gently rolling terrain stretching northwestward from the base of the hills.

Much glacially transported material from these softer rocks is to be found in the Forest, especially on the lower northern slopes. Deer Hill which lies just north of Black Rock (Hill) appears to be largely covered by them.

It is generally thought that the ice sheet completely covered the Highlands in Late Wisconsin time. If this is the case we must assume that the present cover of vegetation has all been acquired since the retreat of this glacier. It may be necessary, however, to change these views as the nature and distribution of glacial erosion and deposition become better known. It is clear that these deposits in the Black Rock Forest are not evenly distributed, but seem to be thickest on the lower and middle north slopes. Soil studies by Crabb and Morrison ('14) are inconclusive in these matters. In their description of the Highlands area the distinction between glacial and so-called residual soils is not a clear one, which is particularly significant because the presence or absence of deeply weathered soils is one of the more important criteria for judging the occurrence of recent glacial action.

Recent studies by Denny suggest that the area has not been overrun by ice since Early or Middle Wisconsin time. Nevertheless the near presence of ice in the Catskill Mountains (Rich, 1935) during the Late Wisconsin induced a rigorous climate in the Forest area. Intense frost action under this arctic or periglacial type of climate disturbed the superficial layer of the glacial deposits in the Forest. Later post-Glacial weathering has further changed both this disturbed layer ("warp") and the underlying compact glacial material. On the uplands the glacial deposits, although thin and discontinuous, are rather uniform.

The present condition of the superficial cove and lower slope soils of the Black Rock Forest, as well as their position in modern soil classifications, have been studied by Harold F. Scholz ('31):

"Brown soils are the predominant genetic soil type of the Black Rock Forest; but occasionally the effect of topography upon moisture and temperature, and the character of the forest vegetation result in a definite leaching of these brown soils and the formation of a slightly podsolized profile.

"This same influence of local climate can be traced by the character of the superficial dead organic layer, which is ordinarily a mår humus, but is sometimes modified into a mull humus or raw humus."

Regarding texture and tilth of these soils he states:

"The soils studied may be separated into five texture categories, viz., (1) loam; (2) clay loam having a clay content of 25 per cent or less; (3) clay loam having a clay content of 25 to 30 per cent; (4) clay; and (5) silty clay loam. The limits of the various areas of differing classes on the soil map are not precise, and the breaks in the cross hatching [Cf. map in Scholz ('31)] indicate the probable separation of the various areas.

"From the standpoint of the frequency of their occurrence, (2) and (3) are by far the most important texture groups."

The condition of humus in the soil is summarized as follows:

"The humus content of the cove and slope soils of the Black Rock Forest is not abnormally low. Apparently humification processes have not been badly upset by the forces which have resulted in the gradual loss of the vitality of the growing stock."

"To the extent that the Highlands of eastern New York lie in a climatic transition belt between these two regions [the northern and southern Appalachians], it would be reasonable to expect that the character of the forest humus would also be intermediate. This the field data for this study substantiate. The depth of the superficial dead organic layer is not ordinarily great—range, 1.0 to 2.0 inches, average 1.7 inches."

It is Scholz's conclusion that "There is no great or convincing evidence of destructive surface erosion, a fact that might be explained upon the basis of the texture and structure of the soil—loam, clay loam, clay, and silty clay loam, oftentimes with a compact structure, especially in the deeper layers. These heavy soils are much less subject to surface translocation by run-off than lighter soils."

It should be noted that Scholz's studies were mainly in the cove and lower slope areas, so that much remains to be done on the physical properties of the surface horizons of the upland soils. The available nutritive material in the soils of the Forest is also poorly understood, and may bring to light distributional influences as yet unknown.

CLIMATE

THE Black Rock Forest lies in a portion of the north temperate zone whose mean annual temperature is approximately 50° Fahrenheit. The absolute minimum temperature reaches approximately —15° and the absolute maximum about 103°. Records for the actual site of the Forest are not available, and those given above are from West Point which lies in the highland region but is on the immediate bank of the Hudson and at a considerably lower elevation than the Forest. The mean annual precipitation is approximately 46 inches. As much as 63.56 inches of rain have fallen in one year and as little as 30.64 inches. Approximately 13 of the 46 inches usually fall during the summer months. The average length of the growing season lies between 160 and 180 days.

There is very little in these facts regarding temperature and precipitation with which the distribution of vegetation or types of timber may be correlated. This is due not only to imperfections in the data themselves, but also to lack of precise knowledge regarding the rate and manner in which plants are affected by differences in the conditions. The most successful efforts to improve this situation have been based largely upon studies of the rate of evaporation under various climatic conditions. The process of evaporation has been singled out largely because it so closely resembles one of the few outward aspects of the plant's functional existence whose measure it approximates—the loss of water in transpiration.

A pioneer effort in this correlation was that of E. N. Transeau ('05). This was based upon evaporation data published by Thomas Russell in 1888, covering a period

of twelve months during 1887-8. The information was collected from about 150 stations in the United States. Transeau took these meagre data and by dividing the total annual precipitation for the stations in the same period by the total annual evaporation, reached a quotient which he used as an index of precipitation effectiveness. He then drew a map of eastern United States upon which were outlined provinces based on these quotients. He proceeded to correlate this map in a very striking manner with the distribution of forest centers in eastern America. A so-called "duration factor" was introduced into the formula by Livingston and Shreve ('21). They took the same evaporation data used by Transeau but confined their calculations to the period of the average frostless season for the stations involved; and they further refined the formula by adding to the total precipitation of the average frostless season that which fell in the preceding 30 days, since the latter would be effective in the early stages of the season's growth. This method brought about a somewhat better correlation between the P-E ratio and the distribution of vegetation, but did not materially change Transeau's major areas. According to Livingston and Shreve the Black Rock Forest region has a P-E ratio derived by this formula of between 80 and 100, and lies near the latter value.

Owing to the fact that evaporation data are so inadequate, Thornthwaite ('31) has devised a technique of computing the P-E ratio from figures which are readily available at weather stations: the mean monthly temperature and the monthly precipitation. This method involves a formula derived from a mass of actual evaporation data secured at twenty-one stations in western United States. On the map of North American climates prepared by Thornthwaite our area is placed among the so-called "B" or humid climates, which have a P-E index of 64 to 127. It is in the so-called "microthermal" (C^1) temperature efficiency province, having a temperature-

evaporation index (T-E) of 32 to 63, and is further classified as belonging in that region where the concentration of temperature efficiency in June, July and August lies between 50 and 69 per cent (c). In the classification of temperature efficiency concentration it lies very close to the section in which only 35 to 49 per cent falls in the three summer months (b). A notable feature of the northern boundary of Thornthwaite's BB'r climate ("r" indicates that the rainfall is adequate at all seasons), having a T-E index of 64-127, is that it has a small northern extension near the Atlantic coast which, if the seasonal distribution of temperature efficiency is considered, might be moved northward to include the southern tip of New York State (see also Kendall '35).

Thornthwaite suggests that his BB'rb climate should be correlated with the deciduous forest climax as outlined by Clements. It will be seen, however, that the deciduous forest climax extends much farther northward. His line of demarkation might better be correlated with the boundary of some southern phase within the deciduous forest climax. His T-E isopleth for the value 48, however, corresponds fairly well with the northern boundary of the deciduous forest.

From the above notes it is evident that the Hudson Highlands are not far from a climatic boundary which has proved to have a rather close correlation with a major transition in forest types. After an extended and exhaustive study of possible correlations between climate and vegetation in the United States, Livingston and Shreve reached this conclusion ('21, p. 517): "The preceding pages have brought out the fact that the moisture ratio π/E [$\pi =$ the total normal precipitation for the average frostless season plus that of the preceding 30 days] is the most important single expression of climatic conditions with respect to the vegetation as a whole"; and, "The isoclimatic line for the ratio value 0.110 closely follows the limit of the Southeastern Mesophytic

Evergreen Forest from Alabama to New Jersey, and then swings westward in such a manner as to approximate closely the southern limit of the eastern section of the Northern Mesophytic Evergreen Forest, failing to dip with the vegetation along the Alleghanies (where there are no data for this climatic map), but closely following the vegetational line to Minnesota.''

The Highlands probably bear a somewhat closer climatic relationship, particularly on their northern slopes, to the northern forest than is the case in the surrounding lowlands from which come most of the climatic data. The Catskill mountains, which lie about 50 miles to the northwest, show the northern vegetational relationship very clearly.

Detailed studies of local climate are yet to be made in the Black Rock Forest, but should prove to be of considerable value not only in accounting for the present distribution of timber types, but also in projected programs for silvicultural treatment. In the summer of 1937 the writer placed recording hygro-thermographs in the white oak-hickory association on the top of Black Rock (Hill), and in the cove timber at the base of the north slope.[1] The instruments were in place for only three weeks during the month of July, and the scanty data give only a suggestion of the differences which may be expected between the two stations. The daily maxima are usually 2 to 5 degrees F. higher at the top of the hill than at the bottom, while the daily minima are lower in the cove by about the same amount. There is also a notable difference in the time of occurrence and the duration of high and low temperatures. At the top of the hill the highest temperatures are usually reached between 2 and 4 o'clock in the afternoon, after which cooling occurs rapidly and temperatures approaching the night's minimum are

[1] The writer is indebted to Dr. Charles F. Brooks of the Blue Hill Meteorological Observatory of Harvard for the loan of one of these instruments.

sometimes attained before midnight. The daily maxima in the cove, on the other hand, are usually reached about noon, and are followed by more gradual cooling during the afternoon and evening. The results of these differences are that the lowest daily temperatures at this time of year are of somewhat longer duration at the top than at the foot of the hill, and that the peak during the heat of the day is considerably sharper at the top than at the foot. The relative humidity, as would be expected, shows more fluctuation at the top than in the cove, the latter commonly showing high values before midnight which persist until morning.

TYPES OF VEGETATION IN THE BLACK ROCK FOREST

THE field studies upon which the following notes are based were made during the summers of 1936-37. They consisted, first, of collections of the vascular flora; second, transects through series of timber types; and third, miscellaneous observations made while collecting or rambling through the woods. The results of the collecting will be found in the appended list of plants known to occur in the Black Rock Forest. The localities for the transects were selected in such a way as to represent as many types of timber as possible, in as many relationships as possible; and their approximate positions are shown by lines on the map. Profiles of the sections appear in Figures 2 to 9. No detailed quadrats were laid down, but a fairly accurate delineation of primary species was made by inspection or by rapid stem-counts in cases where questions arose. After the primary species in the tree and shrub layers were thus determined, lists of all species of secondary importance in the associations were made, with notes on general slope and soil conditions. Very few attempts were made at describing the often complex "layering" in the forest. Young stems of tree species were mainly described as "advance" growth, and were not considered as part of any particular layer. This method seems more consistent with a developmental viewpoint regarding the forest complex as a whole than one in which the plants are looked upon as "life-forms" without immediate respect to their specific potentialities.

TABLE OF SPECIES IN THE PRINCIPAL WOODLAND ASSOCIATIONS OF THE BLACK ROCK FOREST

A circle o indicates that a species is a primary one in the association under which it appears

	Scrub oak	*White oak—hickory*	*Chestnut oak*	*Red oak*	*Mixed hardwood*	*Mixed hardwood (wet phase)*	*Hemlock—hardwood*	*Beech—sugar maple —yellow birch*
	1	2	3	4	5	6	7	8
Equisetum arvense					x			
Lycopodium lucidulum						x		
L. obscurum					x			
Botrychium virginianum				x	x		x	
Osmunda Claytoniana				x	x	o	x	
O. regalis v. spectabilis						x		
Woodsia ilvensis	x							
Cystopteris fragilis							x	
Onoclea sensibilis						x		
Dryopteris hexagonoptera				x				
D. Thelypteris						x		
D. noveboracensis				x	x			
D. marginalis	x	x	x	x	x		x	x
D. spinulosa				x	x	x		x
Polystichum acrostichoides				x	x		x	x
Woodwardia virginica						x		
Athyrium angustum					x		x	
Adiantum pedatum				x				
Pteridium aquilinum v. latiusculum		x	x	x				

	Scrub oak	*White oak—hickory*	*Chestnut oak*	*Red oak*	*Mixed hardwood*	*Mixed hardwood (wet phase)*	*Hemlock—hardwood*	*Beech—sugar maple —yellow birch*
	1	2	3	4	5	6	7	8
Polypodium virginianum		x	x				x	
Tsuga canadensis			x	x	x	x	o	
Pinus Strobus		x	x					
P. rigida	o	x						
Juniperus virginiana	x	x						
Bromus purgans			x					
Festuca obtusa							x	
Glyceria melicaria						x		
Asperella Hystrix		x	x	x				
Sphenopholis pallens							x	
Deschampsia flexuosa	x	x	x	x				
Danthonia spicata	x	x	x	x				
Calamagrostis canadensis						x		
Agrostis tenuis			x		x			x
A. perennans						x		
Cinna arundinacea					x	x		x
Muhlenbergia tenuiflora			x					
Brachyelytrum erectum				x	x			
Oryzopsis racemosa			x					
Panicum latifolium	x	x	x					
P. dichotomum		x		x				
P. linearifolium v. Werneri	x		x					

	Scrub oak	*White oak—hickory*	*Chestnut oak*	*Red oak*	*Mixed hardwood*	*Mixed hardwood (wet phase)*	*Hemlock—hardwood*	*Beech—sugar maple —yellow birch*
	1	2	3	4	5	6	7	8
P. Lindheimeri v. fasciculatum	x	x						
Andropogon scoparius v. frequens	x							
Carex rosea		x			x			
C. rosea v. radiata				x				
C. crinita v. gynandra						x		
C. stricta						x		
C. leptalea						x		
C. virescens			x	x				
C. gracillima					x			
C. pennsylvanica		x	x					
C. platyphylla			x	x	x		x	x
C. anceps					x		x	x
C. scabrata						x		
Arisaema triphyllum				x	x	x		x
Luzula campestris v. multiflora				x				
Uvularia perfoliata		x		x			x	
Oakesia sessilifolia	x	x	x	x	x	x	x	
Lilium philadelphicum					x			
Smilacina racemosa	x	x	x	x	x		x	
Maianthemum canadense		x		x	x	x	x	
Polygonatum biflorum	x		x					
Medeola virginiana				x	x	x		

	Scrub oak	*White oak—hickory*	*Chestnut oak*	*Red oak*	*Mixed hardwood*	*Mixed hardwood (wet phase)*	*Hemlock—hardwood*	*Beech—sugar maple—yellow birch*
	1	2	3	4	5	6	7	8
Trillium erectum							x	
Smilax herbacea					x			
Iris versicolor						x		
Cypripedium acaule		x	x					
Corallorrhiza maculata				x				x
Populus grandidentata				x	x			
Myrica asplenifolia	x	x						
Juglans cinerea					x	x	x	
Carya glabra	x	o	x	x	x			
C. ovata				x	x			x
Ostrya virginiana				x	x			
Corylus rostrata				x				
Betula populifolia				x	x	x		
B. lenta	x	x	x	x'	x		x	x
B. lutea				x	o	o	o	
Alnus incana						x		
A. rugosa						x		
Fagus grandifolia			x	x	x	x	x	o
Castanea dentata		x	x	x	x			
Quercus borealis	x	x	x	o	o	o	x	x
Q. coccinea	x	x						
Q. velutina				x				

	Scrub oak	*White oak—hickory*	*Chestnut oak*	*Red oak*	*Mixed hardwood*	*Mixed hardwood (wet phase)*	*Hemlock—hardwood*	*Beech—sugar maple —yellow birch*
	1	2	3	4	5	6	7	8
Q. ilicifolia	o	x	x					
Q. alba	x	o	x	x	x	x	x	
Q. montana	x	x	o	x	x	x	x	
Ulmus americana				x	x	x		
Laportea canadensis							x	
Asarum canadense					x			
Polygonum Hydropiper						x		
P. arifolium v. lentiforme						x		
P. virginianum				x			x	
Silene antirrhina	x							
Caltha palustris						x		
Actaea alba					x		x	
Hepatica americana							x	
Ranunculus recurvatus							x	
Thalictrum dioicum				x	x		x	
T. polygamum					x			x
Berberis Thunbergii					x			
Liriodendron Tulipifera				x	x	x	x	
Sassafras officinale		x	x	x	x	x		
Benzoin aestivale				x	x	o	x	
Cardamine pennsylvanica					x	x		x
Heuchera americana			x					

	Scrub oak	*White oak—hickory*	*Chestnut oak*	*Red oak*	*Mixed hardwood*	*Mixed hardwood (wet phase)*	*Hemlock—hardwood*	*Beech—sugar maple —yellow birch*
	1	2	3	4	5	6	7	8
Mitella diphylla							x	
Hamamelis virginiana			x	o	o		x	
Platanus occidentalis					x		x	x
Physocarpus opulifolius			x					
Spiraea latifolia						x		
Aronia melanocarpa	o		x					
Amelanchier canadensis	x	x	x	x	x			
Crataegus macrosperma	x	x						
Rubus allegheniensis			x	x	x	x		
R. hispidus	x							
Fragaria virginiana		x						
Potentilla simplex		x		x	x			
Rosa carolina			x				x	
Prunus serotina	x	x	x	x				
P. pumila v. susquehanae	x							
Desmodium nudiflorum					x			
D. bracteosum				x				
D. rotundifolium			x					
Lespedeza intermedia			x					
L. hirta		x						
Amphicarpa bracteata				x			x	
Geranium maculatum				x	x		x	

	Scrub oak	*White oak—hickory*	*Chestnut oak*	*Red oak*	*Mixed hardwood*	*Mixed hardwood (wet phase)*	*Hemlock—hardwood*	*Beech—sugar maple —yellow birch*
	1	2	3	4	5	6	7	8
Rhus glabra	x							
R. typhina	x			x				
R. copallina v. latifolium	x	x						
R. Toxicodendron				x	x	x		x
Ilex verticillata						x		
Celastrus scandens				x				
Acer pennsylvanicum		x	x	x	x		x	
A. rubrum		x	x	x	o	o	x	
A. saccharum			x	x	o		o	o
Impatiens biflora					x	x		x
Ceanothus americanus	x	x						
Vitis aestivale		x	x		x		x	
V. labrusca					x	x		
Parthenocissus quinquefolia	x	x	x	x	x	x	x	
Tilia americana			x	x	x	x	x	x
Helianthemum canadense	x							
Viola blanda						x		
V. pubescens			x	x	x			
Nyssa sylvatica				x	x	o	x	
Circaea latifolia							x	
Aralia racemosa					x		x	x
A. nudicaulis	x	x	x	x	x		x	

	Scrub oak	*White oak—hickory*	*Chestnut oak*	*Red oak*	*Mixed hardwood*	*Mixed hardwood (wet phase)*	*Hemlock—hardwood*	*Beech—sugar maple —yellow birch*
	1	2	3	4	5	6	7	8
Hydrocotyle americana						×		
Osmorhiza Claytoni					×		×	
Cryptotaenia canadensis							×	
Zizia aurea				×				
Cornus florida				o	×		o	
C. rugosa				×				
C. racemosa	×	×				×		
Clethra alnifolia						o		
Pyrola elliptica							×	
Rhododendron nudiflorum v. roseum		×	o	×	×	×		
Rhododendron maximum							×	
Kalmia latifolia		×	o	×	×	×		
K. angustifolia						×		
Gaultheria procumbens		×			×			
Gaylussacia baccata	×	×	o					
Vaccinium pennsylvanicum	×	×	o		×			
V. vacillans	o	o	o	×	×			
V. corymbosum				×	×	o		
V. corymbosum v. pallidum		×						
Lysimachia quadrifolia	×	×	×	×	×			
Fraxinus americana	×	×	×	×	o	o	×	×
F. nigra						×		

	Scrub oak	*White oak—hickory*	*Chestnut oak*	*Red oak*	*Mixed hardwood*	*Mixed hardwood (wet phase)*	*Hemlock—hardwood*	*Beech—sugar maple —yellow birch*
	1	2	3	4	5	6	7	8
Apocynum androsaemifolium	x			x				
Scutellaria lateriflora						x		
Satureja vulgaris			x					
Cunila origanoides			x					
Lycopus uniflorus						x		x
Collinsonia canadensis			x	x	x			
Veronica officinalis					x			
Aureolaria flava				x	x			
A. virginica		x						
Melampyrum lineare v. latifolium.				x				
Epifagus virginiana								x
Cephalanthus occidentalis						x		
Galium lanceolatum				x				
Viburnum acerifolium		o	o	o	x		o	
Viburnum dentatum				x		x		x
V. affine var. hypomalacum	o	o	x	x				
V. Lentago						x		
Lonicera dioica	x	x	x	x				
Diervilla Lonicera	x			x				
Campanula rotundifolia	x							
Solidago bicolor			x					
S. caesia	x	x	x	x	x		x	x

	Scrub oak	*White oak—hickory*	*Chestnut oak*	*Red oak*	*Mixed hardwood*	*Mixed hardwood (wet phase)*	*Hemlock—hardwood*	*Beech—sugar maple—yellow birch*
	1	2	3	4	5	6	7	8
S. odora		×						
S. juncea	×							
S. arguta				×				
Aster macrophyllus	×	×	×	×	×			
A. divaricatus				×	×		×	×
A. Lowrieanus				×				
A. umbellatus						×		
A. patula	×							
A. acuminatus				×	×			
A. linearifolius	×							
Antennaria plataginifolia			×	×				
Helianthus divaricatus		×						
Bidens frondosa						×		×
Senecio obovatus					×		×	
Hieracium pratense				×				
Prenanthes trifoliolata				×	×		×	

The sections in Figures 2 to 9 are annotated only with primary [1] species, and the many lists of secondary ones made in the field have been used to compile the general

[1] The word "primary" is here used in most cases in place of "dominant." The latter implies competition, the amount, and sometimes the existence of which is not easily determined. The word "association" is used in a broad sense to mean any aggregation of plants that is readily seen to be different from its neighbors on account of the preponderance of one or more species that reach their best development in it.

floras of the various types of timber as well as those of minor plant associations in the Forest. Problems arising out of differences in the floras of a single type in various parts of the Forest will be found in the discussions following these floras. Detailed studies of vegetation types other than those of woodland were not made, except as collecting required it. The following notes along this line, therefore, leave much to be desired.

A body of exceedingly useful information and suggestion was derived, in the summer of 1937, from studies of glacial deposits in the Forest. In addition to a description of the surface configuration of these deposits, their internal structure was investigated by means of a series of pits ranging from one to fourteen feet in depth. The sites for the excavations were selected so as to represent not only the various topographic features, but also the different forest associations.

Aquatic and Shore Vegetation

The Forest is notably poor in aquatic life in spite of its seven ponds. All of the artificial ponds have been made so recently that they have not acquired much of a biota, and this is further checked by frequent fluctuations in level. Sutherland Pond has a small aquatic flora which may also be held in check by fluctuations of level, since it has been affected by beaver workings in recent years. There is a tendency to develop a bog type of pond shore vegetation, as shown at the southern end of Sutherland Pond and on the island in Tamarack Pond. The latter occupies the site of a "spruce swamp" which may have been the culminating stage in an old shore development. Some of the coves have evidently had a swamp type of vegetation in earlier times, if not actual ponds. Between Mt. Misery and the Hill of Pines is such an area, where remains of the old ponds are still present during wet seasons. Another is east of Sutherland Pond at the base of

EXPLANATION

Location of transects of shore vegetation shown in text figure 1.

H

Location of vegetation transects A-H inclusive shown in text figures 2-9

Roads

Trails

Topography from Sheet No.1 of map of Palisades Interstate Park by U.S. Geological Survey, 1928

APPROXIMATE MEAN DECLINATION 1927

INDEX MAP

Scale 1/12 000

1 inch = 1000 feet

0 500 1000 2000 3000 4000 feet

0 1/2 1 mile

Contour interval 20 feet

Datum is mean sea level.

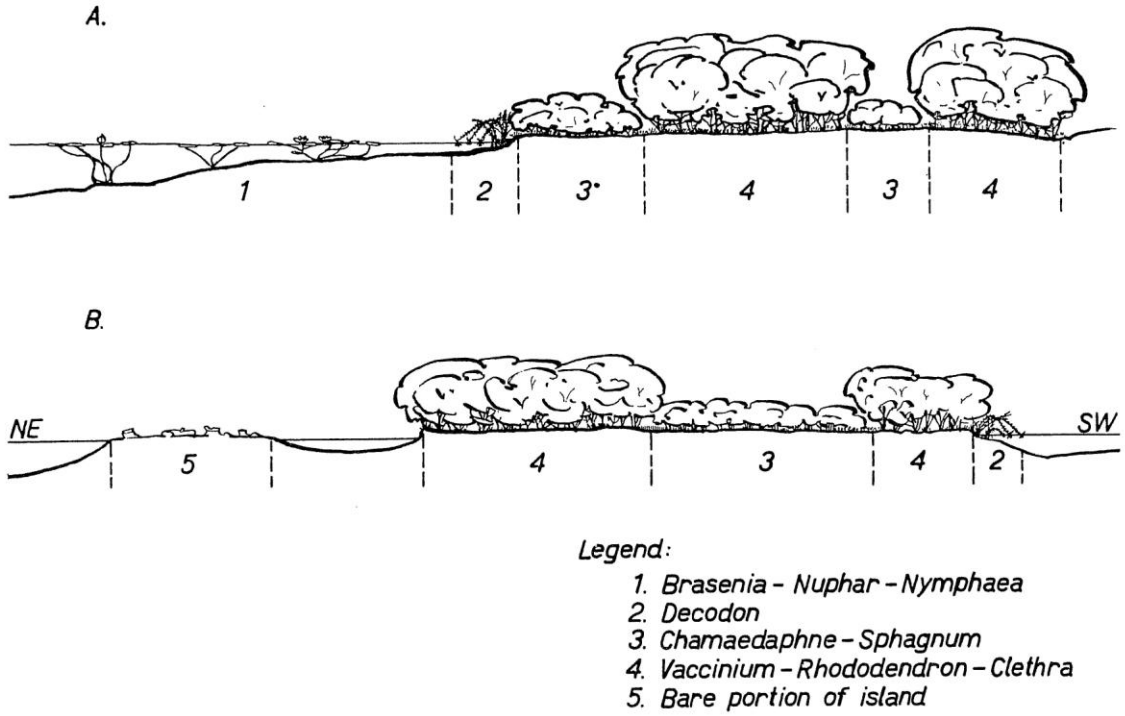


FIG. 1. SECTIONS OF POND SHORE VEGETATION.[1]
A—southern end of Sutherland Pond; B—island in Tamarack Pond.

a steep cliff along the Chatfield Trail (Sect. F. 8). The soil in these coves is peaty.

Figure 1-A is a generalized section of the vegetation at the southern end of Sutherland Pond. Zone 1 contains an open association of water lilies: *Brasenia Schreberi, Nuphar variegatus,* and *Nymphaea odorata.* These occur in patches, the last two mostly on the deeper eastern side of the pond. The western side has a shallow gravelly bottom for a considerable distance off-shore, and has a scanty growth of *Eriocaulon septangulare, Lobelia Dortmanna, Sagittaria graminea, Nymphoides lacunosum,* and *Utricularia minor.*

Zone 2 is composed mainly of the swamp loosestrife, *Decodon verticillatus* var *laevigatus.* It is confined to the southern end of the pond where it grows in muck and forms new hummocks off-shore by its active colonizing habits. *Peltandra virginica* is rather common in this

[1] The writer is indebted to Dr. Leon Croizat for assistance in the preparation of this figure.

zone. Zone 3 is dominated by the leatherleaf, *Chamaedaphne calyculata, Sphagnum* moss which forms a hummocky mass upon which it grows, and the cranberry, *Vaccinium macrocarpon.* Like the loosestrife this association does not extend all around the pond, but is confined to the boggy southern end. (See Plate I.)

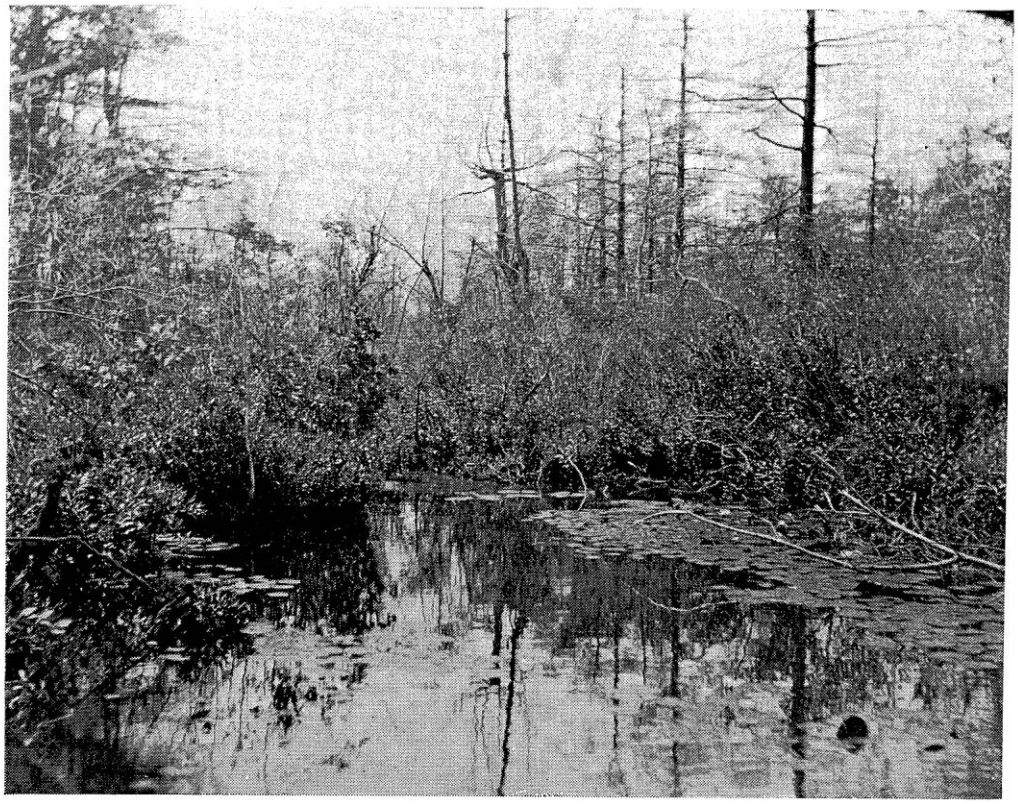


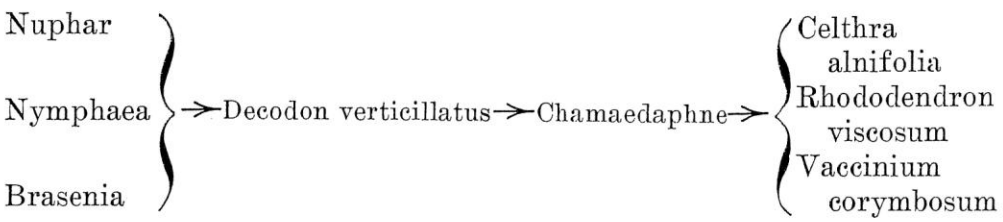
PLATE I. BOGGY SHORE AT SOUTHERN END OF SUTHERLAND POND.

Scattered through the *Chamaedaphne,* and superceding it in places at the shore, is the typical tall shrub association of such habitats, dominated by *Vaccinium corymbosum, Rhododendron viscosum,* and *Clethra alnifolia.* These primary species border most of the pond except where steep rock faces descend to the water's edge. There is a great deal of variation in the association, with one or another of the three forms predominant. Characteristic secondary species in it are as follows:

Dryopteris Thelypteris
Arisaema triphyllum
Carex trisperma
Betula populifolia
Alnus incana
Sarracenia purpurea
Drosera rotundifolia
Spiraea latifolia
Aronia melanocarpa
Aronia arbutifolia
var. atropurpurea
Rhus Vernix
Acer rubrum
Rhexia virginica
Hypericum virginicum
Ilex verticillata
Nemopanthus mucronata
Kalmia angustifolia
Chamaedaphne calyculata
Lycopus uniflorus
Viburnum dentatum
Viburnum cassinoides
Bidens connata var. petiolata
Sphagnum sp.

As noted elsewhere the level of the water was raised recently by beaver workings, and subsequently lowered again, so that around much of the pond there is a narrow band of shrubbery partly killed by the flooding. But the upper part of the shrub association is intact, and the boggy area at the southern end seems not to have been seriously affected. With the addition of a few species, such as *Picea mariana* and *Woodwardia virginica, Sparganium americanum, Ludwigia palustris, Galium trifidum, Rumex Brittanica,* the above list is characteristic for most of the restricted bog-shrub growth in the Forest. Variations of it are to be found in wet peaty places in the cove timber, where water stands for a part of the season. Sometimes the wetter parts of these may have a thick growth of *Osmunda regalis* var. *spectabilis,* or they may have a tussock growth of *Carex stricta* and *Woodwardia virginica* surrounded by a tall shrub association of *Vaccinium corymbosum, Rhododendron viscosum* and *Cephalanthus occidentalis* among which is a stand of the blue-joint grass, *Calamagrostis canadensis.*

Judging by the approximately normal shoreline conditions at the southern end of Sutherland Pond, the open water is being colonized by a succession of associations as follows:



The situation on the island in Tamarack Pond appears to be a special case of the above arrangement of associations, brought about by the artificial ponding of the area. Preparatory to making the pond all the timber and undergrowth was cut off in the spruce swamp which originally stood there. Sometime after the pond was filled the island appeared in it, consisting of a mass of moss, roots and stumps. It looks as though the originally uncompacted peat of the old bog, probably partly afloat in the original condition, simply "domed" up to the surface. Data gathered by probing show that the present vertical thickness of the island is about 4-5 feet. Beneath this is a layer of water from which the peat sampler retracted nothing. The true bottom appears to begin about 12 feet below the present surface of the island, and is composed of peat to a depth of at least 6 feet more. The length of time during which the submergence was complete must not have been very great, since the roots of most of the plants were not killed. Old stumps and cuttings are visible everywhere on the island, and the present woody flora, if not also the herbaceous, is of sprout origin. Figure 1-B is a diagramatic section through it from northeast to southwest. The associations are floristically closely similar to those described above: 2. *Decodon verticillatus;* 3. *Chamaedaphne calyculata, Vaccinium macrocarpon, Sphagnum;* 4. *Vaccinium corymbosum, Clethra alnifolia, Rhododendron viscosum, Sphagnum.* The open water is nearly devoid of aquatic plants; and the area marked 5 is a mass of dead stumps and muck which for some reason did not regenerate its vegetation, possibly because it remained under water too

long, or its flora was too mesophytic to permit any submersion. With such a checkered history, further complicated by the fact that the beaver have built large houses on the southern shore, it is difficult to reconstruct any developmental sequence in the arrangement of the associations on the island.

Two facts are of interest in this connection. The few black spruces are grouped around a single old stump about the middle of the section, in the southern border of Zone 4. They are mostly small, and were thought to be seedlings until it was found that they could be traced to low branches from a single old stump which were trailing through the moss. Another notable fact is that the actively colonizing *Decodon* is confined to the south and west sides of the island, and originates from very old root-stocks which evidently came up with the main mass of peat. These things, together with the presence of a broad band of *Chamaedaphne,* the next stage in the succession, between the *Decodon* and the taller shrubs and spruce, suggest that the southwest shore of the island was the site of a very wet place in the original swamp, probably a pond with marginal associations like those now at Sutherland Pond. It is presumed that the northernmost part of the swamp vegetation in this case would be the most mesophytic, a spruce forest, and that only the southern border of it could have been affected by the "doming" process. At the same time it could not stand submergence as well as the bog shrub types, with the result that what did come up failed to sprout, and remains as the fragment numbered 5 on the diagram.

At best the above is only a working hypothesis to account for the present arrangement of plants. It should be checked by a study of the bottom contours of the pond, and by a study of the topography before the pond was made.

The scanty marginal vegetation of the newer ponds is mostly of the marsh type, made up principally of grasses

and sedges. Jim's Pond has more of this than any of the others, probably because it lies on the south side of the watershed and is not drawn upon for water supply. It should also be noted that this pond is slightly older than the others. One of the first plants to appear on these shores is *Glyceria canadensis,* which often grows in the water. In some places the cattail, *Typha latifolia,* and the bur-reed, *Sparganium americanum* are the first to appear. These are followed by characteristic grasses and sedges of damp shores:

Glyceria striata
Poa palustris
Leersia oryzoides
Scirpus atrovirens
Scirpus cyperinus var. pelius
Carex vulpinoidea
Carex stipata
Carex canescens var. disjuncta
Carex scoparia
Carex stricta
Carex crinita
Carex crinita var. gynandra
Carex comosa
Carex lurida
Carex intumescens

and a variety of other marsh herbs such as: *Pontederia cordata, Juncus tenuis, Iris versicolor, Cicuta bulbifera, Cicuta maculata, Lysimachia terrestris.*

The shrub association which follows this differs from that on bog shores principally in the abundance of the buttonbush, *Cephalanthus occidentalis. Vaccinium corymbosum* is also a primary species, and occasionally *Clethra alnifolia.*

The shores of the water-supply reservoirs, particularly Aleck Meadow and the Upper Reservoir, have a large and rather miscellaneous assemblage of plants drawn from native marsh types and from the more hydrophytic element in the introduced weed flora. During the spring and early summer the water levels are fairly constant, but in late summer large areas of the bottoms are commonly exposed to desiccation, so that the only plants able to thrive in abundance are those able to withstand this periodic drying. It is almost impossible to define the

plant associations under these conditions, but a few prominent features are outstanding.

The most widespread mud plant is *Eleocharis acicularis* which forms a green cover on much of the bottom of Aleck Meadow Reservoir in late summer. Toward the higher water levels there is an abundance of *Eleocharis obtusa, Cyperus strigosus, Juncus acuminatus, Lysimachia terrestris,* and *Ludwigia palustris,* while still farther up, approximately at high water level, are found the usual marshy shore-line forms noted above, common among which are *Glyceria canadensis, Carex lurida, Scirpus atrovirens,* and *Glyceria striata.* Other plants commonly found at these fluctuating pond margins are as follows:

Alisma Plantago-aquatica var. parviflorum
Elymus riparius
Poa palustris
Eleocharis palustris
Carex scoparia
Carex crinita
Carex vulpinoidea
Rorippa palustris
Penthorum sedoides
Hypericum perforatum
Lythrum Salicaria
Steironema ciliatum
Asclepias incarnata
Lycopus uniflorus
Solanum Dulcamara
Veronica scutellata
Bidens frondosa
Bidens connata var. petiolata

Still another marsh type occurs in old beaver ponds which have been drained. Such areas occur in the valley of Mineral Spring Brook on the west side of the Forest, and in the low ground immediately below Sphagnum Pond. The first of these has an almost continuous tangled mat of *Polygonum sagittatum* and *P. arifolium* var. *lentiforme* over large areas, with such accompanying plants as *Impatiens biflora, Epilobium glandulosum* var. *adenocaulon, E. coloratum, Myosotis laxa, Cirsium arvense, Leersia oryzoides, Polygonum scandens.* In later stages this vegetation seems to run into a shrub type in which *Rosa palustris* and *Rubus allegheniensis* are abundant. This form occurs in Compartment X., below Sphagnum Pond. Such marsh plants as *Veronica ameri-*

cana, Lycopus uniflorus, Scutellaria lateriflora, Juncus debilis, Carex debilis var. *Rudgei* are common here.

The beds of brooks have a small but characteristic assemblage of aquatic and uliginous species, merging on the upper parts of the banks with the surrounding forest which in most cases is of a cove type. Particular notes were made of brook floras in Glycerine Hollow and in the stream which drains Jim's Pond. Early in the season these brooks are small running streams, but later they are reduced to damp mud and gravel, or to small pools. It is difficult to determine any predominating species, since the habitat as a whole is unstable, and shifts with every flood. A few species, however, are typical of these wet, shaded situations where running water is available. Among them are *Glyceria melicaria, Leersia virginica, Habenaria psychodes, Laportea canadensis, Pilea pumila, Ranunculus laxicaulis, Chrysosplenium americanum, Callitriche palustris, Hydrocotyle americana, Chelone glabra, Mimulus ringens, Lobelia cardinalis.*

In the bed of Cascade Brook the habitats are roughly divided between the wet crevices among rock and stones, and local bars of gravel, sand and muck. In the former the commonest species are:

Onoclea sensibilis	Hydrocotyle americana
Carex rosea	Lycopus uniflorus
Juncus tenuis	Lobelia cardinalis
Viola sp.	Eupatorium perfoliatum

In wet gravel *Leersia virginica* and *Glyceria melicaria* are the commonest forms, associated with the following:

Sparganium americanum	Chrysosplenium americanum
Glyceria striata	Callitriche palustris
Carex crinita	Impatiens biflora
Pilea pumila	Veronica americana
Polygonum sagittatum	

The bed of the stream which drains Jim's Pond appears to have been more affected by openings in the tim-

ber than the one just described. This may be due in part to cutting, but it must also be affected by its elevation and the relatively drier woodland on both sides. Reference to Sections D and H will show this contrast. The commonest species form a tangle of vegetation over most of the brook bed: *Osmunda regalis* var. *spectabilis, Polygonum Hydropiper, Benzoin aestivale, Rhus Toxicodendron, Parthenocissus quinquefolia, Viburnum dentatum.* Secondary species in the tangle are: *Dryopteris spinulosa, Cinna arundinacea, Rubus allegheniensis, Ilex verticillata, Impatiens biflora, Vitis labrusca, Cornus racemosa, Clethra alnifolia, Lycopus uniflorus.*

As previously stated the brook flora merges imperceptibly with the neighboring woodland, and further phases of it will be found in the discussion of the timber types.

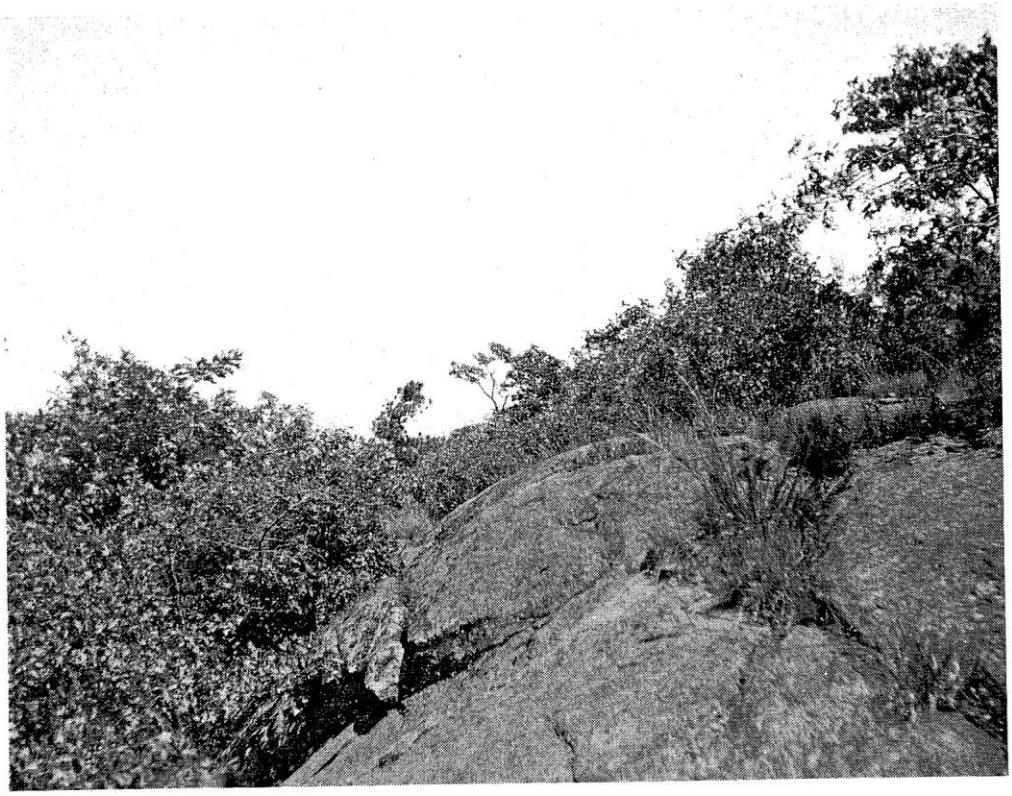


PLATE II. *QUERCUS ILICIFOLIA* AND *ANDROPOGON SCOPARIUS* VAR. *FREQUENS* ON SUMMIT OF SACKETT.

"Alpine" Meadows

A characteristic feature of hill-top vegetation is the occurrence of small areas of natural meadow, usually on southwesterly exposures. In one form or another they occur on nearly all the higher ridges and rounded hills (See Sections A, D, E, F, G), where they are nearly always interspersed with the scrub oak, *Quercus ilicifolia,* and its associates. On summits made up largely of massive rock outcrops such as that of the Hill of Pines the grassy spots are limited to small pockets of soil which have collected in crevices or depressions in the rocks. Other summits like that of Mt. Misery, Black Rock (Hill), and the hill southwest of the White Oak Corner, have comparatively wide areas of stable soil, and consequently a wider expansion of the meadow and scrub oak types. The largest of these is on the rounded knoll southwest of White Oak Corner.

The following is a general list of the meadow flora.

Primary spp.	Deschampsia flexuosa	
	Danthonia spicata	
	Andropogon scoparius var. frequens	
	Polytrichum (commune?)	
	Cladonia spp.	
Secondary spp.	Poa compressa	Helianthemum Bicknellii
	Juncus dichotomus	Lechea intermedia
	Polygonatum biflorum	Cornus racemosa
	Cerastium arvense	Gaylussacia baccata
	Anemone riparia	Vaccinium pennsylvanicum
	Corydalis sempervirens	Vaccinium vacillans
	Prunus pumila var. susquehanae	Apocynum androsaemifolium
		Diervilla Lonicera
	Lespedeza capitata	Campanula rotundifolia
	Rhus copallina var. latifolium	Solidago juncea
		Aster patula
	Hypericum gentianoides	Aster linariifolius
	Helianthemum canadense	Krigia virginica

The above list is drawn up from observations on several sites. The association may be roughly divided into

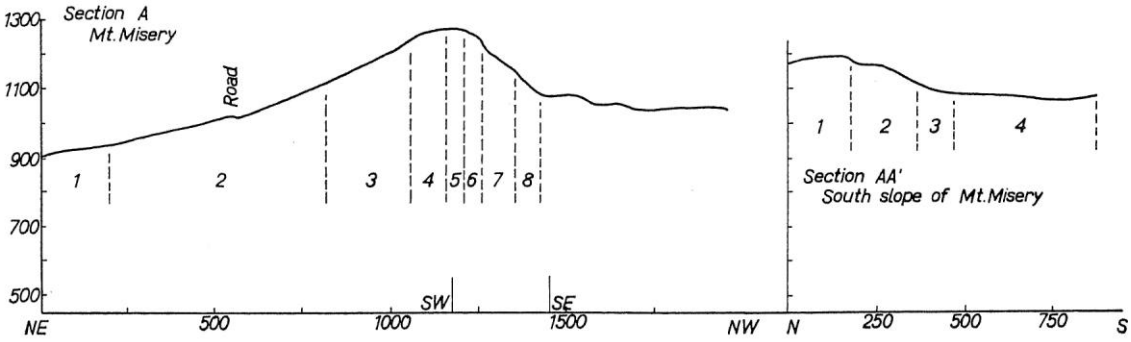


FIG. 2. SECTION A.[1]

1. Quercus borealis—Acer saccharum—A. rubrum—Hamamelis virginiana.
2. Quercus borealis—Viburnum acerifolium—Hamamelis virginiana.
3. Quercus borealis—Q. montana—Viburnum acerifolium—Vaccinium vacillans.
4. Quercus alba—Carya glabra—Viburnum affine var. hypomalacum—Vaccinium vacillans.
5. Quercus ilicifolia—Viburnum affine var. hypomalacum—Vaccinium vacillans.
6. Danthonia spicata—Andropogon scoparius v. frequens—Vaccinium vacillans—Polytrichum —Lichens.
7. Quercus montana—Kalmia latifolia—Viburnum acerifolium—Vaccinium vacillans.
8. Betula lenta.

SECTION AA.

1. Quercus alba—Carya glabra.
2. Quercus montana—Gaylussacia baccata—Kalmia latifolia.
3. Quercus borealis—Q. montana—Hamamelis virginiana.
4. Quercus borealis—Acer saccharum—Cornus florida—Hamamelis virginiana.

[1] On this and the following sections elevations and horizontal distances are given in feet.

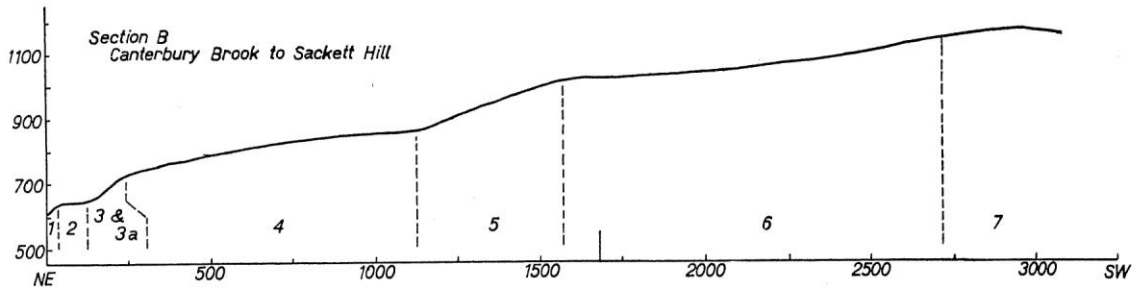


FIG. 3.—SECTION B.

1. Tsuga canadensis—Acer saccharum—Betula lutea.
2. Liriodendron Tulipifera—Acer saccharum—Fraxinus americana—Quercus borealis.
3. Quercus borealis—Cornus florida—Acer saccharum.
3a. Tsuga canadensis—Acer saccharum—Cornus florida—Viburnum acerifolium.
4. Quercus borealis—Q. montana—Cornus florida—Acer saccharum.
5. Quercus montana—Q. borealis—Cornus florida—Acer saccharum—Viburnum acerifolium.
6. Quercus montana—Cornus florida—Acer saccharum.
7. Quercus alba—Carya glabra—Quercus montana.

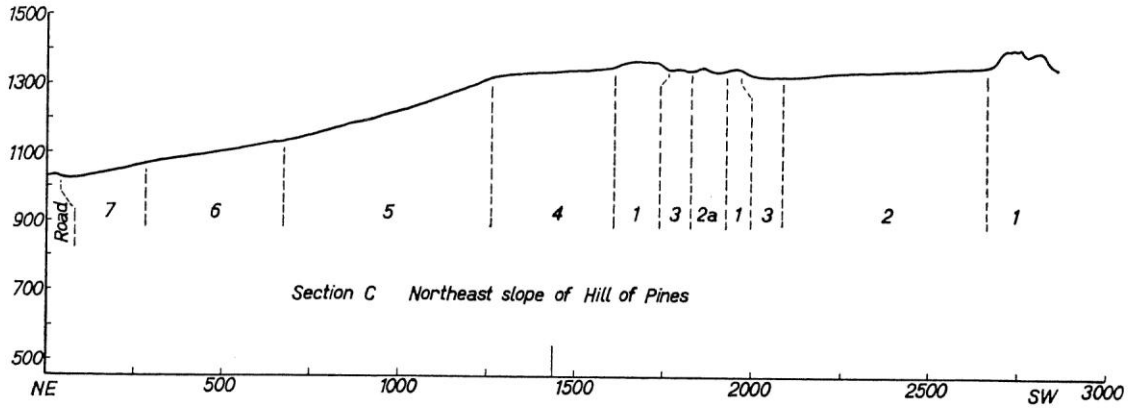


FIG. 4. SECTION C.

1. Quercus ilicifolia—Pinus rigida—Vaccinium vacillans—Aronia melanocarpa.
2. Quercus alba—Q. borealis—Acer rubrum—Viburnum acerifolium.
2a. Quercus alba—Carya glabra—Viburnum affine var. hypomalacum.
3. Quercus montana—Q. borealis—Acer rubrum.
4. Quercus alba—Q. borealis.
5. Quercus montana—Q. borealis—Gaylussacia baccata—Acer pennsylvanicum—Viburnum acerifolium—Acer rubrum.
6. Quercus borealis—Hamamelis virginiana—Acer saccharum.
7. Site 6 opened up and encouraging Fraxinus americana.

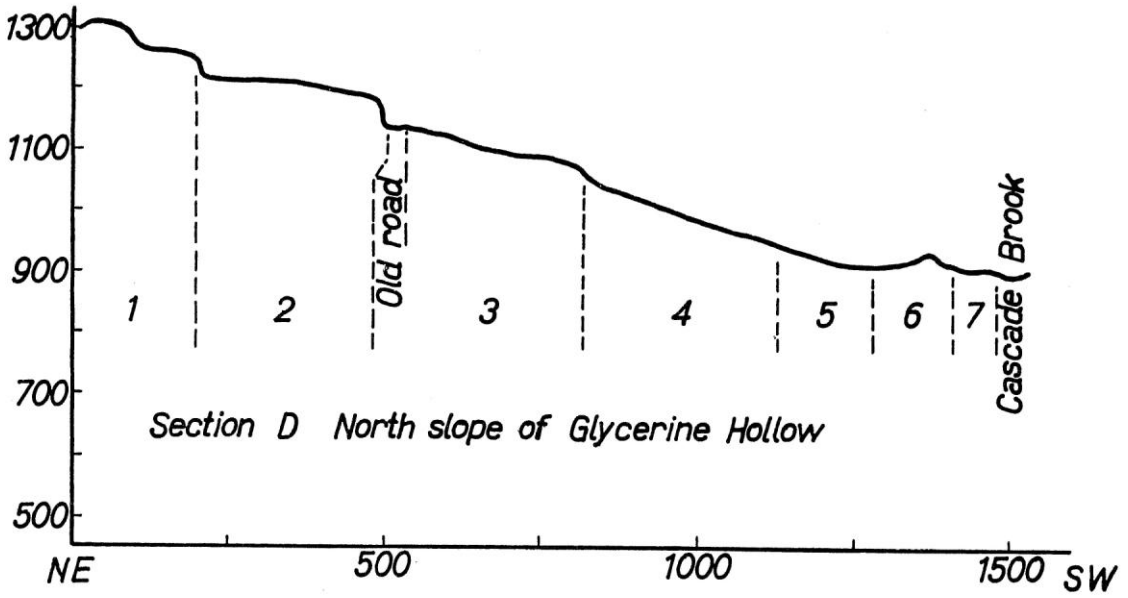


FIG. 5. SECTION D.

1. Pinus rigida—Quercus ilicifolia—Gaylussacia baccata—Deschampsia flexuosa—Danthonia spicata.
2. Quercus alba—Carya glabra—Viburnum acerifolium—Danthonia spicata—Panicum dichotomum.
3. Quercus borealis—Q. montana—Q. alba—Viburnum affine var. hypomalacum—Ceanothus americanus.
4. Quercus borealis—Viburnum acerifolium—Cornus florida.
5. Quercus borealis—Acer saccharum (young sprouts in clearing).
6. Quercus montana—Q. borealis.
7. Quercus borealis—Betula lutea—Acer rubrum—A. saccharum—Fraxinus americana.

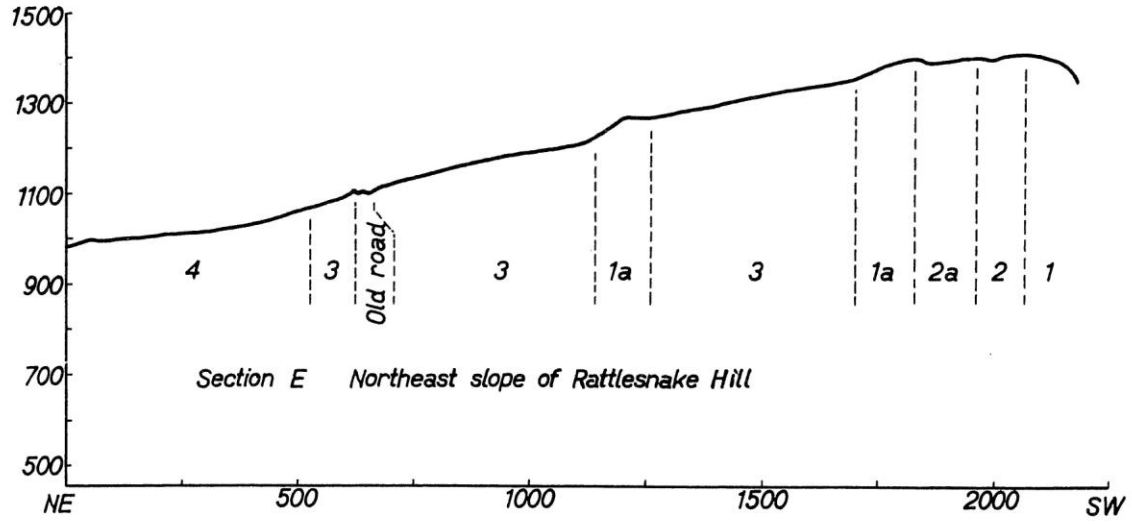


FIG. 6. SECTION E.

1. Quercus ilicifolia—Pinus rigida—Gaylussacia baccata—Danthonia spicata—Andropogon scoparius var. frequens.
2. Quercus alba—Vaccinium vacillans.
2a. Quercus alba—Q. borealis—Q. montana.
1a. Gaylussacia baccata—Vaccinium pennsylvanicum.
3. Quercus montana—Gaylussacia baccata.
4. Quercus borealis—Hamamelis virginiana—Virburnum acerifolium.

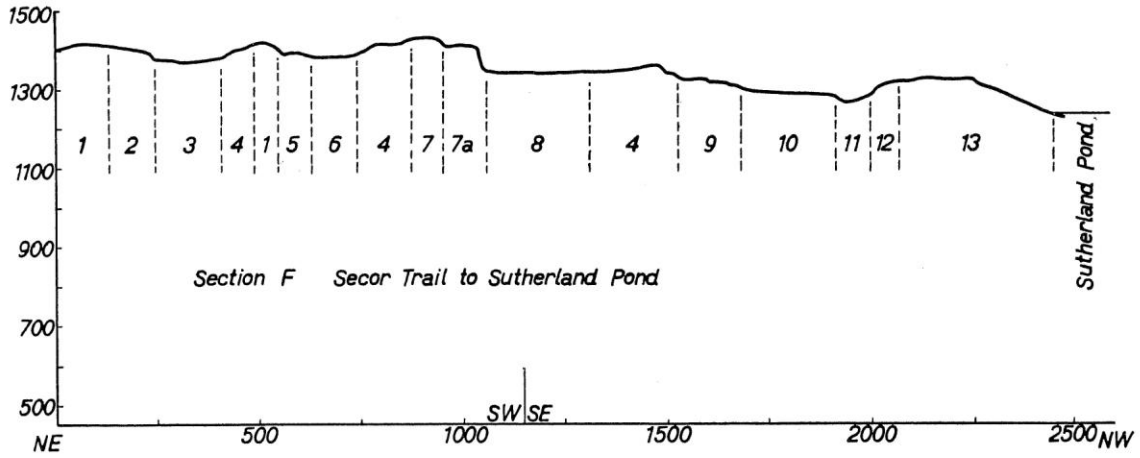


FIG. 7. SECTION F.

1. Quercus montana—Q. coccinea—Danthonia spicata—Vaccinium vacillans.
2. Quercus alba—Q. borealis—Kalmia latifolia—Gaylussacia baccata.
3. Quercus borealis—Q. alba.
4. Quercus alba—Gaylussacia baccata.
5. Quercus alba—Q. borealis—Kalmia latifolia—Gaylussacia baccata.
6. Quercus alba—Q. borealis.
7. Quercus ilicifolia—Pinus rigida—Danthonia spicata—Andropogon scoparius var. frequens—Vaccinium vacillans.
7a. Similar to site 7, with steep cliff.
8. Acer rubrum—Quercus borealis—Nyssa sylvatica—Clethra alnifolia—Vaccinium corymbosum.
9. Quercus montana—Gaylussacia baccata—Kalmia latifolia—Vaccinium vacillans—Vaccinium pennsylvanicum.
10. Quercus borealis.
11. Acer rubrum—Fraxinus americana.
12. Quercus montana—Q. alba.
13. Quercus montana—Kalmia latifolia—Vaccinium pennsylvanicum—Gaylussacia baccata.

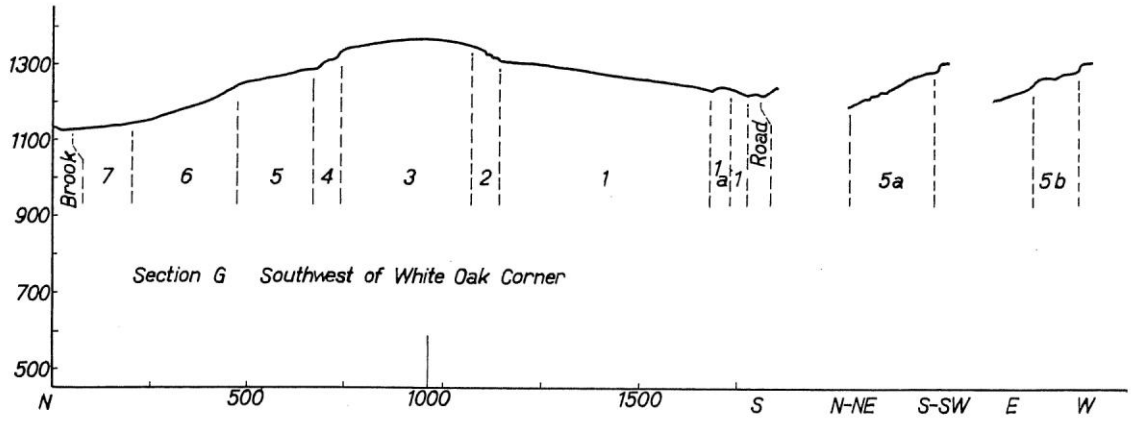


FIG. 8. SECTION G.

1. Quercus borealis—Q. alba—Viburnum acerifolium.
1a. Quercus montana—Gaylussacia baccata.
2. Quercus alba—Vaccinium pennsylvanicum—Gaylussacia baccata.
3. Quercus ilicifolia—Danthonia spicata—Vaccinium vacillans—Andropogon scoparius var. frequens—Pinus rigida—Polytrichum.
4. Quercus alba—Gaylussacia baccata.
5. Quercus borealis—Q. alba—Gaylussacia baccata.
5a. Quercus montana—Q. borealis.
5b. Quercus alba—Carya glabra—Viburnum affine var. hypomalacum—Cornus racemosa.
6. Quercus montana—Gaylussacia baccata—Rhododendron nudiflorum.
7. Quercus borealis—Acer rubrum—Hamamelis virginiana.

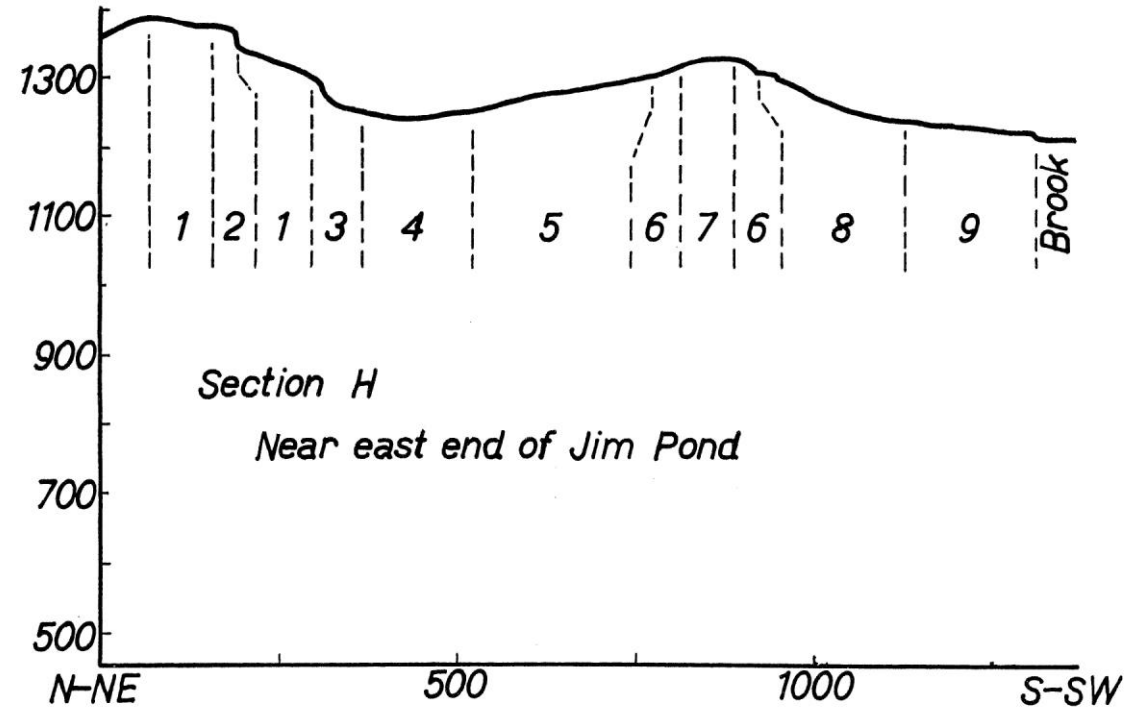


FIG. 9. SECTION H.

1. Quercus borealis—Q. montana.
2. Quercus alba.
3. Quercus montana.
4. Quercus borealis—Acer rubrum—Betula lutea—Hamamelis virginiana—Viburnum acerifolium.
5. Quercus montana—Q. borealis—Gaylussacia baccata.
6. Quercus borealis—Q. alba—Vaccinium vacillans.
7. Quercus ilicifolia—Vaccinium vacillans—Gaylussacia baccata—Deschampsia flexuosa.
8. Quercus montana—Q. alba—Vaccinium vacillans—Gaylussacia baccata.
9. Acer rubrum—Fraxinus americana—Clethra alnifolia—Benzoin aestivale.

two phases which seem to be dependent upon exposure or desiccation. These are well illustrated on Mt. Misery where site No. 6 may be sub-divided into an upper part with gentle slopes, and a steeper, rocky part below it. In the first of these *Deschampsia* and *Danthonia* are the primary grasses. The slope, though gentle, is uneven, and the soil lies on ledges and in pockets among the rock outcrops. The centers of some of these depressions apparently hold their moisture for a considerable part of the season, and in them the *Polytrichum* predominates. The grasses are best developed in crevices and at the rocky margins of the mossy depressions, though masses of dry soil have a mat of *Danthonia.* Most of the other herbaceous species listed grow near the margins of the grassy openings where clumps of scrub oak occur. In places *Vaccinium pennsylvanicum* grows in dense masses to the exclusion of nearly all other species. The rocks themselves have an abundant growth of both crustose and fruticose lichens, and the latter are also abundant in the mats of *Polytrichum* and about the bases of the *Danthonia* and *Deschampsia.*

The lower part of the site is ledgy and steep, with clumps of shrubs and small trees growing in the crevices. The grassy areas resemble those noted above except that *Andropogon scoparius* var. *frequenes* becomes a characteristic species, along with *Danthonia.* On very rocky hill tops this phase is predominant, while on rounded ones the *Danthonia-Deschampsia* phase prevails. Of the total flora of the meadows 10 species were not observed on the wooded slopes below them, although some appear in waste places. These 10 species are as follows:

Poa compressa	Lespedeza capitata
Juncus dichotomus	Hypericum gentianoides
Cerastium arvense	Helianthemum Bicknellii
Anemone riparia	Lechea intermedia
Corydalis sempervirens	Krigia virginica

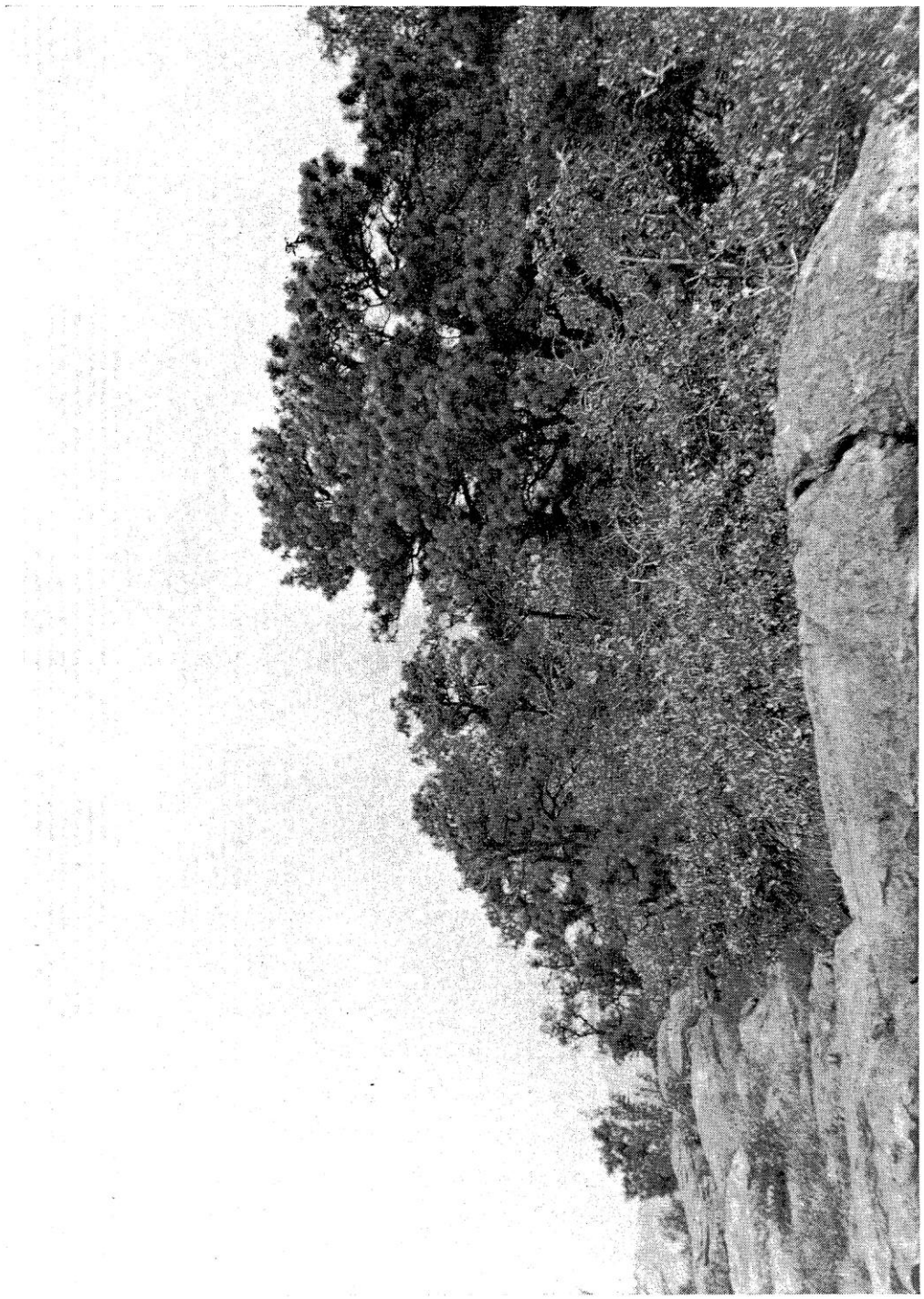


PLATE III. *QUERCUS ILICIFOLIA*—*PINUS RIGIDA* ASSOCIATION ON SUMMIT OF BLACK ROCK.

Slope and Hill-top Forests

Scrub Oak—Pitch Pine Association

Primary spp. *Quercus ilicifolia*
Pinus rigida
Aronia melanocarpa
Vaccinium vacillans

The scrub oak-pitch pine association occurs on nearly every hill top which rises above 1200 feet. It has been estimated that it covers a total of about 150 acres of the Forest (Tryon, '30, p. 34), and like the meadow association its largest areas are on hills with rounded summits. It constitutes most of the "alpine scrub" type as described by Tryon ('30, pp. 30-32). Approximately the same association has been observed at lower elevations on the margin of the Upper Reservoir, and at the northern base of Black Rock (Hill), but always on rocky promontories of northwestern or western exposure. The scrub oak grows in densely tangled clumps, about 6 feet or less high, forming masses several yards in diameter where the soil and topography will permit (Plates II and III). As noted above, the grassy spots are interspersed with these masses, and the whole complex is usually limited to the warm south and west sides of the crowns of the hills. Within the oak clumps the herbaceous flora is scattered, and the grasses do not grow densely. There is very little moss. Comparison of the list of species in this association with that of the meadows and those of the forest types to follow will show a complex intermingling of these groups, suggesting that the scrub oak association should perhaps be regarded only as an ecotone between grassland and timber.

It is possible to group the scrub oak associations in the forest into three phases. The first is best typified on top of Mt. Misery and on the hill southwest of the White Oak Corner. On both of these sites there is a gentle slope with a relatively heavy soil mantle, and the association is

characterized by large tangles of oak and comparatively little pitch pine. Grassy spots are of *Danthonia* and *Deschampsia* rather than *Andropogon*. The second phase seems to be a drier aspect of the one just described and is notable for the abundance of pitch pine and the predominance of *Andropogon* among the grasses. Good examples of this are to be seen on Black Rock (Hill), the Hill of Pines, Sackett (Hill), and Rattlesnake (Hill), on all of which the summits have much bare rock and little soil. A third phase appears to be at the other end of the moisture scale for this association, and is occasional on local rock outcrops on the upper north and east slopes of the hills, where it is inclosed by forests of chestnut or white oaks (See Section E). It also appears on the rolling uplands west of Tamarack Pond and south of Jim's Pond (See Sections F and H). The scrub oaks in this phase usually form rather tall clumps, not at the margins of the rock outcrops, but in crevices away from the surrounding timber. The secondary species are mostly drawn from the more mesophytic group in the scrub associations of the hilltops. *Vaccinium pennsylvanicum, Gaylussacia baccata, Aronia melanocarpa,* and *Diervilla Lonicera* are the most common shrubs, and there is a small development of the grasses. *Pinus rigida* rarely occurs. The borders of the woods surrounding these "inclosed" scrub types seem to be the most suitable habitat for the scarlet oak (*Quercus coccinea*) which occurs here more commonly than anywhere else in the Forest.

White Oak—Hickory Association

Primary spp.	Quercus alba
	Carya glabra
	Vaccinium vacillans
	Viburnum acerifolium
	Viburnum affine var. hypomalacum

This association is common in the Forest, though greatly restricted in total area. There is considerable

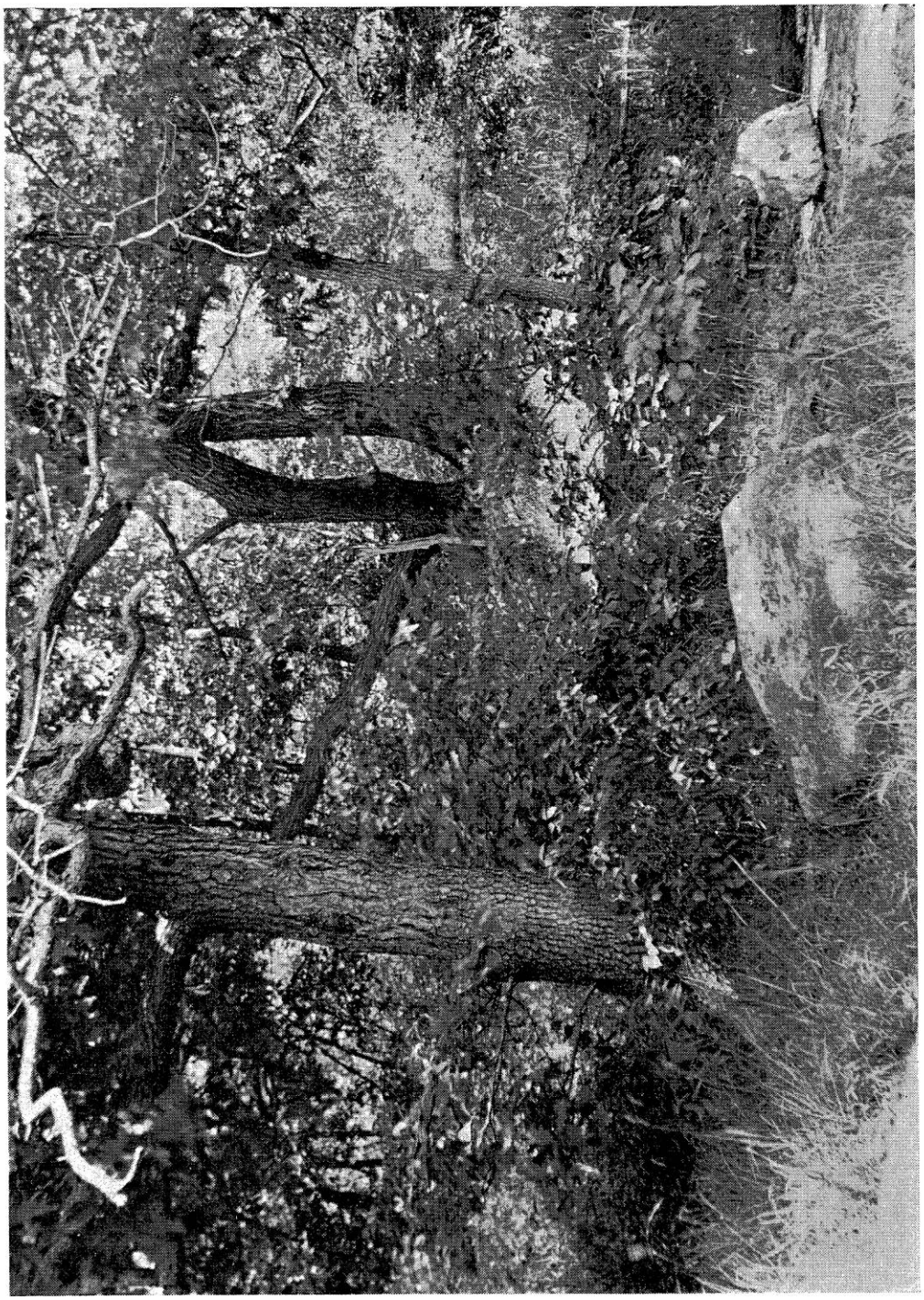


PLATE IV. *QUERCUS ALBA* TYPE ON NORTH SLOPE OF GLYCERINE HOLLOW. SECT. D. SITE 2.

PLATE V. *QUERCUS ALBA—CARYA GLABRA* ASSOCIATION NEAR SUMMIT OF MT. MISERY. SECT. A. SITE 4.

variation in the relative importance of its primary species, but the white oak is predominant in nearly all of the sites (Plates IV and V). Hickory is commonly absent, and with it *Viburnum affine* var. *hypomalacum*. The latter seldom occurs without the hickory. The whole association is characteristically restricted to the northeast sides of the crowns of the hills, and to fine soils which are relatively stable. Its adjustment to this particular situation seems to be a rather delicate one, for it appears even on the small knolls and ridges which lie on the upland west of Tamarack Pond (See Section F). The species listed in it include the transition types between the white oak—hickory association and its surroundings. The type was studied in considerable detail on Mt. Misery, the Hill of Pines, the north slopes of Glycerine Hollow, on a hill southwest of the White Oak Corner, and on the upland between Tamarack and Sutherland Ponds. Notes on its occurrence and general composition were made on several other sites.

The trees are in a relatively open stand, and usually of small stature. They are commonly branched near the ground and of gnarled or twisted form on the more exposed sites, but are fairly well-formed on the gently rolling uplands. Advance growth is usually of the principal species. As noted above the hickory is not always present. Examples of stands in which the white oak predominates or shares prominence with chestnut oak, are to be found on Rattlesnake (Hill), on the rolling upland west of Tamarack Pond, and on hills south of Jim's Pond. These woods usually have less undergrowth in them than the stands which contain hickory, for in the latter *Viburnum affine* var. *hypomalacum* is abundant and often forms a dense shrub layer. The herbaceous flora is much scattered, and there is but little moss or lichen on the ground. Among the herbs *Lysimachia quadrifolia, Panicum dichotomum, Pteridium aquilinum* var. *latiusculum* and *Potentilla simplex* are usually very common. It is of

interest, however, that a section of the soil shows a rather dense turf, 3-5 inches thick, of grass roots although the grasses are not now abundant except in the more open spots.

In addition to this principal variation in the type there should be noted two other phases. One is found where the association grades off into red or chestnut oak types, usually on the upper slopes of the hills. Here the more mesophytic group in the list of plants becomes more prominent: such species as *Polypodium virginianum, Panicum latifolium, Carex pennsylvanica, Uvularia perfoliata, Cypripedium acaule, Maianthemum canadense, Parthenocissus quinquefolia, Kalmia latifolia, Rhododendron nudiflorum,* and the common trees of the middle and upper slopes (see below). This type of transition usually occurs on north and east slopes. On south slopes the conditions seem to be quite different, with an accentuation of more xerophytic elements. The whole association is sometimes extended down the slopes, usually involving a combination of white and chestnut oaks without much hickory. A good example of this is found on the north slopes of Glycerine Hollow, south of the Carpenter trail. A few species appear which are rare or absent from north slopes: *Ceanothus americanus* (abundant), *Juniperus virginiana* var. *crebra, Lespedeza hirta, Vitis aestivalis, Rhus copallina* var. *latifolia, Aureolaria virginica, Helianthus divaricatus, Asperella Hystrix.* Here also *Viburnum affine* var. *hypomalacum* extends far down the slope into the chestnut oak association, although it was not observed at so low a level anywhere else in the forest. A glance at the transects will show that the southerly slopes are usually the steepest, due to the general arrangement of the geologic features of the region. An exception to this is found in Section G, southwest of the White Oak Corner, where there is a long slope throughout Site 1. This slope carries a mixture of white and red oaks

PLATE VI. *QUERCUS MONTANA* TYPE ON NORTHEAST SLOPE OF MT. MISERY.

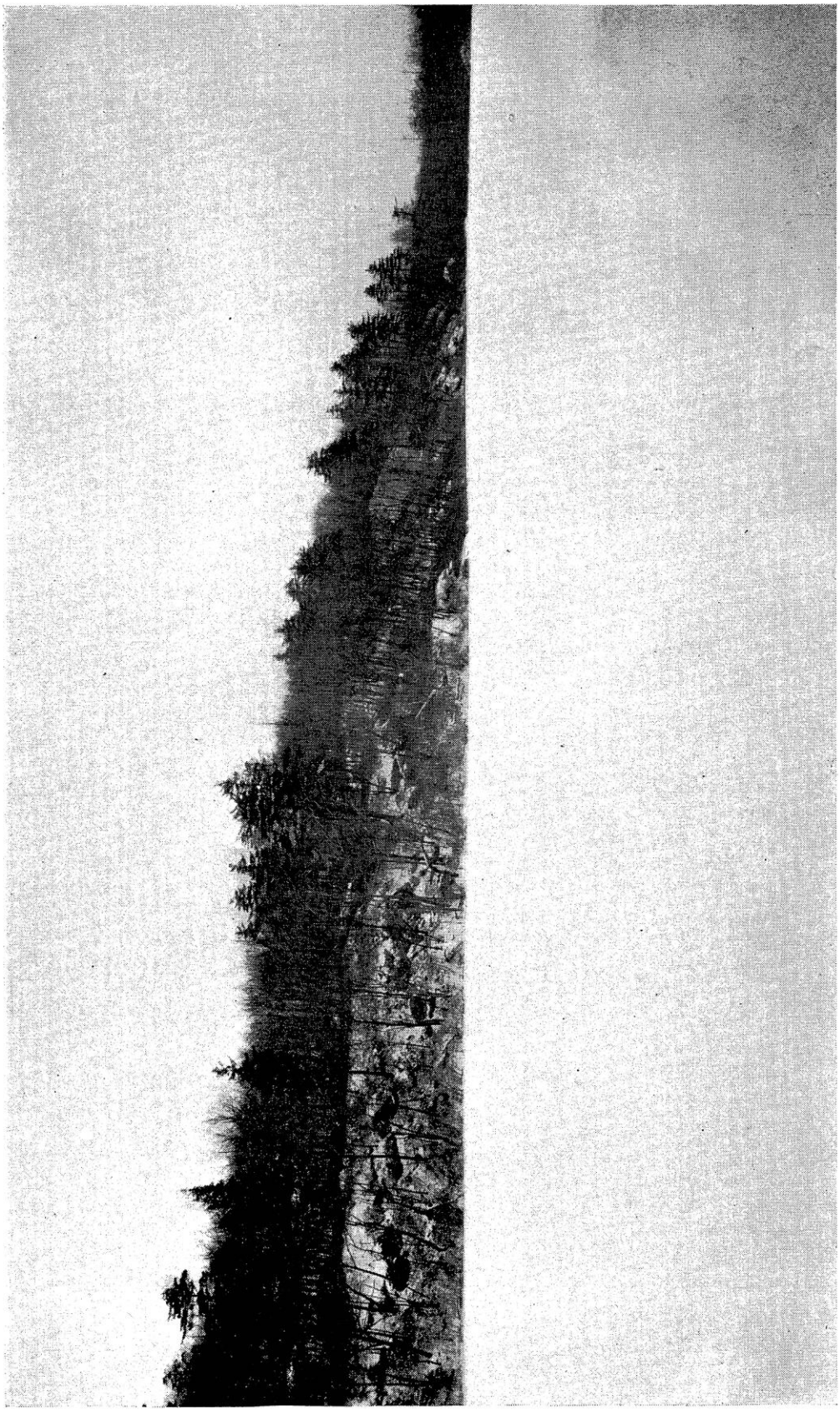


PLATE VII. CHESTNUT OAK—WHITE OAK—WHITE PINE STAND JUST EAST OF SUTHERLAND POND *(See Sect. F, Site 13).*

in a very open stand with little undergrowth, and seems to constitute a phase of the white oak complex.

There is a small group of species which may be regarded as characteristic of the hilltop associations described above. They sometimes occur elsewhere in the Forest, as along roadways or other areas of stirred soil, and in old fields; but except on the higher levels they usually do not inhabit the undisturbed woods. All of them occur in the white oak—hickory association, and some of them spread to the scrub oak and meadow associations.

Pinus rigida	Lespedeza hirta
Juniperus virginiana	Rhus copallina var. latifolia
Panicum Lindheimeri var. fasciculatum	Ceanothus americanus
	Cornus racemosa
Myrica asplenifolia	Viburnum affine var. hypomalacum
Quercus coccinea	Solidago odora
Crataegus macrosperma	Helianthus divaricatus
Fragaria virginiana	

Chestnut Oak Association

Primary spp.	Quercus montana	Vaccinium pennsylvanicum
	Kalmia latifolia	Gaylussacia baccata
	Viburnum acerifolium	Rhododendron nudiflorum
	Vaccinium vacillans	

Most of the slope forests proper may be divided into red oak and chestnut oak types, although the actual boundaries between the two are scarcely ever well defined. As noted by Tryon ('30, p. 30), however, the chestnut oak is most abundant above the 1100-foot contour. Tryon has described this type under the heading of "Sub-alpine Hardwoods," and has estimated that approximately 166 acres are covered by it (Plate VI). The present writer has made no accurate surveys, but general observations indicate that this figure should be considerably increased. The difficulties in defining the area of the type are also present in stating its composi-

tion, but Tryon's figures (given below) for the percentage representations of the principal trees are borne out by the writer's own.

	Number per Acre	%
Chestnut oak	137	62.37
Red oak	59	26.83
White oak	12	5.67
Hard Maple	9	4.22
Red maple	2	0.91

The trees are usually small in stature, and of inferior growth form. They are commonly gnarled and branched far down their trunks.

The chestnut oak association, where best defined, grows on the steepest slopes. The substratum is usually a tumble of angular stones and boulders ranging from the condition of loose "slide-rock" to relative stability. Since the slopes are usually steepest near the tops of the hills and on the south sides, most of the chestnut oak is found in these situations, although some notable exceptions occur. The northeast sides of Honey Hill and of Black Rock and Rattlesnake (Hills) are quite steep nearly all the way to the bottom, supporting a timber of chestnut oak over most of their surfaces. That elevation in itself is not necessarily a determining factor is shown also by the occasional presence of well-defined chestnut oak associations on rocky knolls in the coves. One of these is in Glycerine Hollow at an elevation of about 900 feet (Sect. D, Site 6).

On more gradual slopes there is a transition to red oak, and over large areas it is difficult or impossible to determine which species is primary. Talus on the other hand, brings a thinning out of the stand; and in one place on the west slope of Mt. Misery it is characterized by the predominance of the black birch (*Betula lenta*).

The herbaceous and shrubby floras, though often scattered, show striking contrasts between north and south slopes. *Kalmia latifolia, Viburnum acerifolium,* and *Rho-*

dodendron nudiflorum are most abundant on the former, especially where the association extends far down the slopes as on Honey Hill and Black Rock (Hill). On the north slope of Black Rock, near the 1100-foot contour, there is an almost impenetrable tangle of *Kalmia.* South slopes, on the other hand, commonly have more *Vaccinium* and *Gaylussacia,* often mingled with an abundance of *Ceanothus americanus.* As noted above, *Viburnum affine* var. *hypomalacum* and *Cornus racemosa,* ordinarily characteristic of the hill-top associations, are abundant on the south slope noted in Section D. Shrubs and small trees such as *Cornus florida* and *Hamamelis virginiana,* which are abundant in the red oak and cove associations, extend much farther upward on the north slopes than they do on the south. Further contrasts are shown in the herbaceous flora, wherein certain species which are common or occasional in south slope woods rarely if ever appear on the opposite sides of the hills. Among these are *Asperella Hystrix, Muhlenbergia tenuiflora, Satureja vulgaris, Cunila origanoides, Helianthus divaricatus.*

On the east shore of Sutherland Pond is a phase of the chestnut oak wood which differs from others in the Forest by having a considerable admixture of white pine *(Pinus Strobus)* (Plate VII). There is probably more white pine on this site than anywhere else in the Forest, and also more evidence of the natural reproduction of this species. The timber is on a ridge which rises 60 to 80 feet above the pond (Sect. F, Site 13). The surface is extremely rocky and broken, and covered with a thick tangle of shrubbery in which *Kalmia latifolia, Vaccinium pennsylvanicum,* and *Gaylussacia baccata* are the commonest species. Although the chestnut oak is easily dominant in the timber, white oak and white pine are both common, the former more so than the latter. The trees are of relatively small stature, branched from near the ground in the manner characteristic of most of the chestnut oak type. It is of interest that the white oaks are more

or less concentrated on the upper eastern slopes of the ridge where they merge with those of Site 12 in Sect. F. Toward the north the ridge swings around to the northeast, and its north slope takes on an entirely different vegetational aspect with the development of a hemlock-hardwood cove type.

The table shows 24 species which were not observed in woods above the chestnut oak association, although most of them are to be found at lower levels.

Tsuga canadensis	Rosa carolina
Agrostis tenuis	Desmodium rotundifolium
Muhlenbergia tenuiflora	Lespedeza intermedia
Oryzopsis racemosa	Acer saccharum
Panicum linearifolium var. Werneri	Tilia americana
	Viola pubescens
Carex virescens	Satureja vulgaris
Carex platyphylla	Cunila origanoides
Fagus grandifolia	Collinsonia canadensis
Heuchera americana	Lonicera dioica
Hamamelis virginiana	Solidago bicolor
Physocarpus opulifolius	Antennaria plantaginifolia
Rubus allegheniensis	

It is of interest that none of these is among the primary species and only 3 per cent of them were noted as common, indicating the process of thinning out on the upper slopes. Seven species were noted only in this association, and may constitute a tentative list of character plants: *Muhlenbergia tenuiflora, Oryzopsis racemosa, Heuchera americana, Physocarpus opulifolius, Desmodium rotundifolium, Lespedeza intermedia, Cunila origanoides.* Another tentative list of 9 species constitutes a group which also occurs at high levels, but which have not been observed in more mesophytic woods: *Pinus Strobus, Panicum latifolium, P. linearifolium* var. *Werneri, Carex pennsylvanica, Polygonatum biflorum, Cypripedium acaule, Quercus ilicifolia, Gaylussacia baccata, Solidago bicolor.*

PLATE VIII. *QUERCUS BOREALIS* TYPE ON NORTHEAST SLOPE OF MT. MISERY.

Red Oak Association

Primary spp.	Quercus borealis	Hamamelis virginiana
	Viburnum acerifolium	Cornus florida

A large part of the surface area of the Forest is covered with this association (Plate VII). Tryon has estimated its acreage at about 2040; but as suggested above, a certain amount of this might better be classified in the Chestnut oak association. Most of the red oak wood is on the lower slopes of the hills, and has been roughly classified by Tryon ('30, pp. 25-26) as the Hardwood Slope type. It seems necessary to further restrict its acreage by placing large areas on the north slopes of the Forest in the mixed hardwood cove type. Tryon's description of the composition of the red oak type is as follows:

	Number per Acre	%
Red oak	114	48.9
Chestnut oak	69	28.9
White oak	20	8.6
Red maple	10	4.3
Hard maple	8	3.6
White ash	3	1.0
Hemlock	3	1.0
Yellow poplar	2	0.9
Yellow birch	1	0.45
Black birch	1	0.45
Hickory	1	0.4
Basswood	1	0.4
Tupelo, Pitch Pine, Aspen	0.5	0.2

This description agrees fairly well with that of the present writer, except that if the north slope timber is in part reclassified, such cove trees as *Liriodendron Tulipifera, Tilia glabra, Betula lutea, Nyssa sylvatica,* and *Tsuga canadensis* are even further restricted in number.

The trees are mostly straight and of good form, especially near the base of the hills, and constitute an impor-

tant part of the Forest's timber resources. The soils are rocky, but relatively more stable than those occupied by the chestnut oak type. As in the case of the latter, mere elevation does not seem so important in determining the distribution of the association as the stability or rockiness of the soils, and the direction of exposure. Section A, on Mt. Misery, shows a typical arrangement of the red oak. It extends far up the northeast slope, merging with the chestnut oak throughout Site 3; but on the south and west slopes the chestnut oak association stands out clearly, and the red oak becomes dominant only near the foot of the hill. Contrasts between these associations at the same level are well shown on the northward-facing slope just southwest of the White Oak Corner (See Sect. G, Sites 5 and 5a). Here the two exist side by side with approximately the same exposure; but the red oak site is of gentle slope while that of the chestnut oak is steep and rocky.

The undergrowth and ground cover are relatively open, though composed of a considerably larger flora than in the chestnut oak type. There is no great variation except at the upper ecotones where the dominant shrubs merge with those of the chestnut oak. In places *Cornus rugosa* is characteristic of this upper transition zone, and is rarely found elsewhere in the Forest. The red oak type merges imperceptibly into the cove timber, with which it is closely related floristically.

An examination of the flora of the red oak association shows no less than 45 species which are rare or nonexistent in the chestnut oak and more elevated associations:

Botrychium virginianum
Osmunda Claytoniana
*Dryopteris hexagonoptera
Dryopteris noveboracensis
Dryopteris spinulosa
Polystichum acrostichoides
*Adiantum pedatum
Brachyelytrum erectum
*Carex rosea var. radiata
Arisaema triphyllum
*Luzula campestris var. multiflora
Medeola virginiana
Corallorrhiza maculata
Populus grandidentata

Carya ovata
Ostrya virginiana
*Corylus cornuta
Betula populifolia
Betula lutea
*Quercus velutina
Ulmus americana
Liriodendron Tulipifera
Benzoin aestivale
*Desmodium bracteosum
Amphicarpa bracteata
Geranium maculatum
Rhus Toxicodendron
*Celastrus scandens
Nyssa sylvatica
*Zizia aurea
Cornus florida
*Cornus rugosa
Vaccinium corymbosum
Aureolaria flava
*Melampyrum lineare subsp. latifolium
*Galium lanceolatum
Viburnum dentatum
*Solidago arguta
Aster divaricatus
Aster Lowrieanus
Aster acuminatus
*Hieracium pratense
Prenanthes trifoliolata

Most of these are also common in one phase or another of the cove timber, but 14 (marked * in the above list) have been observed only in the red oak association. Further observation will probably modify this list, but it clearly indicates the close relationship between the red oak and cove types. The 14 species noted only in the former will make a tentative list of characteristic plants.

Cove Forests

Under the term "Cove Forests" are grouped the woodlands which occupy the more or less level or sloping lands between the hills, those which grow in shaded rocky ravines, and those which occur on the more gently sloping, lower north slopes of the Forest. They may be divided roughly into three types which intergrade freely: mixed hardwood, hemlock—mixed hardwood, and beech-maple. Tryon ('30, pp. 19-24) has described three types in a slightly different arrangement, not recognizing the beech-maple: hardwood swamp, hardwood cove, hemlock and hardwood cove. It seems more suitable for present purposes to consider the hardwood swamp as a phase of the mixed hardwood type. Most of the cove timber is below the 1100-foot contour line.

Mixed Hardwood Association

Primary spp.	Quercus borealis	Fraxinus americana
	Betula lutea	Cornus florida
	Acer saccharum	Hamamelis virginiana
	Acer rubrum	

Most of the better-drained cove soils are occupied by this type, which constitutes one of the more valuable timber sources of the Forest (Plate VIII). Tryon estimated that only about 265 acres were occupied by it, but the writer's observations indicate that large areas on the lower north slopes of the Highlands, principally represented in the Forest by rather gently sloping surfaces in the valleys of Canterbury and Black Rock Brooks, are covered with it. Its trees are usually tall and straight-boled, and are fairly well pruned of lower branches. The average height-growth is greater than in any other type. Floristically it stands next to the red oak association in number of species (87), and much higher than any other part of the cove forest. The shrub and small tree layer is very scanty, and in many places it is difficult or impossible to define primary species. Advance growth is abundant and, like that in most of the slope forests, is principally confined to the present facies; also it is approximately of the same proportions. The soil, although rocky, has a larger percentage of fine materials than is found on the slopes, and has a higher humus content with greater water holding capacity (See Scholz, '31). There is but little moss or lichen on the ground.

An outstanding feature of this forest is the mixed character of its principal facies. It is a common experience, in attempting to note its primary species, to find one's self making a list of 6 or 8 kinds of trees, whereas most of the other types in the Forest can be defined in terms of one or two. In a few places, such as the low ground at the foot of Mt. Misery, red oak and sugar maple predominate. In others white ash becomes a primary spe-

PLATE IX. COVE TYPE ALONG CASCADE BROOK IN GLYCERINE HOLLOW. SECT. D. SITE 7.

cies, as in coves at the east and south of Jim's Pond. It is of note that when one or two species do obtain prominence they are red oak, white ash and hard maple rather than beech, tulip-tree, or basswood.

Considering the whole flora, out of the total of 87 species listed 60 also occur in the red oak association of the lower slopes, 8 were observed *only* in the mixed hardwood type, and the remaining 19 are shared with other cove and slope types. Those noted only in the mixed hardwood type are:

Equisetum arvense	Smilax herbacea
Lycopodium obscurum	Asarum canadense
Carex gracillima	Berberis Thunbergii
Lilium philadelphicum	Desmodium nudiflorum

Mixed Hardwoods (Swamp Phase)

Primary spp.	Betula lutea	Osmunda Claytoniana
	Quercus borealis	Benzoin aestivale
	Nyssa sylvatica	Clethra alnifolia
	Acer rubrum	Vaccinium corymbosum
	Fraxinus americana	

Several coves in the Forest have wet, peaty depressions in which a modified hardwood swamp type prevails. One of these areas is at the southern base of Mt. Misery (See Section A), and there are several of them in the district south of Sutherland Pond. The above list of primary species is a composite one formed from observations in several localities, so that all of the species are not equally prominent on every site. Just south of Mt. Misery, for instance, the principal species are *Betula lutea* and *Acer rubrum,* with a dense growth of *Osmunda Claytoniana* beneath them. The substratum here is of muck with a few large rocks, and is hummocky with the tall ferns making the "cores" of the hummocks except where the trees occur. In this place is the heaviest moss mat observed in the Forest. The trees are mostly at the margins of the wetter areas, in which the ferns are

most dense. There seems to be a successional trend in which the yellow birches are the first trees to appear. These are followed directly by white ash, red oak, elm, etc.

Swamp lands near the southern end of Sutherland Pond (See Sect. F, Site 8) have a more boggy type of cover. The surrounding forest is dominated by *Acer rubrum, Quercus borealis,* and *Nyssa sylvatica.* Wet areas in this forest have a thick growth of *Carex stricta* and *Woodwardia virginica* among hummocks of *Sphagnum* moss. The margins of the swamps are colonized by *Cephalanthus occidentalis, Rhododendron nudiflorum,* and *Vaccinium corymbosum* among which is a stand of the tall grass, *Calamagrostis canadensis.* These shrubs make only a narrow margin for the swamp forest, in which *Clethra alnifolia* and *Vaccinium corymbosum* predominate in the undergrowth.

Stream bank associations in the coves have already been discussed, but another phase of the wet swamp forest remains. At the margins of small peaty pools is an association of *Festuca obtusa* and *Cinna arundinacea,* commonly with a tangle of *Rhus Toxicodendron.* The latter is abundant in waste places and on old stone walls, but is not common in the natural forests except in damp coves. A variety of secondary species occurs in this association, among which *Osmunda regalis* var. *spectabilis, Polygonum arifolium* var. *lentiforme,* and *Viburnum Lentago* are prominent.

Twenty-nine of the 66 species listed in the swamp forest owe their presence in the woods to this type. A tentative list of them is as follows:

Lycopodium lucidulum
Osmunda regalis var. spectabilis
Onoclea sensibilis
Dryopteris Thelypteris
Woodwardia virginica
Festuca obtusa
Glyceria melicaria
Calamagrostis canadensis
Agrostis perennans
Carex crinita var. gynandra
Carex stricta
Carex leptalea
Carex scabrata
Iris versicolor
Alnus incana
Alnus rugosa

Polygonum Hydropiper	Kalmia angustifolia
Polygonum arifolium var. lentiforme	Fraxinus nigra
Caltha palustris	Scutellaria lateriflora
Spiraea latifolia	Cephalanthus occidentalis
Ilex verticillata	Viburnum Lentago
Viola blanda	Aster umbellatus
Hydrocotyle americana	

Hemlock—Hardwood Association

Primary spp.	Tsuga canadensis	Cornus florida
	Acer saccharum	Viburnum acerifolium
	Betula lutea	

It has already been noted that most of the hemlock in the Forest occurs in ravine coves on the northern slopes. Its percentage representation varies a great deal, from stands in which it is doubtfully of primary importance to others in which it is nearly pure. The latter are mostly confined to the lower valleys of Canterbury and Black Rock Brooks. Outside the Forest boundary a good example of the hemlock woods is found in the gorge of Mineral Spring Brook. Within the Forest the only upland timber observed in which *Tsuga* forms a dominant element is on a northward-facing cliff near the upper end of Sutherland Pond.

More or less detailed notes on the hemlock-hardwood type were made in the valley of Canterbury Brook at an elevation of about 600 feet (See Section B). Most of the hemlock is on the immediate banks of the stream (Site 1) or on the steep slopes of older terraces (Site 3a). Site 1 is a comparatively narrow area where Section B was made, but farther down the stream it widens out somewhat. It is very rocky and subject to washing at flood time. The ground cover is quite sparse, and is composed, on this site, of only about 15 species. With the exception of the abundance of hemlock the facies does not differ greatly from that of the mixed hardwood type. The ground is covered with debris and supports very little

moss. The shade is more dense than anywhere else in the Forest, due not only to the hemlock but also the northern exposure. The slopes in Site 3 have two phases, one of which is very steep and composed of a rocky and unstable soil. This carries a timber which is intermediate between mixed hardwood and red oak types. Its principal species are *Quercus borealis, Acer saccharum,* and *Cornus florida,* with *Quercus montana* also abundant. There is a considerable amount of the xerophytic grasses of the upper slopes, *Deschampsia flexuosa* and *Danthonia spicata.* A second phase (Site 3a) is a little farther up the brook and in a small cove where flood waters probably do less damage. Here the slopes are less steep and more stable, with a much richer flora. The shrub and small tree layers indicate that the whole facies is reproducing itself adequately and will be perpetuated for a long time. The beech, though present here and there, is not an important part of the timber. One of the most prominent herbs in this association is the Christmas fern, *Polystichum acrostichoides.* The hemlock association extends up the ravine of Canterbury Brook to an elevation of 1000-1100 feet, and above this point is replaced by cove and slope hardwoods.

A glance at the table will show that the hemlock-mixed hardwood association is much poorer in number of herbaceous species than timber of mixed hardwood alone. It contains a total of only 58 species, 42 of which also occur in the latter. Nine species have been noted only in the hemlock mixed timber: *Cystopteris fragilis, Sphenopholis pallens, Trillium erectum, Laportea canadensis, Hepatica americana, Ranunculus recurvatus, Mitella diphylla, Cryptotaenia canadensis, Pyrola elliptica.* All of these are extremely shade-tolerant; and the dense shade of the hemlock forest probably accounts for the elimination of many species from the mixed hardwood type.

Beech—Maple Association

Primary spp. Acer saccharum
Fagus grandifolia
Betula lutea

The beech-maple association is very poorly represented in the Black Rock Forest, and occupies a much smaller area than any of the other timber types. From a silvicultural standpoint it is probably of no intrinsic importance, but is described here because of the bearing it has upon the vegetational relationships of the whole region. It appears to be restricted to small local flood plains in the valleys of the streams, and has been observed within the Forest only along Canterbury Brook just below the junction of the Hulse and Continental Roads. Outside the Forest boundary it has been noted in the valley of Mineral Spring Brook, and in a ravine just below Hickory Corner, south of the Forest. It is very poor in number of species due in part to its incomplete development and extremely local occurrence.

Wherever this type has been found it is on "flood plain" soils in which there is considerable fine material. Small flood plains are formed behind outcrops of bed rock or masses of boulders, to be later eliminated by headward cutting. As a result of this process a cross-section of the valley bottom consists of a series of small plains with steep-cut banks separating them. The lower sites in Section B illustrate this arrangement. The plains themselves usually have some phase of the mixed or slope hardwoods, whereas the steep sides have a hemlock-hardwood type as described above. Usually the largest plains are in the down-stream portion of the valley, but a large outcropping of rock in the upper reaches commonly forms a large plain high in the hills. Such areas are to be found both on Canterbury and Mineral Spring Brooks, and are the sites of the beech-maple forest. For some reason the beech-maple type has not developed on the lower flood plains in either of these valleys.

In the Canterbury Brook site the beech and maple trees are up to a foot in diameter and occupy small remnants of a flood plain in a steep-sided rocky ravine. The substratum is so cut up by erosion that the ground and shrub floras are extremely scattered. Where the beech, maple and birch predominate there is very little of red oak or of the other trees of the mixed hardwood type. The ravine slopes just above are clothed with a loose forest of chestnut oak.

The Mineral Spring Brook site resembles the above very closely; but below Hickory Corner the beech-maple wood occupies more of the lower ravine slopes and covers an area of at least an acre or two.

Only 28 species have been listed in this type of forest, showing the poor development of the latter in this locality. A single species is noted as peculiar to it, and this is *Epifagus virginiana,* parasitic on the roots of the beech.

Old Field Associations, and Plants of Waste Ground

Most of the abandoned farm land in the Forest is now being utilized for plantations of one sort or another, chiefly red pine (*Pinus resinosa*), white spruce (*Picea glauca*), larch (*Larix decidua*), and tulip-tree (*Liriodendron Tulipifera*). The result is that there are few data available on the succession of timber types in such areas. The initial stage is a stand of gray birch (*Betula populifolia*) and red maple (*Acer rubrum*) with an admixture of other hardwoods and *Juniperus virginiana* var. *crebra.* Common secondary species in this association are:

Quercus alba	Ostrya virginiana
Q. borealis	Viburnum dentatum
Q. coccinea	Robinia Pseudo-Acacia
Q. ilicifolia	Populus grandidentata
Acer saccharum	P. tremuloides
Prunus serotina	Fraxinus americana

In wet places *Alnus rugosa* is abundant and may form a primary part of the cover.

Some old clearings along the West Point Road near the Upper Reservoir have not recently been disturbed. Here the gray birches have grown to maturity, and seem to be giving way to oaks, mainly white and red. This would indicate that the gray birch—red maple stage is quite temporary and due to be replaced by the common facies of the Forest.

From the silvicultural standpoint this association is looked upon as weed growth. It comes up vigorously in the relatively good soil of the old fields, and sprouts readily when cut back. Consequently if plantations are to be successful, repeated weedings are necessary to keep the young conifers or less active hardwoods from being crowded out before they have a chance to get well started.

It has already been noted that within the granitic Highlands there has never been much farming and consequently not much complete clearing of the land. Immediately adjacent to the Highlands, however, are large areas of farm lands on the finer textured and more fertile Dutchess soils. Here the abandonment of fields has produced a quite different effect, with the invasion of red cedar. This tree often seeds in to form nearly pure stands with practically no undergrowth. The cedars do not seem to reproduce themselves, and are succeeded directly by hardwoods (ash, oak and maple) of which white ash (*Fraxinus americana*) is the commonest. This succession can be seen in all stages in the vicinity of the Forest, from the initial invasion by young cedars to rich stands of white ash in which the cedars are old and decrepit. What follows the white ash has not been definitely determined, but some stands of oak (chiefly white and red) on Deer Hill appear to be of second growth origin, and may be the next stage in the succession. Some areas on Sackett (Hill) which evidently were clear at one time have old cedar stands now giving way to white ash.

It is suggested that this may be due to the greater concentration of fine soils in glacial till on the northwest side of the Forest (See Denny, in press).

Reference to the appended catalogue will indicate the large proportion of the total flora which is characteristic of old fields, waste places, roadsides and trails. Approximately 152 species may be listed in this category, against a total of 213 for the woodland associations. It is of note that there is an overlap of only 11 species between the two groups, and that all of the 11 enter the woods only in very wet or very dry situations. The relative numbers of species naturalized from Europe in the two lists is also significant. In the open ground there are 47 of these, or approximately 30 per cent of the total flora of waste land, while only 5 species in the woodland associations, or about 2.3 per cent, are introduced. The boundaries, moreover, are rather finely drawn, and often involve less than a dozen feet of transition ground at the side of the road or trail. There is good evidence here of the extreme conservatism and stability of the natural woodland associations of the Forest. Their species do not readily invade open lands; and they are exceedingly resistant to invasion from without, either by native or introduced ruderal plants.

HISTORY OF EXPLOITATION

THE history of the human exploitation of natural resources in the Black Rock Forest region is at once complex and obscure. A proper evaluation of it must be the subject of special research, and is extremely desirable. The following brief notes are mainly from a summary published by Mr. H. H. Tryon ('30).

The nature of the soil has determined the general pattern of land utilization, and has permitted only small areas to be used for agriculture. This is in sharp contrast to such lands as are utilized at the Harvard Forest in north central Massachusetts, where most of the land surface was formerly in cultivated fields or cleared pastures. The results of these contrasts are of first importance in the consideration of trends in the development of the modern forest; for, as will be shown later, forest lands which have been cleared or culled in this region without the complete removal of the woodland as a type of vegetation have had an entirely different subsequent history from those used for agriculture.

Most of the formerly cultivated land in the Black Rock Forest is in five tracts, the largest of which extends along the old Continental Road between the vicinity of Tamarack and Arthur's Ponds and the junction with the Hulse Road; this is known locally as the "Chatfield Place." Another is southwest of Sutherland Pond at the junction of the Huber, Arthur, and Sutherland Trails, and is known as the John Odell Farm. A third, now called the "Clark Lot," is on the lower slopes of Black Rock (Hill) along the Hulse Road. The Ryerson and Isaac Odell farms were in the valley of Mineral Spring Brook and in Cat Hollow, respectively. Most of these lands are now in

experimental plantations of one sort or another, but a few areas have been allowed to revert to timber. Judging from estimates made by Mr. Tryon the total acreage formerly cleared of timber was something less than 100, or approximately 3.2 per cent of the total.

It is at present impossible to say when the woods were first used for fuel or saw timber, but it is reasonable to suppose that exploitation was not extensive until local communities were well established. With the Dutch trading posts set up at New York and in the vicinity of the present city of Albany by 1614, the Hudson itself became a highway for commerce, and no doubt a certain amount of cutting was done on the immediate banks of the river in those early times. The first settlements in the vicinity of Cornwall were made in the 1690's.

The industries which appear to have consumed most of the timber increment in these parts during the past two centuries are those of iron and brick. The first demanded large amounts of charcoal which were burned in the vicinity, and the second used large quantities of cordwood for kilns. Charcoal was produced extensively until after the middle 1800's. It is of particular interest that neither of these industries demanded quality timber, and could use large and small stems. The general result was much clear cutting at relatively short intervals of perhaps 30-40 years.

Other cuttings of less extent have been for railroad ties, posts, boat fenders, ship timber, wagon stock, hoop poles, telephone poles, mine timbers, cordwood for household use, and a certain amount of building lumber.

Fires have ravaged the timber repeatedly, and if we may credit the early Dutch writers (Van der Donck, 1655) they were common enough before the advent of the white man. Although it is probable that they increased in frequence and intensity during the period of cutting and clearing, yet they must have been an important part of the habitat complex from time immemorial, started

either by lightning or by the aborigines. With such an early origin it is difficult or impossible to say what ultimate damage they have done, or what the natural vegetation would be if they had never occurred.

As noted above, one of the most important effects of varied cultural history has been to introduce on formerly cultivated ground a succession of timber types not found on the lands left in woods. Red cedar (*Juniperus virginiana* var. *crebra*) and gray birch (*Betula populifolia*) are among the more notable trees in this succession. Another outstanding result has been the institution of a complex series of age-classes. These have been mapped by Mr. Tryon ('30) from actual ring-counts and from information derived from local sources. A third result, highly significant from the silvicultural standpoint, has been a change in the reproduction of the growing stock. "Repeated clear cuttings, making no provision whatever for natural regeneration have . . . greatly increased the number of stool sprouts. It appears that the formation and maintenance of these fast-growing and quickly-forming coppice stands may have been of marked effect in keeping down seedling growth either through shade-killing or stunting of the natural reproduction. And the generally universal practice hereabouts of clear-cutting these coppice stands over a rotation of only thirty to forty years has probably helped to keep down the percentage of seedlings by removing the overwood before it attained sufficient size and vigor to function as a really effective source of seed" (Tryon '30). It has been commonly assumed that this treatment has raised the percentage of "less desirable" species in the forest, such as chestnut oak, red maple, gray birch, and big-toothed aspen; but until more is known about the original forest this cannot be proved.

There seems little evidence of destructive erosion on the forested lands. If such had taken place its effects should be found on the upper slopes of the hills, and de-

posits should be formed on the lower slopes and in the coves. But such deposits are rare or non-existent over most of the Forest. Scholz' findings are particularly significant in this connection, since he could find in the soils of the coves and lower slopes little proof either for surface erosion or for the movement of fine materials from upper to lower layers. The series of soil sections described by Denny (in press) substantiate this, and give evidence of great stability in the forest soils over long periods of time. It seems that if there were formerly a much thicker cover of humus and mineral soils on the upper slopes of the hills, its removal to the lower slopes would have modified the physical characteristics of the soils of the latter materially; yet no such change is evident. The only deep, steep-sided ravines in the Forest are on the north slopes, mostly below the 1200-foot contour line, and even these show little evidence of excessive surface erosion.

As noted above, a history of timber uses on the Forest area would greatly facilitate the understanding of current developments. Data for this are to be looked for in old records of land tenure, in the miscellaneous notes made by travelers and local commentators, and in the records of the industries which have consumed the wood. Until the early 1800's the land appears to have remained mostly in large grants, the records for which antedate those in the local county and town offices, so that they must be searched for in less accessible places. Dutch colonial writings probably contain a wealth of information about local conditions in those early times, but will require much bibliographic research.

RELATION OF THE PRESENT TIMBER TO THE PRE-COLONIAL FOREST

THE forest associations just described may be arranged in three categories: hill-top, slope, and cove. The first is characterized by the dominance of white oak, hickory, pitch pine, and scrub oak; the second by chestnut and red oaks, and (formerly) chestnut; and the third by a mixture of hardwoods in which sugar maple, red oak, white ash, tulip tree, red maple, and yellow birch are most prominent. In limited areas hemlock is primary in the cove forests, and in still more limited ones, the beech. If these types of timber are to be utilized on a sound economic basis, involving a sustained yield of lumber or cordwood over a long period of years, it becomes essential, before a proper program can be started, to know the relationship between the present stands and those which preceded the period of exploitation. With our present limited knowledge of the highly involved interactions which go on not only between the forest complexes and their immediate surroundings, but also within the associations themselves, there seems no other way to determine the potentialities of sites in this region than by such a study of past productiveness. In short, are the arrangement and composition of the associations as we see them today a product of the repeated cutting and fire which have occurred during the past three centuries? And if this is the case may we expect them, under proper management, either to return to a hypothetical former state of greater productiveness or to move into a controlled one of greater richness than they now have? On the other hand, is it possible or probable that the types as we see them now are essentially as they were in the

primeval forest except for the smaller size of the trees and the preponderance of sprout over seedling origin? If this is the case should we attempt to change materially such a persistent set of facies by silvicultural methods, or would it be more economical in the long run to facilitate the natural improvement of the present stands by protection and by judicious silvicultural treatment? In either event a further question arises from the long time intervals with which the forester must deal. Allowing even a century for each generation of commercially grown hardwoods, the time involved for rotating crops of trees soon reaches dimensions that involve sizable trends in climatic and vegetational change (Douglas, '19 and '28; Sears, '33; Raup, '37). Consequently if a program of intense management is entered upon it becomes necessary to estimate the rate and kind of these trends; likewise if a "natural" system is followed it is essential that the limited management imposed should be in accord with the main course of development.

There is some evidence that the present arrangement and content of the timber types in the Black Rock Forest have persisted from pre-colonial times. Although this evidence is scanty, it gathers force from the fact that it represents various lines of inquiry, and that very little has been found which points in the opposite direction. It involves the present configuration of type boundaries, the nature of advance growth in the present stands, the known effects of recent disturbance, the general condition of the soils, the distribution and form of very old trees, and the relation of the present types to their regional geographic distribution in eastern North America.

The exploitation of the woods has not been equally distributed in space or time, due to differences in the accessibility of the stands as well as to differing demands in the market. Consequently a map of existing age classes in the Forest is a patch-work affair whose only system would have to be unravelled from the complicated

history of land holdings and economic trends which have affected the region (See Tryon, '30, Plate III). If the effects of cutting and fire are very significant in determining the present timber, there should be a degree of correlation between the age classes and the arrangement of the types. This correlation, however, does not exist. The map of timber types is closely identified with the contours of the country except for modifications due to the degree of slope and to directional exposure. Its lines everywhere cut through the age classes.

Evidence from the persistence of types through cutting and fire is found in the history of certain stands during the past century. A short distance east of the summit of the Hill of Pines is a ridge with an east and west trend. Occasional rocky knolls rise above the general level and bear an association of scrub oak and pitch pine, but most of the ridge is covered by a mixture of red, chestnut and white oaks, and pignut hickory (See Sect. C, Sites 1 to 4). Where the surface takes the form of a small plateau with finely divided soils and steep slopes on either side, the white oak and hickory predominate and have a thick shrub layer including *Viburnum affine* var. *hypomalacum* beneath them. Elsewhere, particularly on the rocky northeast slopes, red and chestnut oaks make up most of the timber, with considerable red maple.

A casual glance at this stand shows that two age classes are involved. There is a rather open stand of chestnut oaks with 8-10 inch diameters; these all appear to be of sprout origin. A younger class, also of sprout origin, is mainly of red oak and red maple with common diameters of 3-4 inches. A cut into an old chestnut oak showed it to be about 85 years old and that it grew rapidly during most of its first 30 years. It then grew more slowly for about 20 years, to be subsequently released for more rapid enlargement. It has had one minor period of rather slow growth since, but for the most part

the last 30-35 years of its life have been favorable ones. A red oak from the younger age class proved to be between 30 and 35 years old, and had had fairly rapid growth during its entire life. Most of the stumps from which this class grew are still visible, some showing only rotten bases and others dead upright sticks in their centers. Most of these old sticks, as well as most of the older trees on the ridge, show fire scars at their bases.

From these few facts we may suppose that the history of the stand was approximately as follows. About 80-90 years ago the site was cut over, or the timber otherwise removed. There came up a stand of red and chestnut oaks, the former apparently in the ascendency. Since this stand appears to have been largely of sprout origin the preceding one must have been primarily of the same facies. About the beginning of the present century there was a fire which destroyed most of the red oak on the upper part of the ridge. A little lower down on the northeast slope the fire did less damage to the red oak, although numerous scars show that it went through. The chestnut oaks were probably protected by their thicker bark. The result of this fire was the release of the older chestnut oaks and the initiation of the present sprout growth of red oaks and red maples.

The most striking conclusion derived from this inquiry is that in spite of the cutting or fire (or both) of 80-90 years ago, and in spite of the destructive fire of 30-35 years ago, the primary facies of the site has not changed materially except for a possible small increase in the amount of red maple. On the neighboring site 2a, where a white oak—hickory stand occurs, the same history is indicated. A group of older trees is scattered through a growth of younger ones which have come up as sprouts around charred stumps. Thus we may also conclude that during this period the agencies of fire and cutting have not seriously affected the boundaries of even the lesser

and more narrowly circumscribed types such as the white oak—hickory.

The undergrowth of sprouts and seedlings growing beneath the older trees gives little indication of succession within the types. If secondary agencies had been responsible for recent and repeated modification of the facies, we should expect to find a variety of stages in the development of the ensuing stands. The fact that the advance growth nearly everywhere represents the existing facies, not only in species but also in percentage composition, argues for the resistance of the types to change by these agencies. The Forest management has succeeded in modifying the types on a few selected areas by carefully planned selection cuttings, which will be discussed on a later page.

In sharp contrast to this resistance to change on the part of the woodland types is the well-defined succession of facies in abandoned fields. Here, as noted above, a strong admixture of gray birch, red maple, alder, and black cherry invades the land, to be followed by stages approaching the surrounding forest. On the finer soils outside the Forest still another phase is introduced with the abundance of red cedar.

A few very old trees are still standing in the Forest, or have been cut but recently. They date either from the pre-colonial forest or at least from a time which preceded active exploitation. The actual number of these trees is not known, since no complete census has ever been made, but the random sampling done by means of the transect studies outlined above suggests that they are more numerous than is commonly supposed. The writer found an old chestnut oak among the line of Section E, on the northeast slope of Rattlesnake (Hill). It is in Site 3, a short distance above the old road. Although still alive it is hollow in the center and obviously in a decrepit state. Its trunk is about 3 feet in diameter, considerably gnarled and twisted, and has large branches

starting about 10 feet above the ground. Mr. Tryon recently cut a tree of the same species on the lower north slope of Black Rock (Hill). This one was solid to the center, though not so large as the one in Section E, and proved to be about 274 years old. It also was branched from comparatively low on the trunk.

The writer has examined several old white oaks in different situations. One of the most striking marks the "White Oak Corner" of the Forest, east of the Upper Reservoir. This is a tall straight tree with branches comparatively high. Its great size (over 3 ft. in diameter) indicates that it belongs to an age class now almost extinct, evidently dating back to pre-colonial time. Another ancient white oak, nearly as large in diameter but with a somewhat shorter stem, was found on a stony plain along the brook which drains Jim's Pond, west of Bog Meadow Pond. Several old white oaks were observed along the line of Section F, on the rolling upland between the Secor Trail and Sutherland Pond, and their ages were estimated by means of an increment borer. On Site 5 is a gnarled and twisted specimen with branches a foot in diameter arising from not more than 4 feet above the ground. This tree is approximately 225 years old, which would have made it a sapling in the first two decades of the 18th century. This was not long after the first settlements were formed in these parts, and certainly before the exploitation of such isolated areas. Two more trees, on Sites 4 and 5, are each about 125 years old. They are in somewhat better soils and have a better habit of growth, but at that their branches arise only 6 or 8 feet above the ground. A much gnarled tree on Site 7 proved to be about 135-140 years old. Along the Chatfield Trail at the point where the Ledge Trail takes off there is an old white oak of similar habit to the above. Its trunk is so large that its age could only be approximated with the borer available, but 320 years would be a conservative estimate. Several ancient

white oaks of similar form were observed on the eastern slopes of Rattlesnake (Hill). They are on the upper part of the slope, mostly on the crown of the hill. In the same area, but lower down, are two very old black birches and an old sugar maple.

The outstanding suggestion to be derived from these scanty data is that wherever the very old trees are found their position and growth form are consistent with the existing forest of their immediate surroundings. If, as may be argued, the old trees were allowed to persist because of their poor form or unmarketable species this consistency should not be so pronounced, particularly in a region where so much of the cutting has been for cordwood. The old chestnut oaks are in well defined existing stands of this species. They do not tower above the younger trees, and resemble them rather closely in form. If there had been a pre-colonial forest of tall stature with clean, straight-boled trees on these sites it is inconceivable that the existing relics from it should have acquired the forms which they now have. The same is true of the open white oak woods of the high lands. There is good indication here that neither the form nor the composition of the timber have changed materially. In striking contrast are the old white oaks found on better sites. The one at the White Oak Corner has obviously been growing in cove timber all its life, and has the excellent form of the trees in this type. The one southeast of Jim's Pond is intermediate both in form and habitat between those of the hill-top sites and those in the coves.

It is of interest that in the "sorting" of species throughout the several categories of timber the resulting facies prove to be representatives of at least three forest types whose geographic ranges in eastern North America are different and fairly well defined. The cove timber is a form of the hemlock-northern hardwood-white pine forest which ranges throughout much of the

northern Great Lakes states and New England, sending a long tongue southward along the Appalachians (See Nichols, '35). The coniferous element is poorly developed in the Hudson Highlands, as is also the beech-sugar maple-yellow birch association which is commonly regarded as part of the "climax." Our form is better correlated with the so-called "transition hardwoods" of central New England (Spaeth, '20), where the prevailing species are red oak, white ash, white and black birch, red and sugar maple. Most of the coves and lower slopes in the Black Rock Forest have this association, with the paper birch nearly eliminated and with considerable numbers of the tulip-tree added. The extremely reduced development of the beech-maple-yellow birch association has already been noted. It has been found in somewhat better form in a ravine on the northeast slope of Schunemunk Mountain just west of the main axis of the Highlands, and it is highly developed in the Catskills and Poconos of the younger Appalachians to the northwest and west. The relation between the transition hardwoods, or the cove types described here, and the mixed mesophytic forest of the central Appalachian plateaux has not been studied. The mixed nature of the primary facies, and its local division into simpler communities suggest similarities which would repay further investigation (See Braun, '35a, for recent description and discussion of the mixed mesophytic forests of southeastern Kentucky).

The chestnut oak- (formerly) chestnut stands represent a southern and middle Appalachian phase of the deciduous forests. In western Maryland, Shreve, Chrysler, Blodgett and Besley ('10) described old growth forests of this type on ridges and upper slopes, and Weaver and Clements ('29) have recently pointed out the affinities of the type (See also Zon and Sparhawk, '23, map facing p. 522). We have, therefore, on the lower slopes of the Forest a broad ecotone between two well-defined regional

phases of the deciduous forest, a northern or "transition" one represented by the red oak and a southern Appalachian one represented by the chestnut oak and the tulip-tree.

The hill-top association of white oak and hickory, on the other hand, has a middle western affinity. This is accentuated by the local abundance of *Viburnum affine* var. *hypomalacum,* which represents a distinctly mid-western species.[1] The oak-hickory forests have their greatest development in the Mississippi basin, and are also represented in southern New England.

It may be possible to define a fourth type of regional affinity in the scrub oak-pitch pine association of the hill-tops. This has its closest counterpart on the coastal plain, and is well developed on Cape Cod.

Well defined regional affinities for the Black Rock Forest types suggest that they are of long standing on their present sites, and that they probably came here, not as individual species, but in associations similar to those now existing. They do not seem to be the result of an unordered period of exploitation. The writer, in an earlier paper, has commented as follows upon the probable stability of the regional types involved ('37).

"The present geographic ranges of the three forest types . . . are commonly, and probably rightly, thought to be determined by climatic and historical factors operating over very long periods of time. The climatic influences of the Appalachian mountains on the one hand, and the increasing aridity toward the westward in the Mississippi basin on the other, acting through long periods in the evolutionary history of the deciduous forests, have led to the development of the xerophytic

[1] Specimens of this species collected in the summer of 1936 were erroneously determined as *V. pubescens* var. *Deamii.* They were noted under this name in a recent paper by the present writer ('37). Further study of the material, however, with good fruiting specimens collected in 1937, has led to the above identification.

chestnut oak-chestnut, and white oak—hickory types respectively (Weaver and Clements, '29).''

''There is the suggestion here that we are dealing with a group of forest associations which may be as old as the species which compose them. There is some evidence that the most ancient of the group was the mesophytic type, consisting of beeches, with ancestral oaks and chestnuts. The scanty fossil evidence indicates that these date far back in the Cretaceous, whereas the modern lobe-leaved oaks, for instance, as well as the hickories, are not known as fossils until the early Tertiary (Berry, '23). If this is the case it is not unreasonable to consider that these xeric expressions within the deciduous forest appeared under the stimulus of the aridity which developed in the interior of America early in the Tertiary.'' (For further discussion of the development of the major associations in the deciduous forest see Braun, '35.)

Bray ('30) has expressed the opinion that in the Hudson Highlands a rather heavy ''organic soil blanket'' has been removed from the surface since exploitation began. He reasons from this that the prevalence of oak forests and the abundance of such xerophytic species as *Vaccinium vacillans, Ceanothus americanus,* and *Pteridium aquilinum* var. *latiusculum* may be due to recently induced edaphic rather than to climatic causes.

If a heavy forest of large trees had ever covered the hill slopes in the Forest it might be expected that with its removal there should have been notable changes in the soil profiles as Bray suggests, with loss of humus materials and erosion of one sort or another. Scholz' views ('31) regarding the condition of the cove and lower slope soils have already been quoted in part. It was his opinion that ''The abuse to which the Forest has been subjected is seemingly more strongly reflected in the degeneration of the growing stock than of the soil.'' Nor could he find much evidence either of surface erosion or

vertical translocation of materials in the soil. It was also his opinion that the humus content had not been seriously altered by excessive exploitation.

Even though the above data are too scanty to draw complete conclusions, they have led the writer to consider as an adequate working hypothesis that the pre-colonial forest on the upper slopes and hill-tops was not a heavy one of tall straight trees, and that the general distribution of types was not far different in arrangement and composition from the present one. There is a little indication, as will be pointed out in another place, that the original forests were somewhat less mesophytic than the modern ones. It is impossible in the present paper to enter into the problem of historical evidence, but a single quotation from the Journal of Robert Juet, mate on the Half-Moon in 1609, is in order. Under date of Sept. 30 he wrote: "The thirtieth was fair weather, and the wind at south-east a stiff gale between the mountains. We rode still the afternoon. The people of the country came aboard us, and brought some small skins with them, which we bought for knives and trifles. This is a very pleasant place to build a town on. The road is very near, and very good for all winds, save an east north-east wind. The mountains look as if some metal or mineral were in them; for the trees that grew on them were all blasted, and some of them barren with few or no trees on them." The Half-Moon was anchored just above Storm King Mountain and not far from the site of the town of Newburgh. With the "fair weather" indicated, there was a good view of the northern slopes of the Highlands in this vicinity, including parts of the Black Rock Forest southwest of Storm King. The view must have been not unlike that which one now has from the Newburgh-Beacon Ferry. Juet gives no indication that the aspect of the hills was much different from what it is today.

THE DEVELOPMENT OF FOREST TYPES

If the present arrangement of forest types is to be dated far back in the pre-colonial period, it is necessary to look for causes either among secondary agencies which might have been effective in those early times, or to the complex of climatic, edaphic, and historical factors which have been in operation throughout the long period of post-Glacial time. Bromley ('35), in a discussion of the pre-colonial forests of southern New England, has postulated intensive burning of the woods each year by Indians during many centuries before the coming of Europeans. He has based his contention mainly upon the writings of early colonial travelers and historians. There seems no doubt that fire has always been an important factor in the control of forests, whether started by Indians or by lightning; but the evidence cited by Bromley nearly all applies to a few localities about the early coastal settlements of New England, and can be used only by inference to account for the inland pre-colonial forests. Furthermore the early writers' explanation of "open" woodland as due to fire is open to question because of their probable unfamiliarity with park-like timber growing naturally (for further discussion of this question see a recent paper by the present writer, '37). It is more reasonable to consider that the normal environmental complex (with fire an occasionally effective part of it), at work over a long period of time and subject to gradual change, has determined the present disposition of timber types.

The preponderance of oak wood over most of the Black Rock Forest is indicative of the generally xerophytic nature of the habitat. It is in the forest zone

outlined by Bray ('30) as dominated by oaks, hickories, chestnut, tulip-tree, etc., and considered by him as determined mainly by climatic considerations. That is, it represents a northeastern extension of middle and southern Appalachian or Piedmont conditions. As noted above, however, he has expressed some doubt as to the influence of the climatic factor in determining the present forest of the Hudson Highlands.

Reference to maps of precipitation-evaporation ratios (Transeau, '05; Livingston & Shreve, '21; Thornthwaite, '31) will show that there is a well defined extension of southern climates northeastward through southern New York State and southern New England which might well account for the southern and middle Appalachian forests in those regions. It is in accord with the prevalence of oaks and other "sprout hardwoods"[1] in the Black Rock Forest, and although it has not been subdivided in such a way as to be correlated in detail with the ecotone between the northern and the sprout hardwoods, it is to be expected that such a correlation exists.

The problem of correlating the local timber types in the Black Rock Forest with climatic or edaphic conditions is further complicated by the presence and character of the cove and oak-hickory associations. The difficulty met with in designating primary species in the cove type is, to a certain extent, indicative of an "undeveloped" condition. Although with the possible exception of the tulip poplar, the commonest species in the coves are northern hardwoods, yet the association does not seem to have progressed very far toward the climax type of the northern hardwoods: beech—sugar maple—yellow birch. The question naturally arises as to whether the coves, in pre-colonial times, had a somewhat more mesophytic forest which had reached a beech-

[1] This term is used for a forest association dominated by oaks (mainly white and black), hickory, and (formerly) chestnut, with the tulip-tree a common constituent.

maple-birch stage, but by clearing and burning was subsequently thrust back into the somewhat unstable condition which we now see.

There is at present no historical evidence bearing upon this matter. If the cove forests were at one time more mesophytic than they are now, it is to be expected that they occupied somewhat more territory by extending up the lower slopes into what is now the red oak association. It seems that there should be found, in particularly favorable localities, remnants of this hypothetical beech forest, and that these remnants should be scattered generally through the cove areas. As noted above, however, this is not the case, and the only stands of beech available are extremely localized on small stream flood plains, or upon even more localized lower ravine slopes. Furthermore, the reasoning previously used concerning the antiquity of the present types also applies here. If the cove type formerly extended farther up the lower slopes and had been materially changed in composition by secondary agencies, we should not expect to find the sharp definition which we do between cove and slope types generally. If the cove types had been materially changed by exploitation we should expect to find evidence of succession in the advance growth. As already stated, this very rarely occurs, and the natural reproduction in the cove forests is almost identical with the existing stands.

Some evidence of value concerning the status of the cove forest in this region is to be found in the low country which lies north of the Highlands. The underlying rocks here are more easily weathered and have produced finer textured soils. Although outside the Highlands proper, the soils have a rather close counterpart on the lower north slopes of the Black Rock Forest, where a thick mass of glacial material derived largely from the lowlands has been deposited. A stand of ancient cove timber was found along a small northern tributary of

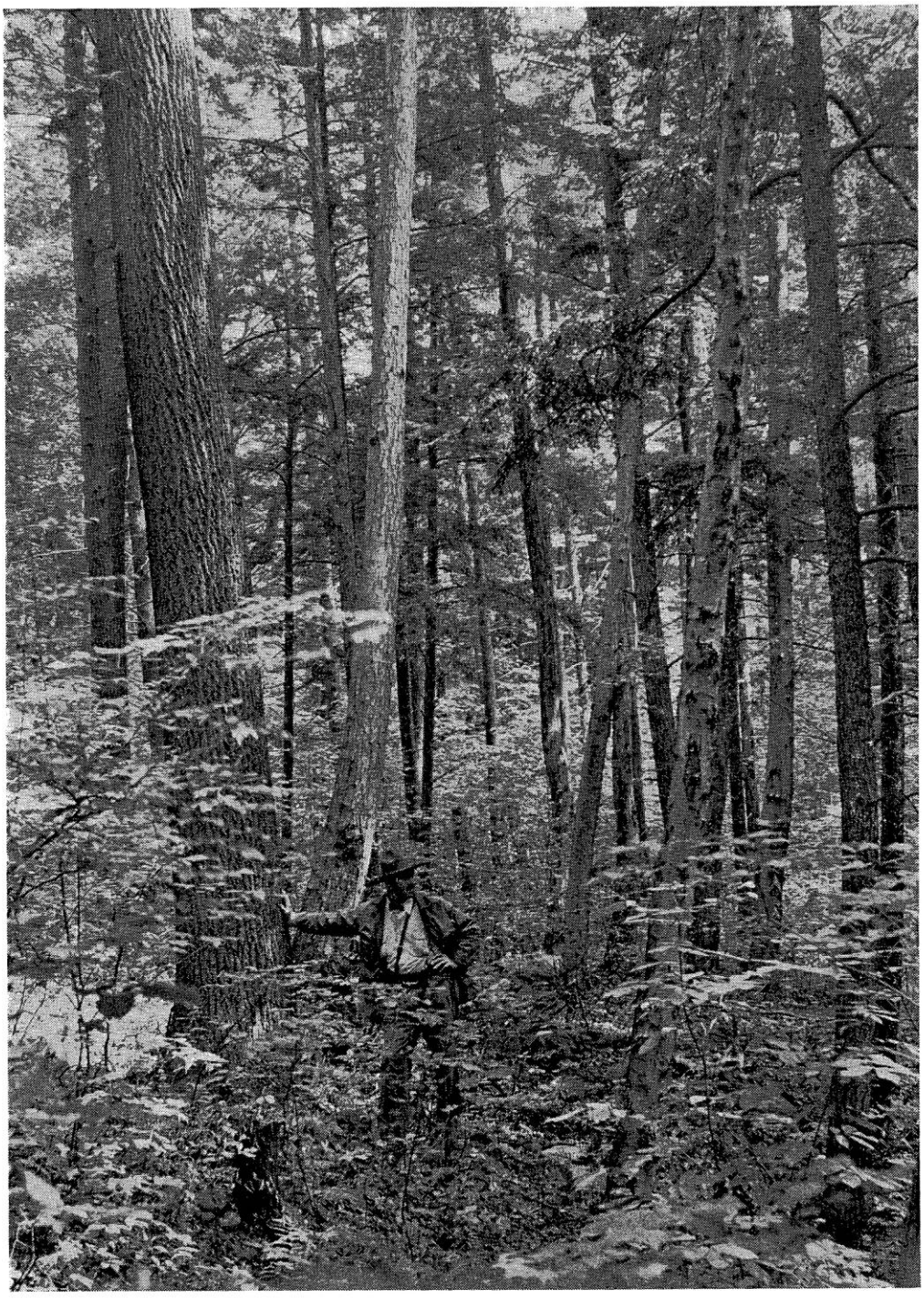


PLATE X. HEMLOCK—HARDWOOD COVE TIMBER ALONG CAESAR'S LANE. THE LARGE TREE AT THE LEFT IS *LIRIODENDRON TULIPIFERA*.

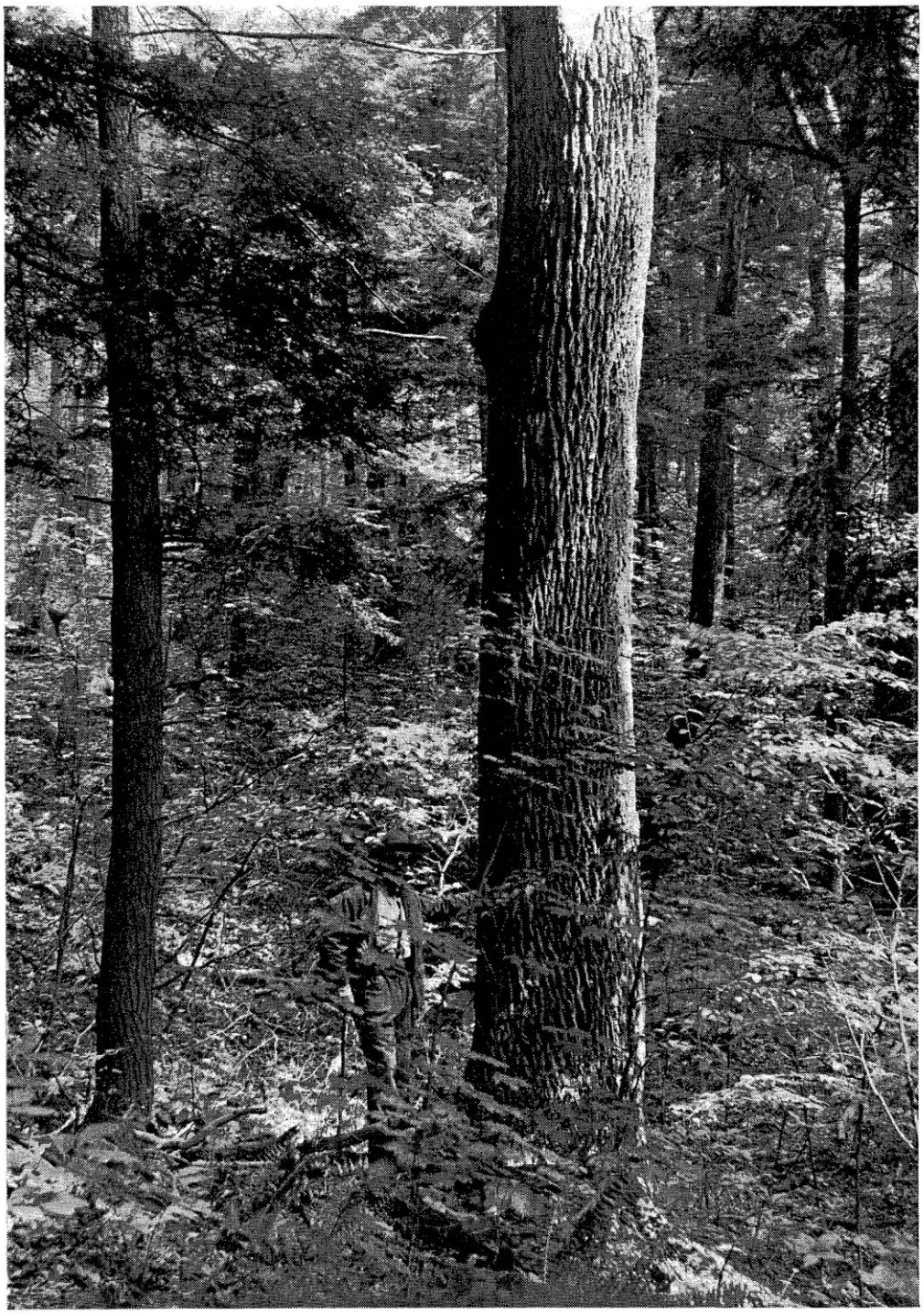


PLATE XI. HEMLOCK—HARDWOOD COVE TIMBER ALONG CAESAR'S LANE. THE LARGE TREE IN THE FOREGROUND IS A WHITE ASH, *FRAXINUS AMERICANA*.

Moodna Creek (Plates IX and X). This tributary lies along Caesar's Lane, a small thoroughfare which leads off the Cornwall-New Windsor Road just north of the Forge Hill Road. The valley of the tributary is rather shallow, not more than two or three hundred yards wide, and its slopes are gradual and covered by a gravelly soil. The stand of timber is at present being grazed; but no attempt was made to determine how long this had been going on, or what the earlier history of the tract had been. There is little or no evidence of axe work, although a few dead chestnuts have been cut out, with an occasional small hemlock. The primary species are hemlock and a group of hardwoods including black birch, tulip-tree, white ash, white and red oaks, chestnut oak, red maple, yellow birch, sycamore, butternut, shagbark hickory, and basswood. The ground flora is reduced to almost nothing, probably due to the grazing. The trees are the largest which the writer has seen in this part of the country. White oaks 4 feet in diameter are not uncommon, and the beech, tulip, and the white ash reach diameters of 3 feet. There appears to be abundant reproduction of the species which make up the main canopy, but no indication of succession. It is of note that here, as in the coves of the Forest, it was difficult to define primary species among the hardwoods, although the stand is unquestionably a relic of the primeval woods.

Since the cove types are so definitely circumscribed in habitat, and since they show little indication of having been seriously affected by exploitation, it seems just as reasonable to consider that they are relatively recent newcomers in the region, showing a mixed facies because they are "immature" from a successional standpoint. There is very little positive evidence in the associations themselves, other than their mixed nature, which points in this direction, although there are some matters relating to the development of the vegetation of the region

as a whole which suggest that this hypothesis may be tenable.

The oak-hickory type on the hill-tops is even more anomalous than the cove type because it represents a distinctly middle western aspect. Its extremely restricted and patch-work distribution in the Forest suggests that it is a relic of a formerly more continuously spread association. Whatever are the factors which determine its present distribution, it seems clear that its adjustment to its surroundings is a delicate one. By no other way can we account for its usually being limited to only one side of the crowns of the hills, and then to the northeast side. This is true not only of high rounded hills like Mt. Misery and Black Rock (Hill), but also on the rocky uplands where the only relief is in the form of small knolls or ridges. Section F affords an excellent example of this restricted but rather orderly arrangement. The white oak is consistently most abundant on the upper northeast and east slopes, even on the small elevations. Where the slopes are not very rocky or steep the white and red oak types alternate in this manner on the east and west sides, but where the slopes are very steep the chestnut oak appears in considerable numbers, with approximately the same relative position that it holds on the larger hills.

It might be argued that the white oak—hickory type could, like the cove type, be considered a relatively new arrival, securing a foothold only in the more stable though dry soils of the hill-tops. If this were the case we should expect it to be of even more local occurrence than it is, growing on one hill-top and not on the next. Such is not the case, however, for the type is found in one form or another on practically every knoll in the Forest which rises above 1200 feet. Furthermore, if the white oak-hickory type were a newcomer, aggressively colonizing the tops of the hills, it ought to show evidence of invading the drier parts of the slopes. An exami-

nation of the transect studies upon which a considerable part of this paper is based shows that the white oak and hickory do this on very rare occasions. On the contrary the red oak type extends far up the slopes and often occurs in considerable numbers within the hill-top associations.

An outstanding fact is that we have here two forest types whose adjustment to their living conditions appears to be of a delicate nature. They are so delicately adjusted that a change in general conditions of mesophytism toward the more humid or the less humid could be expected to accentuate the cove types on the one hand, or the dry hill-top associations on the other. In case of the former the oak-hickory association, and probably also the chestnut oak association, would become more restricted than they now are, or they would be completely eliminated, while if the woods as a whole became drier the cove associations could be expected to suffer the same fate. These things strongly suggest that a historical factor must be inserted into the problem of placing the local timber in its proper relationship to that of the surrounding regions. In other words, the present arrangement of the forest types cannot be looked upon entirely as the product of local climatic or edaphic interactions, but must be seen also in the light of the probable developmental history and current trend of the whole vegetation. A decision with regard to the direction of this development becomes of considerable silvicultural significance. If, for instance, the present trend is toward a more northern mesophytic association, it should prove to be more economical to encourage northern and transition hardwoods in the coves than such central species as white oak or tulip-tree.

It has been stated previously that the major forest boundaries in eastern United States seem to be correlated with the general distribution of climates, these in turn largely influenced by topography. It seems reasonable

that a shift in climate one way or the other during comparatively recent geologic time should be reflected in the movement of such forest ecotones as that between the northern and sprout hardwoods.

The writer has recently investigated to a certain extent the evidence for such a change of climate in southern New England and adjacent New York State during the past 3000 years or less (Raup, '37). This evidence, though scanty, becomes significant when it is gathered into one place out of the many lines of inquiry from which it arises. There is reason to believe that during this period a warmer and drier climate prevailed over most of northeastern North America. Indications of it are to be found in the contrast between modern and recently fossilized marine invertebrate faunas, and in the development of aboriginal maize culture patterns of southern New England. Forest studies in southern New England strongly suggest that the ecotone between northern and southern hardwood forests is moving southward, an event which is reflected in the distribution of many distinctly southern Appalachian plants throughout the uplands of New England. Many of these plants have scattered and disrupted ranges, indicating a former more continuous range made possible by a northern extension of their optimum growing conditions. Other evidence is to be found in the probable larger development of the southern coast white cedar in southern New England during comparatively recent times; likewise there appears to have been a larger development of oak forests on the island of Nantucket at no very distant date. Some rather convincing evidence for such a warm, dry climate is to be found in peat deposits of northern New England and the Maritime Provinces, where layers of woodland deposits are found between layers of marsh or bog peat. There is some indication of change in forest boundaries also to be found in drowned forests along the coast, and

in the earlier northward extension of certain coastal plain trees as shown by recently fossilized remains.

There is some evidence that the return to warm, humid conditions may have become effective approximately a thousand years ago. This figure is based upon the relationship between the depth of fossil beds beneath sea level and the estimated rate of subsidence of the coast. The warm, dry climate in New England appears to be generally coincident in time with similar climates which prevailed in middle western United States (Sears, '33), in northwestern Europe (Godwin, '34; Antevs, '25), and in Greenland (Nörlund, '24; Hovgaard, '25). The time at which the warmer climate in Greenland finally declined is placed at about the twelfth century (Brooks, '26), which agrees fairly well with the disappearance of the warm water marine fauna from the New England coast.

In middle western United States it has been shown that vegetational relics of this comparatively recent warm, dry climate are still in existence (Gleason, '23; Sears, '26; Transeau, '35); and one may regard the scattered and disrupted ranges of southern plants and animals in New England as examples of the same persistence of effects. It is thought that the pre-colonial upland forest of most of southern New England east of the Berkshires was composed primarily of oak, chestnut and hickory, with the white pine locally abundant; and that this prevailingly sprout hardwood forest was merely persisting in this region. It was probably just holding its own against the invasion of northern hardwood types, and was aided in this by the fact that it was sufficiently dry to burn easily. It is thought further that with the elimination of such upland forests during the period of European settlement and agriculture, a succession was initiated on abandoned farm lands which is trending, not toward a sprout hardwood type, but toward a more mesophytic one involving northern or transition hard-

woods among which red oak, white ash and hard maple are prominent.

Judging by these findings we should expect to see in the Black Rock Forest some evidence of this former warm, dry climate, even though the latter may have disappeared a long time ago. Furthermore, we should expect to find a developmental trend toward more mesophytic forests, even though current climatic changes are of too small a magnitude to have any direct effect.

The oak-hickory type might be regarded as a relic of the forest of more southern and western character which invaded southern New England and adjacent New York State during the period of warm and dry climates. Its wide, though scattered, distribution suggests this, as does also its apparent lack of vitality in invading the other associations. On the other hand, the cove types may be looked upon as the beginning of an invasion by northern hemlock-hardwood types. On this basis we can expect the red oak association of the lower slopes to become more mesophytic, with a possible greater invasion from below of white ash, sugar maple, basswood, elm, beech and hemlock. The chestnut oak association which is characteristic of steep, rocky slopes would be further restricted than it now is, and possibly eliminated from many northward exposures.

We have no way of knowing whether there is a climatic change going on now which will prove to be of as great magnitude as that which appears to have occurred about a thousand years ago. The scanty climatic data which are available for the past hundred years or so are insufficient for a judgment on this question. There is some indication that the climate has become a little warmer during the past 50 to 75 years, but there is also indication that in so doing it is only returning to a warm peak which occurred 100 to 125 years ago (Kincer, '33). Rainfall cycles of short period duration have been noted by Pack ('33) and Kincer ('36), but no long term trends

are apparent. This is also shown by Marshall ('27) and Lyon ('36) in their studies of growth rings in the hemlock. With our present knowledge it seems best to consider that the same vegetational trend which has been going on during the past thousand years is still operative.

RELATION OF THE VEGETATION TO LOCAL SOILS AND CLIMATES

ACTUAL causes for the present arrangement of timber types on the area are not defined. One of the most suggestive correlations made to date is that between the thick glacial deposits and the cove timber. This material rests on the lower north slopes of the Highlands, and ranges in elevation within the Forest from 450 to 1200 feet. Except on the immediate banks of the cove streams, and in occasional upland peaty depressions, the upper boundary of the cove forest is clearly marked by the upper boundary of the thick deposits.

In some places, as on the east slope of Sackett (Hill) (See Sect. B, Fig. 3) the transition is rather gradual, and contains a broad association in which red oak and hard maple are prominent. Even here the actual boundary is striking, however, due to the change from tall, straight-boled trees of the cove type to lower, branchy forms in the upper slope forests. An excellent view of the arrangement of the cove timber, particularly in mid-summer, can be had from some of the northernmost ridges such as Storm King Mountain. The large, pale green leaves of the tulip-tree stand out in contrast to the rest of the cover, and their upper limit is a rather smooth curve along the sides of the north-facing hills. Where a ravine cuts this line there is a long narrow upward extension of the tulip-trees. It should be noted also that the margin of the thick glacial deposits is marked in many places by a distinct topographic break. The surface of these deposits is relatively even and not so steep as the rough and rock-strewn surfaces of the higher slopes.

So far as their physical characteristics are concerned,

the glacial deposits of the upper slopes and hill-tops do not differ materially from the upper strata of the thick ones on the north slopes, nor is there great variation from one part of the upland to another. There appears to be no correlation, moreover, between minor differences in the thin and discontinuous glacial deposits of the uplands and the well-defined differences in upland forest types outlined above. The only exception to this appears to be the preference of the chestnut oak for the steeper rocky slopes. It appears that if the physical nature of the glacial soils is to account for the relation between the cove timber and the thick till, the thickness itself or the nature of the deeper strata must be the significant features. It has been pointed out by Denny (in press) that the glacial deposits may be divided vertically into three major horizons. The deepest of these is a bluish-gray unweathered mass of great compactness and water-holding capacity. It has been found only in the lower parts of the north slopes where the streams have dissected the thick till, and its upper surface is about 12 feet deep. Above this is a layer which gives evidence of having been weathered in place from material similar to that below. It still maintains its till structure, but is leached of carbonates and is stained yellowish brown. Its thickness is about 7-8 feet. Though more permeable than the bluish-gray layer, it still retains more water than the soils above it. The third horizon is a frost-heaved layer, or "warp," which has lost most of its till structure and contains varying quantities of granitic rock fragments from the neighboring ledges. It is comparatively loose in texture. Denny has shown, further, that the warp has been subject to slow movement en masse down the slopes during an earlier, more rigorous ("peri-glacial") climate; and that this movement, together with frost heaving at right angles to the surface, has tended to smooth the slopes and eliminate the topographic forms of the typical ground moraine.

The distribution of the two upper horizons in the Forest depends upon the total thickness of the deposits. If they are less than 3-5 feet thick the warp rests directly upon the bed rock, but if they exceed this depth the weathered till appears. This, in turn, lies directly on the bed rock unless the deposit is more than about 12 feet thick, as on the lower north slopes. It follows that there are three major categories of water-holding capacity in these soils, and three planes for the flow of water, excluding the surface. The first of the latter is at the top of the weathered till, the second at the top of the unweathered till, and the third is on the bed rock. It is clear also that the unweathered till of the lower north slopes, together with the thick mass of weathered till above, form a reservoir which collects and holds the water which flows from the bed rock and more permeable glacial deposits of the upper slopes.

Whether the water factor alone can be held accountable for the coincidence of the thick till and the cove timber is not proved, since other factors such as local climate and soil nutrients have not been investigated sufficiently. However, the coincidence is striking, and this theory for its explanation is made more reasonable by the fact that the cove timber ascends higher in the hills along the immediate banks of the streams where the water table is near the surface.

That there are well-defined variations in local climate has been shown by the all-too-meager observations made in the summer of 1937. A proper understanding of topographic differences in temperature, wind velocity and frequency, and rate of evaporation not only on the ground but also in the forest canopy, are essential to further investigation of local growing conditions. This is particularly true at higher levels where the forest types do not appear to be so well correlated with physical differences in the soil. The natural division of the hilltop vegetation into northeastern and southwestern

aspects suggests that the local climate may be a determining influence. Exposure to warm sun for a greater part of the day, and the exposure to drying westerly winds may determine the concentration of the scrub oak-pitch pine and meadow associations on the southwest sides. Additional evidence for this comes from the fact that the vegetational division is apparently independent of local soil differences.

It should be noted that in the Catskill Mountains, about 50 miles northwest of the Hudson Highlands, the cove type of timber, there represented by a northern hardwood association of beech, yellow birch and hard maple, ascends the high rocky slopes without regard to the presence or absence of thick till. It is presumed that the climate is somewhat different there, with the greater elevation and distance from the sea, and it is also probable that some basic soil differences occur. There is the suggestion, however, that under a slightly different climate the cove timber in the Black Rock Forest might be released from any dependence it has upon the thick till, and cover most of the slopes.

Mitchell (personal communication) has recently made some leaf analysis studies in various parts of the Forest. The sites were chosen so as to represent the major types of timber, and the investigation was based upon the red oak which occurs in nearly all of the types. Although these studies are far from complete, they suggest that gradients occur in the amounts of available mineral nutrients in the soils. The magnitudes and significance of these differences are not yet well enough known to be applied to the present problem.

SUMMARY AND DISCUSSION

THE timber of the Black Rock Forest has been described in eight types whose arrangement on the hills appears to be largely controlled by the topography. The hill-top and upper slope types include the pitch pine—scrub oak association which is mainly confined to the west and south sides of the crowns of the higher hills; and the white oak—pignut hickory association which is on the north and east sides of the hill-tops. Most of the hill slopes are covered with forests dominated by red or chestnut oaks, alone or in mixtures. Very rocky, steep slopes have chestnut oak predominating, and gentler slopes have red oak. The steepening of the slopes at higher levels has led to a concentration of chestnut oak near the tops of the hills. Valley bottoms in the upland part of the Forest, stream banks, and some of the northward-facing slopes that descend below 1200 feet on the north side of the Hudson Highlands, have a richer mixture of species in which hemlock, tulip-tree, white ash, linden, hard maple, red maple, yellow birch, and beech play a prominent part. These cove types can be divided into hemlock-hardwood stands which frequent cool northward-facing ravines, mixed hardwood stands of red oak, hard maple, white ash, tulip-tree, and linden which grow also in upland coves and southward-facing valleys, and swamp hardwoods composed largely of yellow birch and red maple. A fourth cove type, dominated by beech, hard maple, and yellow birch, is rare in the Forest.

It has been pointed out that these various types of timber have affinities with wide-ranging associations of the deciduous forest region of eastern America. The pitch pine—scrub oak type is most nearly related to vege-

tation on the coastal plain, while the adjacent white oak-hickory type is closely related to forests of the middle west and southern New England. The chestnut oak stands represent the chestnut oak- (formerly) chestnut forests of the central Appalachians. The cove forests, of mixed composition, appear to be representative of the so-called transition hardwoods of central New England. They thin out into red oak timber on the lower slopes, and approach the northern hardwoods of beech, yellow birch and hard maple in some of the deeper coves.

There is considerable evidence that the local arrangement and composition of the types have persisted with little modification since pre-colonial times. This evidence appears in six categories, the first of which is that the areal configuration of the type boundaries conforms to the topography or to deep-seated soil differences rather than to exploitation boundaries. Advance growth in the various associations agrees in composition with the existing timber and does not show a developmental trend due to exploitation. Recent cutting and fire (within the last 100 years) are shown to have had little effect upon the composition of even the more delicately adjusted upland types. The soils show little evidence of recent change due either to surface erosion or the vertical movement of materials. Wherever very old trees are found (those reaching back to the early period of settlement or to pre-colonial times), they are similar in form and species to the existing stands. Finally, identity of the types with wide-ranging associations of the deciduous forests as a whole suggests that they have remained fairly stable in composition for a long period of time.

Another finding which argues for the conservatism of the woodland types generally is that they are highly resistant to invasion by introduced or native ruderal species. Less than 3 per cent of the woodland flora falls within this classification, as against about 30 per cent in fields or along roadsides and trails.

The hill-top and cove forests appear to be rather delicately adjusted to their several environments. Evidence for this is found in the extremely circumscribed area, for instance, of the white oak—hickory association, which is immediately replaced by red oak, chestnut oak, or the scrub oak—pitch pine type wherever the required slope, exposure or soil conditions are changed. It is suggested that the cove type is also delicately adjusted, or at least is in a stage of successional development. This is shown by its mixed and variable composition, and also by its limited range in the Forest. Whether any trends of development can be detected is uncertain, but it is suggested that apparent long-term movements of forest boundaries in northeastern America should be reflected here. These movements appear to indicate increased mesophytism, and an expansion of transition and northern hardwoods at the expense of central, or "sprout" hardwoods.

Certain aspects of the timber impinge directly upon the problem of silvicultural planning. First among these is the apparent stability of the principal associations through long periods of time and excessive exploitation. If large areas had been completely cleared of timber and reduced to pasture or cultivated land a very different situation might have arisen, as it has in the surrounding regions; but since this has never occurred we have to deal with forests which seem to be determined by the normal conditions of climate, soil, topography, and historical factors affecting the development of the vegetation as a whole. It is of note that the timber is made up of *associations* rather than *individual species,* and that these associations give evidence of being as old and stable as the species which compose them. It follows that the behavior of species under silvicultural management should be more accurately predictable if they are allowed to remain in their natural associations than if they are handled singly. This is especially true since our

knowledge of the actual environmental relationships of individual species is extremely limited.

It begins to be apparent from other lines of inquiry that associations of trees as well as many other plants are held together by bonds which, though poorly understood, are essential to the continued well-being of these associations. The discovery and control of these bonds becomes one of the most intriguing and significant problems in silviculture. There is abundant evidence of a close relationship between the roots of many plants and mycorrhizal fungi; and the relationship appears to be beneficial to forest trees in many natural soils (Hatch, '36, '37; Mitchell, Finn, and Rosendahl, '37). The effect of earthworm activity upon the modification of certain soils has long been recognized, and its relation to changes in forest types has been outlined in studies at the Harvard Forest in Petersham, Massachusetts (Fisher, '28; Griffith, Hartwell, and Shaw, '30). Further it is clear that demands made upon the soil by various tree species for nutrient materials differ greatly; and in their effects upon site quality they probably react in a complementary manner (Alway, Kittredge, and Methley, '33; Chandler, '37; Heimberger, '34; Hicock, Morgan, Lutz, Bull, and Lunt, '31; Mitchell, '36; Plice, '34). The success of silvicultural experiments involving whole associations is indicative of the advisability of this method (see Tarbox & Reed, '24; Cline & Lockard, '25). The advantages are not only in the quality of the growing stock, but also in the more successful control of disease and insect pests.

In certain experimental areas on the better sites in the Black Rock Forest, particularly in Glycerine Hollow and on the lower north slopes of Black Rock (Hill), it has been possible to increase, by careful selection cuttings, the percentage of commercially desirable species in the stands (white ash and tulip-tree). It may be that this could be further accentuated by the selection of genetic strains in the desirable species which would be particu-

larly suitable to the region. In the light of suggestions made above, this "change" though it may be successful in the present generation of trees, involves what is probably an artificial and temporary arrangement of species, the total effect of which is not predictable. If it were possible to produce even a semi-permanent association composed largely of white ash or tulip-tree, we should be able to find an example of it somewhere in the woods, with all the clear cutting and culling which has been done. However, such stands have not yet been found. If we may judge by the past efforts of foresters at growing trees in stands which deviate materially from the natural facies of the site, the continuation of the program is likely to entail increasing expense with decreasing returns (See Troup, '28, for a discussion of European silvicultural systems which have been in effect long enough to see the results of this type of management). It is reasonable to expect that if a series of nearly pure stands were to be grown consecutively on the same site, there would follow a deterioration in soil productivity not unlike that faced by agriculturists. The latter have resorted to crop rotation systems which appear to be eminently successful; but in forestry the long time intervals involved and the lack of knowledge of forest reactions upon the soil have precluded the development of such systems. Much experiment is yet needed before it can be determined, for any given region, the point at which the modification of natural facies for immediate higher financial returns must be curtailed in order to maintain productivity.

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PART II

CATALOGUE OF THE VASCULAR PLANTS OF THE BLACK ROCK FOREST, ORANGE COUNTY, NEW YORK

THE following catalogue of plants of the Black Rock Forest is based entirely upon collections made during the field seasons of 1936 and '37. Most of them were made between June 22 and September 12, 1936, and were supplemented with a collection of the spring flora gathered during the third week in May, 1937. In all there are 1011 field numbers, all but 37 of which are the writer's own. These 37 were collected by Mr. Russell Rosendahl, who was serving as assistant at the Forest during this period. Most of the numbers were made in triplicate, and the first set, containing all the unicates, forms a permanent herbarium at the Forest. The remaining two sets will be found at Harvard University and the New York Botanical Garden, respectively. The determinations have been made in the Gray Herbarium, and in the Herbaria of the Arnold Arboretum and the New England Botanical Club.

The order of families and genera is, with the exception of the Gramineae, that of Engler and Diels' *Syllabus der Pflanzenfamilien* (11th edition). The grasses are arranged according to Hitchcock's *Manual of the Grasses of the United States.* The nomenclature follows in general the International Rules. Synonyms have been added only where they are necessary for making the list referable to current manuals touching the flora of this region such as Britton and Brown's *Illustrated Flora of the Northern States and Canada,* Gray's *New Manual of Botany* (7th edition), House's *Annotated List of the Ferns and Flowering Plants of New York State,* and Wiegand and Eames' *Flora of the Cayuga Lake Basin, New York.* Names which have more recently come into use are accompanied by a reference to periodical literature where they are discussed. Common names have been

added only in cases where widely accepted ones are available. Introduced plants have been indicated by an asterisk (*).

The catalogue is far from complete, as would be expected from the amount of field work involved, but it will serve as an adequate working basis for further contributions along this line. It has been limited to those plants actually found to date within the boundaries of the Forest.

EQUISETACEAE

Equisetum arvense L. — FIELD HORSETAIL. — Apparently only occasional in the Forest, and found on damp brook banks in the cove woods.

Equisetum sylvaticum L. var. **pauciramosum** Milde. — WOODLAND HORSETAIL. — Found thus far only in swampy thickets in a clear cutting south of the Upper Reservoir.

Equisetum prealtum Raf. — *E. hyemale* L. var. *affine* (Engelm.) A. A. Eat.—SCOURING RUSH. — Apparently rare in the Forest, and found thus far only in a wet thicket near the Upper Reservoir.

LYCOPODIACEAE

Lycopodium lucidulum Michx. — Occasional in wet mossy woods of the coves and lower north slopes. Found with young sporangia early in July.

Lycopodium obscurum L. — GROUND PINE. — Rare or occasional in damp cove woods.

Lycopodium complanatum L. var. **flabelliforme** Fern. — CLUB-MOSS. — Apparently rare or occasional in the Forest. Found with immature strobili in dry woods southwest of Sutherland Pond late in June.

SELAGINELLACEAE

Selaginella rupestris (L.) Spring. — Apparently rare in the Forest, and found thus far only in open rocky places on the tops of the hills.

OPHIOGLOSSACEAE

Botrychium virginianum (L.) Sw. — RATTLESNAKE, or GRAPE FERN. — Occasional in the rich woods of coves and lower slopes. Found maturing its spores about mid-July.

OSMUNDACEAE

Osmunda regalis L. var. **spectabilis** (Willd.) Gray. — ROYAL FERN. — Occasional to common in wet swampy woods and thickets. Fruit maturing in late June or early July.

Osmunda Claytoniana L. — INTERRUPTED FERN. — Common in damp woods and thickets. Spores mature in late June and early July.

POLYPODIACEAE

Woodsia ilvensis (L.) R. Br. — Rare, and found thus far only in dry rock crevices near the tops of the hills.

Cystopteris fragilis (L.) Bernh. — *Filix fragilis* (L.) Gilib. — FRAGILE FERN. — Apparently rare in the Forest; found only in damp rocky ravines.

Onoclea sensibilis L. — SENSITIVE FERN. — Common in wet meadows and thickets, and on damp stream banks in the cove woods.

Dryopteris Phegopteris (L.) C. Chr. — *Phegopteris polypodioides* Fée. — *Thelypteris Phegopteris* (L.) Slosson. — BEECH FERN. — Apparently rare, and found only in the rocky ravine of Black Rock Brook.

Dryopteris hexagonoptera (Michx.) C. Chr. — *Phegopteris hexagonoptera* (Michx.) Fée. — *Thelypteris hexagonoptera* (Michx.) Weatherby. — BEECH FERN. — Apparently rare in the Forest, and collected thus far only in red oak woods on northerly slopes.

Dryopteris Thelypteris (L.) Gray. — *Aspidium Thelypteris* (L.) Sw. — *Thelypteris palustris* Schott. — MARSH SHIELD FERN. — Common in wet woods and at swampy pond margins.

Dryopteris noveboracensis (L.) Gray. — *Aspidium noveboracense* (L.) Sw. — *Thelypteris noveboracensis* (L.) Nieuwl. — NEW YORK FERN. — Occasional to common in rich woods in the coves and on lower slopes.

Dryopteris marginalis (L.) Gray. — *Aspidium marginale* (L.) Sw. — *Thelypteris marginalis* (L.) Nieuwl. — MARGINAL SHIELD FERN. — Common in woods, especially those of the lower slopes and coves.

Dryopteris spinulosa (O. F. Müll.) Ktze. — *Aspidium spinu-*

losum (O. F. Müll.) Sw. — *Thelypteris spinulosa* (O. F. Müll.) Nieuwl. — SPINULOSE SHIELD FERN. — Common in rich woods on the lower slopes and in the coves.

Polystichum acrostichoides (Michx.) Schott. — CHRISTMAS FERN. — Common to abundant in the rich woods of the lower slopes and coves.

Woodwardia virginica (L.) Sm. — *Anchistea virginica* (L.) Presl. — CHAIN FERN. — Common in bog thickets such as those about the lower end of Sutherland Pond and on the island in Tamarack Pond.

Camptosorus rhizophyllus (L.) Link. — WALKING FERN. — Extremely rare, and known only from a large limestone erratic boulder in the valley of Black Rock Brook.

Asplenium Trichomanes L. — MAIDENHAIR SPLEENWORT. — Rare in the Forest, and found thus far only in crevices of a large limestone boulder in the ravine of Canterbury Brook. In fruit in mid-summer.

Asplenium platyneuron (L.) Oakes. — EBONY SPLEENWORT. — Occasional in upland rocky woods.

Dennstaedtia punctilobula (Michx.) Moore. — *Dicksonia punctilobula* of auth. — HAYSCENTED FERN. — Common in damp open woods and shaded banks.

Athyrium angustum (Willd.) Presl. — *Asplenium Filix-foemina* of authors. — LADY FERN. — Occasional to common in damp woods and swales.

Adiantum pedatum L. — MAIDENHAIR FERN. — Common in rich woods on the lower slopes of the hills.

Pteridium aquilinum (L.) Kuhn var. **latiusculum** (Desv.) Underw. ex Heller. — *Pteridium latiusculum* (Desv.) Maxon. — *Pteris aquilina* of auth. — BRACKEN FERN. — Abundant in dry woods and thickets, particularly on the upper slopes.

Polypodium virginianum L. — *P. vulgare* of auth. — COMMON POLYPODY. — Occasional to common on ledges and boulders in shady woods.

PINACEAE

Picea mariana (Mill.) BSP. — BLACK SPRUCE. — Known within the Forest only on the Island in Tamarack Pond. It was formerly common in the swamp now occupied by this pond, but

is now reduced to a few individuals produced by layering from old stumps.

Picea glauca Voss. — *P. canadensis* BSP., not Link. — CANADA, or WHITE SPRUCE. — Known in the Forest only in experimental plantations.

Tsuga canadensis (L.) Carr. — HEMLOCK. — Common to abundant in ravines and on lower slopes. It is a primary species in parts of the ravine woods on the north side of the Forest.

Larix laricina (DuRoi) Koch. — *L. americana* Michx. — AMERICAN LARCH, or TAMARACK. — Known in the Forest only in experimental plantations.

Larix decidua Mill. — *L. Larix* Karst. — *L. europaea* DC. — EUROPEAN LARCH. — Known in the Forest only in experimental plantations.*

Pinus Strobus L. — WHITE PINE. — Occasional on the higher wooded slopes throughout most of the Forest; but common only in a stand of timber on a rocky knoll just east of Sutherland Pond.

Pinus rigida Mill. — PITCH PINE. — Common to abundant on rocky hill-tops where it shares dominance on southerly and westerly exposures with scrub oak.

Pinus resinosa Ait. — RED, or NORWAY PINE. — Known in the Forest only in experimental plantations.

CUPRESSACEAE

Juniperus virginiana L. var. **crebra** Fern. — See Rhod. **37**: 131-3 (1935). — RED CEDAR. — Common on rocky hill-tops mainly in the meadow and scrub oak associations. Also common in abandoned fields, where it is a predominant species on the clayey soils north and west of the Forest.

TYPHACEAE

Typha latifolia L. — CATTAIL. — Common in pond shore marshes. Found flowering in July.

Typha angustifolia L. — NARROW-LEAVED CATTAIL. — Found thus far only at the outlet of Arthur's Pond, where it grows in a marshy place below the dam. Flowers in early summer.

SPARGANIACEAE

Sparganium americanum Nutt. — BUR-REED. — Common to abundant on the shores of the older ponds, such as Jim's, and occasional along slow streams. Found with flowers during late June, and with maturing fruit in late July and August.

POTAMOGETONACEAE

Potamogeton natans L. — POND WEED. — Rare or occasional; found thus far only in the swamps about the lower end of Sutherland Pond.

ALISMACEAE

Sagittaria graminea Michx. — Occasional in shallow water on the shore of Sutherland Pond, but not known elsewhere in the Forest. Found only in a sterile condition, late in July.

Sagittaria latifolia Willd. — Pond margins; apparently rare. Flowers in mid-summer.

Alisma Plantago-aquatica L. var. **parviflorum** (Pursh) Farwell. — See Rept. Comm. Parks & Boulev., Detroit, **11**: 44 (1900). — WATER PLANTAIN. — Occasional on wet gravelly pond shores. Found flowering late in July.

GRAMINEAE

Bromus purgans L. — BROME GRASS. — Occasional in rocky slope woods. Matures about mid-summer.

Bromus ciliatus L. — BROME GRASS. — Occasional along woodland roads. Found maturing late in August.

Festuca elatior L. — MEADOW FESCUE. — Occasional in dry soil of old clearings and roadsides. Found in anthesis early in July.*

Festuca obtusa Spreng. — *F. nutans* Spreng. — NODDING FESCUE. — Occasional to common in damp ravines and along streams in cove woods. Maturing late in June or early in July.

Glyceria melicaria (Michx.) Hubb. — *G. Torreyana* (Spreng.) Hitch., of auth. — *Panicularia melicaria* (Michx.) Hitchc. — Common on swampy stream margins in the cove woods. Maturing fruit early in July.

Glyceria canadensis (Michx.) Trin. — *Panicularia canadensis* (Michx.) Ktze. — RATTLESNAKE GRASS. — Common to abundant at marshy pond and swamp margins. In flower during late June and July.

Glyceria striata (Lam.) Hitchc. — *G. nervata* (Willd.) Trin. — *Panicularia nervata* (Willd.) Ktze. — FOWL MEADOW GRASS. — Common to abundant at wet stream and pond margins. Found in flower and fruit during late June and the first half of July.

Poa compressa L. — CANADA BLUE GRASS, or WIRE GRASS. — Common to abundant on roadsides and in waste places. Occasional in the meadows and dry open woods of the hill-tops and upper slopes. Found flowering throughout the summer.*

Poa palustris L. — *P. triflora* Gilib. — Occasional in damp thickets. Found in anthesis early in July.

Poa pratensis L. — JUNE, or KENTUCKY BLUE GRASS. — Occasional on roadsides and in waste places. Found with maturing spikelets about mid-July.

Dactylis glomerata L. — ORCHARD GRASS. — Occasional to common in dry soil of clearings and roadsides. In anthesis early in July.*

Agropyron repens (L.) Beauv. forma **aristatum** (Schum.) Beauv. — See Rhod. **35**: 182-5 (1933). — COUCH GRASS. — Occasional to common in waste ground. In anthesis early in July.*

Elymus riparius Wieg. — See Rhod. **20**: 81 (1918). — WILD RYE. — Occasional in damp thickets at the margins of reservoirs. Matures late in the summer.

Asperella Hystrix (L.) Humb. — *Hystrix patula* Moench. — *H. Histrix* (L.) Millsp. — BOTTLE-BRUSH GRASS. — Common in dry upland woods. In anthesis about mid-summer.

Lolium multiflorum Lam. var. **diminutum** Mutel. — ITALIAN RYE GRASS. — Occasional to common on roadsides and in fields. Found in anthesis early in July.*

Sphenopholis pallens (Spreng.) Scribn. — Occasional in shaded hemlock ravines. Found in anthesis late in June.

Sphenopholis obtusata (Michx.) Trin. — Occasional on dry roadsides. Fruit maturing early in July.

Deschampsia flexuosa (L.) Trin. — HAIR GRASS. — Common to abundant in the small meadow areas on the tops of the hills, where it often shares dominance with *Danthonia spicata*. Occa-

sional to common throughout the slope woods. Found maturing in late June.

Avena sativa L. — Common Oat. — Occasional on roadsides and in waste places.*

Arrhenatherum elatius (L.) Beauv. — Tall Oat Grass. — Occasional on dry roadsides and common to abundant in old fields. Mature early in July.*

Danthonia spicata (L.) Beauv. — Wild Oat Grass, or Curly Grass. — Abundant in hill-top meadows, and common along trails and in old fields. Found in anthesis late in June.

Danthonia compressa Aust. — Common in the dry soil of old clearings and trails. Maturing early in July.

Calamagrostis canadensis (Michx.) Nutt. — Blue Joint Grass. — Occasional to common in damp thickets in the upland woods. In anthesis about mid-summer.

Calamagrostis cinnoides (Muhl.) Barton. — Occasional in damp places along woodland trails. Found in anthesis late in August.

Agrostis tenuis Sibth. — *A. alba* var. *vulgaris* of auth. — Rhode Island Bent Grass. — Common in the dry soil of clearings and roadsides. Found in anthesis during late June and early July.*

Agrostis stolonifera L. var. **compacta** Hartm. — Apparently rare or occasional in the Forest, and known thus far only from a damp roadside on the lower south slope of Black Rock Mountain. Maturing about mid-July.*

Agrostis scabra Willd. — *A. hyemalis* of auth., in part. — Hair Grass. — Occasional to common on damp pond margins. Found in anthesis about mid-summer.

Agrostis perennans (Walt.) Tuckerm. var. **aestivale** *Vasey.* — See Rhod. **35**: 317-18 (1933). — Thin Grass. — Occasional in damp woods. In anthesis late in August.

Cinna arundinacea L. — Wood Reed Grass. — Occasional in damp cove woods. Found in anthesis early in August.

Phleum pratense L. — Timothy. — Occasional in dry clearings and waste places. In anthesis early in July.*

Muhlenbergia tenuiflora (Willd.) BSP. — Occasional in dry woods on the slopes. Found in anthesis during late July and early August.

Muhlenbergia mexicana (L.) Trin. — Occasional along shady woodland roads, in damp soil. In anthesis late in August.

Brachyelytrum erectum (Schreb.) Beauv. — *Dilepyrum erectum* (Schreb.) Farwell. — Common in the rich woods of coves and lower slopes. In anthesis late in June.

Oryzopsis asperifolia Michx. — MOUNTAIN RICE. — Occasional in dry upland woods. Matures late in June.

Oryzopsis racemosa (Sm.) Ricker. — MOUNTAIN RICE. — Occasional in dry slope woods. Found maturing late in July.

Anthoxanthum odoratum L. — SWEET VERNAL GRASS. — Common in the dry soil of trails, roadsides, and old clearings. Found in anthesis in May and June.*

Leersia virginica Willd. — *Homalocenchrus virginicus* (Willd.) Britton. — WHITE GRASS. — Occasional to common in wet woods, particularly in springy places. In anthesis late in July.

Leersia oryzoides (L.) Sw. — *Homalocenchrus oryzoides* (L.) Poll. — RICE CUT-GRASS. — Occasional on wet stream banks in marshy areas. Matures in August.

Digitaria Ischaemum Schreb. — *D. humifusa* of auth. — *Syntherisma Ischaemum* (Schreb.) Nash. — CRAB GRASS, or FINGER GRASS. — Occasional to common along roadways and in waste ground. Matures late in the summer.*

Panicum capillare L. var. **occidentale** Rydb. — See Rhod. **21**: 110 (1919). — Occasional to common on damp banks and roadsides. Found in anthesis late in the summer.

Panicum depauperatum Muhl. var. **psilophyllum** Fern. — See Rhod. **23**: 193 (1921). — Occasional on damp roadside banks. Maturing early in July.

Panicum linearifolium Scribn. — Common along dry roadsides and trails. In anthesis late in June.

Panicum linearifolium Scribn. var. **Werneri** (Scribn.) Fern. — Occasional in dry hill-top woods and on dry roadside banks. Matures early in July.

Panicum dichotomum L. — PANIC GRASS. — Common in slope and upland woods. In anthesis late in June.

Panicum Lindheimeri Nash. var. **fasciculatum** (Torr.) Fern. — See Rhod. **23**: 223 (1921). — Occasional in the meadow and scrub oak associations of the hill-tops, and common on dry roadsides and banks at lower levels. Matures about mid-summer.

Panicum latifolium L. — Common in the dry woods of upper slopes and hill-tops. Found in anthesis late in June.

Echinochloa muricata (Michx.) Fern. — *E. crusgalli* (L.) Beauv. var. *Michauxii* House. — Rhod. **17**: 106 (1915) and **23**: 57 (1921). — BARNYARD GRASS. — Common in damp soil of waste places and reservoir margins. Found maturing late in August.

Setaria lutescens (Weigel) Hubb. — *S. glauca* of auth. — *Chaetochloa lutescens* (Weigel) Strontz. — FOXTAIL. — Common in old clearings, cultivated ground, and at roadsides. In anthesis late in the summer.*

Andropogon scoparius Michx. var. **frequens** Hubb. — BEARD GRASS. — Common to abundant in the drier parts of hill-top meadows, and in the dry soil of roadsides and clearings at lower levels. Matures late in the summer.

CYPERACEAE

Carex leptalea Wahl. — Common in very wet places in the cove woods. Found maturing early in July.

Carex stipata Muhl. — Occasional to common at swampy pond margins. Mature in the latter part of June.

Carex convoluta Mackenzie. — Occasional in damp cove woods. Flowers in spring.

Carex rosea Schk. — Occasional to common in woods of slopes and ravines. Mature about mid-summer.

Carex rosea Schk. var. **radiata** (Wahl.) Dewey. — *C. radiata* (Wahl.) Small. — Occasional to common in rich rocky woods of lower slopes and ravines. Mature about mid-July.

Carex cephalophora Muhl. — Occasional in dry rocky slope woods. Found maturing late in June.

Carex sparganioides Muhl. — Occasional in woods on rocky slopes. Matures about mid-summer.

Carex vulpinoidea Michx. — Common in wet thickets and pond margins. Mature about mid-summer.

Carex trisperma Dewey. — Known in the Forest only in boggy places such as the island in Tamarack Pond. Found with immature fruit late in July.

Carex canescens L. var. **disjuncta** Fern. — Occasional in pond shore marshes. Found with mature fruit late in June.

Carex bromoides Schk. — Occasional in damp woods, mainly along streams. Flowers in spring.

Carex Howei Mackenzie. — *C. scirpoides* Schk. var. *capillacea* (Bailey) Fern. — Occasional on the damp soil of pond margins. Fruit mature in late June and early July.

Carex tribuloides Wahl. — Occasional on the damp shores of reservoirs. In flower early in July.

Carex scoparia Schk. — Common on wet shores of ponds and reservoirs. Found flowering in late June and early July.

Carex foenea Willd. — Occasional in dry rocky woods on the upper slopes. Mature about mid-summer.

Carex torta Boott. — Occasional at rocky stream margins in cove woods. Flowers in spring.

Carex stricta Lam. — Common on marshy pond margins and in boggy swamps in the upland woods. Mature early in July.

Carex crinita Lam. — Common on wet pond shores. Mature late in June.

Carex crinita Lam. var. **gynandra** (Schwein.) Schwein. & Torr. — *C. gynandra* Schwein. — Common on marshy pond margins, and in wet places in the cove woods. Mature early in July.

Carex prasina Wahl. — Occasional in wet cove woods. Mature in the latter part of June.

Carex pallescens L. — Occasional on damp roadsides. Mature late in June.

Carex triceps Michx. var. **hirsuta** (Willd.) Bailey. — *C. hirsutella* Mackenzie. Occasional in upland woods. Mature early in July.

Carex virescens Muhl. — Common in dry upland woods and trails. Mature about mid-summer.

Carex virescens Muhl. var. **Swanii** Fern. — *C. Swanii* (Fern.) Mackenzie. — Occasional in upland woods. Mature about mid-summer.

Carex scabrata Schwein. — Occasional in swampy cove woods. Found flowering in July.

Carex communis Bailey. — Occasional in rather dry upland woods. Mature in late June.

Carex varia Muhl. — Occasional in rocky woods. Flowers in spring.

Carex pennsylvanica Lam. — Common to abundant in dry upland woods. Flowers in spring and early summer.

Carex pennsylvanica Lam. var. **lucorum** (Willd.) Fern. — *C. lucorum* Willd. — Similar in habitat to the species.

Carex platyphylla Carey. — Common in rocky woods of slopes and coves. Mature about mid-June.

Carex digitalis Willd. — Occasional on damp banks along woodland roads. Mature about mid-summer.

Carex anceps Muhl. — *C. laxiflora* Lam. var. *patulifolia* (Dewey) Carey. — Occasional in the rich woods of coves and lower slopes. Found maturing early in July.

Carex albursina Sheldon. — Occasional in damp thickets. Flowers in spring.

Carex pedunculata Muhl. — Occasional in damp cove woods. Flowers in May.

Carex granularis Muhl. — Occasional on damp pond margins. Mature in late June.

Carex debilis Michx. var. **Rudgei** Bailey. — Occasional in upland swamps. Mature about mid-summer.

Carex gracillima Schwein. — Occasional in damp ravine woods. Mature about mid-June.

Carex comosa Boott. — Occasional on marshy pond shores. Mature early in July.

Carex lurida Wahl. — Abundant on damp pond shores. Mature about mid-summer.

Carex intumescens Rudge. — Occasional on marshy pond shores and in wet places in upland woods. Found maturing early in July.

Cyperus strigosus L. — Common on damp pond margins and in wet thickets in the cove woods. Matures late in the summer.

Scirpus planifolius Muhl. — Apparently rare or occasional in wet ravines. Flowers in spring.

Scirpus atrovirens Muhl. — Common to abundant on wet pond shores and in damp places along roads and trails. Found flowering in late June.

Scirpus cyperinus (L.) Kunth var. **pelius** Fern. — Common in wet thickets and on damp pond shores. Matures late in the summer.

Eleocharis obtusa (Willd.) Schultes. — Spike Rush. — Common to abundant on wet muddy pond shores. Maturing about mid-summer or later.

Eleocharis palustris (L.) R. & S. var. **typica** Rouy. — See

Rhod. **31**: 57-77 (1929). — Occasional in shallow water on wet muddy or gravelly pond shores. In flower early in July.

Eleocharis acicularis (L.) R. & S. — Abundant on the wet shores of the reservoirs, particularly those whose levels fluctuate greatly during the season. In a sterile condition it forms a green felt-like mat on the shallow bottoms. Found flowering in July and August.

Eleocharis capitata (L.) R. Br. var. **borealis** Svenson. — See Rhod. **20**: 23 (1918); **34**: 198-203 (1932). — Rare or occasional on damp peaty pond margins. Mature about mid-summer.

ARACEAE

Calla palustris L. — Wild Calla. — Occasional in upland boggy woods. Flowers in spring.

Peltandra virginica (L.) Kunth. — Arrow Arum. — Common on wet boggy pond shores.

Arisaema triphyllum (L.) Schott. — Indian Turnip, or Jack-in-the-Pulpit. — Common in the rich woods of coves and lower slopes. Flowers in spring and early summer. Late flowers found on the island in Tamarack Pond late in July.

ERIOCAULACEAE

Eriocaulon septangulare With. — Pipewort. — Common in shallow water on the gravelly west shore of Sutherland Pond. In flower late in July.

PONTEDERIACEAE

Pontederia cordata L. — Pickerel-weed. — Occasional on the peaty shores of Sutherland Pond. In flower early in August.

JUNCACEAE

Juncus effusus L. var. **solutus** Fern. & Wieg. — Common in damp thickets and pond shores. Matures in July.

Juncus tenuis Willd. — Abundant on damp roadsides and trails, especially about the ponds. Found maturing in late July.

Juncus tenuis Willd. var. **anthelatus** Wieg. — Occasional in damp upland thickets. Maturing in July.

Juncus dichotomus Ell. var. **platyphylla** Wieg. — Apparently rare, and found only in crevices on the hill-tops. Mature in mid-August.

Juncus marginatus Rostk. — Common in damp upland thickets. Maturing about mid-summer.

Juncus acuminatus Michx. — Common to abundant in damp thickets at the gravelly margins of the reservoirs. Maturing in July.

Juncus debilis Gray. — Occasional in swampy thickets. Found flowering in the latter half of July.

Juncus brevicaudatus (Engelm.) Fern. — Found only in a damp thicket on clayey soil north of Tamarack Pond. Maturing late in July.

Luzula campestris (L.) DC. var. **multiflora** (Ehrh.) Celak. — Wood Rush. — Common in the dry soil of old clearings and roadways. Occasional in rather dry slope woods. Mature late in June.

LILIACEAE

Veratrum viride Ait. — American White Hellebore. — Common along streams in cove woods. Flowers in early summer.

Uvularia perfoliata L. — Bellwort. — Common in woods, particularly on the slopes. Flowers in spring; fruits mature early in July.

Oakesia sessilifolia (L.) Wats. — *Uvularia sessilifolia* L. — Sessile Bellwort. — Common throughout the woods. Flowers in spring; fruits mature from middle to late summer.

Allium vineale L. — Field Garlic. — Occasional in moist fields and waste places. In flower in June.*

Lilium philadelphicum L. — Wood Lily. — Occasional in damp thickets and rich woods. In flower early in July.

Lilium canadense L. — Meadow, or Canada Lily. — Occasional in damp meadows. In flower in mid-July.

Erythronium americanum Ker. — Yellow Adder's-tongue, or Dog's-tooth Violet. — Occasional to common in rich lowland woods. Flowers in early spring.

Smilacina racemosa (L.) Desf. — *Vagnera racemosa* (L.) Morong. — False Solomon's Seal. — Common in rich woods of lower slopes and coves, and occasional throughout the upland

woods. Flowers in spring; fruits mature in middle or late summer.

Maianthemum canadense Desf. — *Unifolium canadense* (Desf.) Greene. — WILD LILY-OF-THE-VALLEY. — Occasional to common in dry or rich woods. Fruits maturing in late June.

Streptopus roseus Michx. — TWISTED STALK. — Apparently rare; found thus far only in a wet thicket at the edge of the woods south of the Upper Reservoir. Flowers in spring.

Polygonatum pubescens (Willd.) Pursh. — *P. biflorum* of auth. — SMALL SOLOMON'S SEAL. — Occasional in rich slope woods. Fruit maturing in late June.

Polygonatum biflorum (Walt.) Ell. — *P. commutatum* of auth. — SOLOMON'S SEAL. — Common in dry woods on the upper slopes, and in the scrub oak thickets. Occasional at lower levels. Found with immature fruit late in June.

Medeola virginiana L. — INDIAN CUCUMBER ROOT. — Common in rich woods on the slopes and in coves. Collected in flower late in June.

Trillium erectum L. — PURPLE TRILLIUM, or BIRTHROOT. — Apparently rare, in wet thickets and damp wooded ravines. Fruits maturing early in August.

Smilax herbacea L. — CARRION-FLOWER. — Occasional in old clearings and in cove woods. Fruit maturing in July.

Smilax rotundifolia L. — CAT BRIER, or GREEN BRIER. — Occasional in old clearings and roadside thickets.

AMARYLLIDACEAE

Hypoxis hirsuta (L.) Coville. — STAR GRASS. — Common in damp grassy places along upland wood roads. In flower late in June.

DIOSCOREACEAE

Dioscorea villosa L. — WILD YAM-ROOT. — Occasional in damp roadside thickets.

IRIDACEAE

Sisyrinchium graminoides Bickn. — *S. gramineum* Curtis. — BLUE-EYED GRASS. —Occasional in damp meadows and thickets.

Flowers and immature capsules found in late June and early July.

Iris versicolor L. — Blue Flag. — Occasional to common at pond margins and in marshes. Found with immature fruit late in June.

ORCHIDACEAE

Cypripedium parviflorum Salisb. var. **pubescens** (Willd.) Knight. — *C. pubescens* Willd. — Larger Yellow Lady's Slipper. — Apparently rare; found thus far only in rather rich upland woods. Flowers in spring.

Cypripedium acaule Ait. — Stemless Lady's Slipper, or Moccasin Flower. — Common in dry upland woods. Flowers in May.

Spiranthes cernua (L.) Richard. — *Ibidium cernuum* (L.) House. — Ladies' Tresses. — Occasional in damp upland thickets. In flower late in August.

Habenaria flava (L.) Gray var. **virescens** (Muhl.) Fern. — *Perularia flava* of auth., in part. — See Rhod. **23**: 148 (1921). — Occasional in damp upland thickets on the borders of woods. Flowers in late June and early July.

Habenaria psychodes (L.) Sw. — *Blephariglottis psychodes* (L.) Rydb. — Purple Fringed Orchis. — Apparently rare and found only in moist thickets at the borders of woods.

Malaxis unifolia Michx. — *Microstylis unifolia* (Michx.) BSP. — Adder's Mouth. — Apparently quite rare; found thus far only in rather dry upland woods near the south shore of Jim's Pond. In flower in late June and early July.

Corallorrhiza maculata Raf. — Coral Root. — Occasional in rich woods of the coves and lower slopes. Found flowering in mid-summer.

SALICACEAE

Populus tremuloides Michx. — Trembling Aspen. — Common in old fields and clearings. Flowers in early spring.

Populus grandidentata Michx. — Large-toothed Aspen. — Occasional in the rich woods of coves and lower slopes, particularly where much clear cutting has occurred. Flowers in early spring.

Salix nigra Marsh. — BLACK WILLOW. — Occasional on stream banks and pond margins.

Salix lucida Muhl. — SHINING WILLOW. — Apparently rare or occasional in the Forest, and seen thus far only in a damp thicket by Aleck Meadow Reservoir. Flowers in spring.

Salix Bebbiana Sarg. — *S. rostrata* Richards., not Thuill. — Occasional in damp upland thickets.

Salix cordata Muhl. — Occasional in damp upland thickets.

Salix sericea Marsh. — Occasional to common in damp upland thickets.

Salix discolor Muhl. — PUSSY WILLOW. — Occasional to common in wet roadside thickets and about the reservoirs. Flowers in spring.

Salix humilis Marsh. — PRAIRIE WILLOW. — Occasional in openings in the upland woods.

MYRICACEAE

Myrica asplenifolia L. — SWEET FERN. — Common in dry open woods on the hill-tops. Flowers in early spring; fruit found maturing in late June.

JUGLANDACEAE

Juglans cinerea L. — BUTTERNUT. — Occasional in rich woods of coves and lower slopes. Flowers in early spring.

Carya cordiformis (Wang.) K. Koch. — *Hicoria cordiformis* (Wang.) Britton. — BITTERNUT. — Occasional in rich woods. Flowers in spring.

Carya glabra (Mill.) Sweet. — *Hicoria glabra* (Mill.) Britton. — PIGNUT HICKORY. — Common to abundant in the dry woods of upper slopes and hill-tops. In the latter it is commonly a dominant tree. Flowers in spring.

Carya ovata (Mill.) K. Koch — *Hicoria ovata* (Mill.) Britton. — SHAGBARK HICKORY. — Occasional to common in the rich woods of coves and lower slopes. Flowers in spring.

BETULACEAE

Carpinus caroliniana Walt. var. **virginiana** (Walt.) Fern. — See Rhod. **37**: 424-5 (1935). — BLUE, or WATER BEECH. — Occa-

sional in damp ravine woods and on lower slopes. Flowers in early spring.

Ostrya virginiana (Mill.) K. Koch. — IRONWOOD, or HOP HORNBEAM. — Occasional in rich woods of coves and lower slopes. Flowers in early spring.

Corylus cornuta Marsh. — *C. rostrata* Ait. — HAZELNUT. — Occasional in rather dry slope woods. Flowers in early spring.

Betula lenta L. — BLACK, or CHERRY BIRCH. — Abundant throughout most of the woods except in very wet coves or on dry hill-tops where it is occasional. Flowers in early spring; fruit mature about mid-summer.

Betula lutea Michx. f. — YELLOW BIRCH. — A predominating species in much of the cove woods, and common on the lower slopes. Flowers early in the spring.

Betula populifolia Marsh. — GRAY BIRCH. — Occasional in cove and slope woods; predominant in old fields and clearings. Aments mature about mid-summer.

Betula papyrifera Marsh. — PAPER, or CANOE BIRCH. — Apparently rare in the Forest, and known only in open upland woods near Arthur's Pond. Flowers early in spring.

Alnus incana (L.) Moench. — SPECKLED ALDER. — Occasional to common in old clearings and on the boggy island in Tamarack Pond. Flowers early in spring; found with immature fruiting cones about mid-summer.

Alnus rugosa (DuRoi) Spreng. — SMOOTH ALDER. — Common on wet pond and stream margins. Flowers in early spring.

FAGACEAE

Fagus grandifolia Ehrh. — BEECH. — Occasional in the rich woods of coves and lower slopes. Common or abundant only in very limited areas in the stream valleys. Flowers in early spring.

Castanea dentata (Marsh.) Borkh. — CHESTNUT. — Common throughout most of the slope woods and occasional in the coves. Young saplings 6-10 feet high are common, but they do not usually survive the blight long enough to grow larger.

Quercus alba L. — WHITE OAK. — Occasional to common in all of the types of natural woods, and a predominant species on parts of the crowns of the hills.

Quercus bicolor Willd. — SWAMP WHITE OAK. — Rare in the

Forest; known thus far only near the Upper Reservoir, at the eastern base of Mt. Misery.

Quercus montana Willd. — *Q. Prinus* L. — Rock, or Chestnut Oak. — Common throughout the natural woods, but predominant only on very rocky slopes, usually at the higher levels.

Quercus borealis Michx. f. — *Q. rubra* L. — Red Oak. — Common in all of the types of natural woods and a primary species in the coves and on the lower slopes. Our common form of the red oak, with broad, shallow acorn cups, is designated by some authors as var. *maxima* (Marsh.) Sarg. — See Rhod. **18**: 45-8 (1916).

Quercus velutina Lam. — Black Oak. — Occasional in rich slope woods.

Quercus coccinea Muench. — Scarlet Oak. — Common on rocky hill-tops and upper slopes where it is usually found in the white and scrub oak associations.

Quercus ilicifolia Wang. — Scrub Oak. — Abundant on dry hill-tops where it forms dense thickets particularly on southerly and westerly exposures.

ULMACEAE

Ulmus americana L. — American Elm. — Common in rich cove and lower slope woods. Flowers in early spring.

URTICACEAE

Laportea canadensis (L.) Gaud. — *Urticastrum divaricatum* (L.) Ktze. — Wood Nettle. — Abundant on shaded gravelly flood plains in the bed of Black Rock Brook below the sawmill, but not observed elsewhere in the Forest. In flower early in August.

Pilea pumila (L.) Gray. — Clearweed. — Common in damp shaded roadways, particularly in low ground. Found flowering late in August.

SANTALACEAE

Comandra umbellata (L.) Nutt. — Bastard Toadflax. — Apparently rare or occasional, and found only in dry rocky upland woods or thickets. Flowers in spring.

ARISTOLOCHIACEAE

Asarum canadense L. — WILD GINGER. — Common in parts of the mixed hardwood cove timber. Flowers in early spring.

POLYGONACEAE

Rumex Brittanica L. — GREAT WATER DOCK. — Known in the Forest only on the boggy island in Tamarack Pond where it was found in a sterile condition late in July.

Rumex crispus L. — YELLOW, or CURLED DOCK. — Common on damp roadways and in waste places. Found fruiting late in June.*

Rumex obtusifolius L. — BITTER DOCK. — Occasional to common at roadsides and in waste places. Found with maturing fruit late in July.*

Rumex Acetosella L. — SHEEP SORREL. — Common on roadsides and in waste places. Found flowering late in June.*

Polygonum aviculare L. — KNOTWEED. — Common on roadsides and in waste places. Flowers in the latter part of the summer.

Polygonum pennsylvanicum L. var. **laevigatum** Fern. — Common on damp pond margins and in waste places. Flowers late in the summer.

Polygonum Hydropiper L. — COMMON SMARTWEED, or WATER PEPPER. — Common to abundant along streams in upland woods. Found flowering in August.

Polygonum punctatum Ell. — WATER SMARTWEED. — Occasional to common on upland pond margins. In flower about midsummer.

Polygonum Persicaria L. — LADY'S THUMB, or HEARTWEED. — Common to abundant in old clearings and waste places. Found flowering in July and August.*

Polygonum virginianum L. — *Tovara virginiana* Raf. — VIRGINIA KNOTWEED. — Common about the sawmill clearing in the valley of Black Rock Brook, but not seen elsewhere in the Forest. Flowering early in August.

Polygonum sagittatum L. — ARROW-LEAVED TEAR-THUMB. — Abundant in marshy places. Flowers late in the summer.

Polygonum arifolium L. var. **lentiforme** Fern. & Grisc. — See

Rhod. **37**: 167 (1935). —HALBERD-LEAVED TEAR-THUMB. — Common in swampy woods and at pond margins. Flowers in late summer.

Polygonum scandens L. — CLIMBING FALSE BUCKWHEAT. — Common in damp thickets. Flowers in late summer.

Polygonum dumetorum L. — Rare or occasional in rather dry woods on the lower slopes. Found fruiting late in August.

PHYTOLACCACEAE

Phytolacca americana L. — *P. decandra* of auth. — POKEWEED. — Occasional in damp meadows. Found with flowers and immature fruit late in July.

CARYOPHYLLACEAE

Paronychia fastigiata (Raf.) Fern. — *Anychia polygonoides* Raf. — See Rhod. **38**: 416-21 (1936). — Occasional in the dry soil of woodland roads. Found flowering about mid-summer.

Paronychia canadensis (L.) Wood. — *Anychia canadensis* (L.) BSP. — FORKED CHICKWEED. — Occasional on dry roadsides in the woods. In flower about mid-summer.

Stellaria graminea L. — CHICKWEED. — Occasional in grassy upland trails and roadways. Found flowering late in June.*

Cerastium arvense L. — MOUSE-EAR CHICKWEED. — Occasional on dry rocky hill-tops.

Cerastium vulgatum L. — Occasional along old roads in the upland woods. Found with flowers and maturing capsules late in June.*

Sagina procumbens L. — PEARLWORT. — Occasional in springy places along upland trails. Found with mature capsules late in June.

Silene antirrhina L. — SLEEPY CATCHFLY. — Occasional in dry rock crevices on the hill-tops. Found with maturing capsules late in June.

Silene stellata (L.) Ait. — STARRY CAMPION. — Rare or occasional in rocky slope woods. Flowers in late summer.

Silene latifolia (Mill.) Britten & Rendle. — BLADDER CAMPION. — Rather common in old clearings and waste places. Flowers collected early in July.*

Dianthus Armeria L. — DEPTFORD PINK. — A common weed in old fields, roadsides, and waste places. Flowers from late June to August.*

NYMPHAEACEAE

Brasenia Schreberi Gmel. — WATER SHIELD. — Found only in Sutherland Pond, where it is common.

Nuphar variegatum Engelm. — *Nymphozanthus variegatus* (Engelm.) Fern. — COW LILY, or YELLOW POND LILY. — Common in Sutherland Pond, where it flowers early in summer.

Nymphaea odorata Ait. var. **rosea** Pursh. — See Rhod. **18**: 161 (1916). — WHITE WATER LILY. — Common in Sutherland Pond, but not seen elsewhere in the Forest. Flowers collected late in July.

RANUNCULACEAE

Caltha palustris L. —MARSH MARIGOLD. — Occasional to common in swampy cove woods. Flowers in early spring.

Actaea alba (L.) Mill. — WHITE BANEBERRY. — Common in rich cove woods. Found with immature fruit in late June and early July.

Aquilegia canadensis L. — COLUMBINE. — Occasional in rocky slope woods. Flowers in spring; maturing fruit found late in June.

Anemonella thalictroides (L.) Spach. — *Syndesmon thalictroides* (L.) Hoffmg. — RUE ANEMONE. — Common in rich slope and cove woods. Flowers in spring.

Anemone virginiana L. — TALL ANEMONE. — Common in old clearings. Found with flowers and immature fruiting heads early in July.

Anemone riparia Fern. — Apparently rare or occasional, and found thus far only on a dry rocky hill-top. With flowers and immature fruit in mid-July.

Anemone quinquefolia L. — WOOD ANEMONE. — Occasional in rich woods. Flowers in May.

Hepatica americana (DC.) Ker. — *H. triloba* of auth. — LIVERLEAF, or HEPATICA. — Common in rich ravine and lower slope woods. Flowers in early spring.

Clematis virginiana L. — VIRGIN'S BOWER. — Common in moist roadside thickets. In flower about mid-summer.

Ranunculus laxicaulis (T. & G.) Darby. — *R. obtusiusculus* Raf. — WATER PLANTAIN, or SPEARWORT. — Apparently occasional in the swampy channels of cove brooks. Found with flowers and maturing fruits in late July and early August.

Ranunculus abortivus L. — SMALL-FLOWERED BUTTERCUP. — Occasional to common along roadsides and in cove woods. Flowers in May.

Ranunculus recurvatus Poir. — HOOKED CROWFOOT. — Occasional in damp thickets and rich lowland woods. Maturing fruit found in late June and early July.

Ranunculus bulbosus L. — BULBOUS BUTTERCUP. — Occasional to common as a weed in waste places. Flowers in spring.*

Ranunculus acris L. — TALL CROWFOOT, or BUTTERCUP. — Common in waste places, fields, and along wood roads. Flowers and maturing fruit found late in June.*

Thalictrum dioicum L. — EARLY MEADOW RUE. — Common in rich woods of coves and lower slopes. Flowers in spring.

Thalictrum polygamum Muhl. — MEADOW RUE. — Common in damp meadows, particularly about the reservoirs. Occasional in cove woods. Found flowering in late June. Fruits mature in July.

BERBERIDACEAE

Caulophyllum thalictroides (L.) Michx. — BLUE COHOSH. — Apparently rare, and found thus far in the Forest only in rich woods in Glycerine Hollow. Flowers in early spring.

Berberis Thunbergii DC. — BARBERRY. — Occasional in cove woods near old clearings.*

MENISPERMACEAE

Menispermum canadense L. — MOONSEED. — Occasional in damp thickets and old clearings. Flowers in early summer.

MAGNOLIACEAE

Liriodendron Tulipifera L. — TULIP TREE, or YELLOW POPLAR. — Common to abundant in the rich woods of coves and lower slopes. Flowers in early summer.

LAURACEAE

Sassafras officinale Nees & Eb. — *S. variifolium* (Salisb.) Ktze. — *S. Sassafras* (L.) Karst. — SASSAFRAS. — Common in rich woods, mostly on the slopes; occasional in the dry hill-top associations.

Benzoin aestivale (L.) Nees. — SPICE BUSH. — Common to abundant in the rich woods of coves and lower slopes. Flowers early in spring.

Benzoin aestivale (L.) Nees. var. **pubescens** Palmer & Steyermark. — Similar to the species in habitat and flowering.

PAPAVERACEAE

Corydalis sempervirens (L.) Pers. — *Capnoides sempervirens* (L.) Borkh. — Occasional in crevices on rocky hills, and on dry roadsides. Found flowering late in June, and with maturing fruit about mid-July.

CRUCIFERAE

Lepidium virginicum L. — PEPPERGRASS. — Common to abundant along dry roadsides and in waste places. Summer.

Alliaria officinalis Andrz. — GARLIC MUSTARD. — Occasional as a weed in waste places. Flowers in spring.*

Brassica arvensis (L.) Ktze. — WILD MUSTARD, CHARLOCK. — A common weed in waste places. Summer.*

Brassica nigra (L.) Koch. —BLACK MUSTARD. — Occasional as a roadside weed. In flower in early summer.*

Barbarea vulgaris R. Br. — YELLOW ROCKET. — Common on damp roadsides, particularly at the lower levels. Fruit mature by mid-summer.

Rorippa palustris (L.) Besser. — *Radicula palustris* (L.) Moench. — MARSH CRESS. — Common in wet places about the reservoirs. Found with flowers and maturing fruits in June and August.

Cardamine pennsylvanica Muhl. — Common in damp places in the cove woods. Flowers early in summer.

Arabis lyrata L. — ROCK CRESS. — Occasional in rock crevices,

usually near the tops of the hills. Common on an erratic limestone boulder in the valley of Black Rock Brook. Summer.

Arabis laevigata (Muhl.) Poir. — Occasional in dry upland woods. Found with maturing pods late in June.

Arabis canadensis L. — Sickle Pod. — Apparently rare, and found thus far only in rocky woods near the top of Sackett Hill. Fruit maturing in mid-summer.

SARRACENIACEAE

Sarracenia purpurea L. — Pitcher Plant. — Common on the boggy island in Tamarack Pond and in a similar habitat at the lower end of Sutherland Pond. Flowers late in July.

DROSERACEAE

Drosera rotundifolia L. — Sundew. — Found thus far only on the boggy island in Tamarack Pond and at the lower end of Sutherland Pond, where it is abundant on the mossy hummocks. In flower about mid-summer.

CRASSULACEAE

Sedum triphyllum (Haw.) S. F. Gray. — Live-forever. — Occasional as a weed in old clearings.*

SAXIFRAGACEAE

Penthorum sedoides L. — Ditch Stonecrop. — Common in a swampy place in an old clearing at Aleck Meadow Reservoir, but not seen elsewhere in the Forest. In flower late in July.

Saxifraga virginiensis Michx. — Early Rock Saxifrage. — Occasional in rocky woods on lower slopes and in ravines. Flowers in early spring.

Mitella diphylla L. — Miterwort, or Bishop's Cap. — Occasional to common in rich ravine woods. Flowers in spring; fruits maturing late in June.

Heuchera americana L. — Alum Root. — Apparently rare, and noted thus far only on a steep rock slide on the west slope of Mt. Misery. Fruit maturing about mid-summer.

Chrysosplenium americanum Schwein. — GOLDEN SAXIFRAGE. — Occasional in wet places in swampy woods. Flowers in spring.

Ribes rotundifolia Michx. — GOOSEBERRY. — Occasional on upland rocky slopes. Fruit maturing late in June.

HAMAMELIDACEAE

Hamamelis virginiana L. — WITCH-HAZEL. — Common to abundant in cove and slope woods. In the red oak and parts of the cove associations it becomes a predominating species in the shrub layer. Flowers in autumn; fruit maturing in summer.

PLATANACEAE

Platanus occidentalis L. — SYCAMORE, or BUTTONWOOD. — Occasional in the cove woods.

ROSACEAE

Physocarpus opulifolius (L.) Maxim. — *Opulaster opulifolia* (L.) Ktze. — NINEBARK. — Occasional in dry upland rocky woods. Flowers in early summer; fruit mature in August.

Spiraea latifolia (Ait.) Borkh. — MEADOW-SWEET. — Common to abundant in damp meadows and roadside thickets. Flowers in summer.

Spiraea tomentosa L. — HARDHACK, or STEEPLE BUSH. — Common in damp thickets of clearings and roadsides. In flower about mid-summer.

Pyrus communis L. — CULTIVATED PEAR. — Occasional in old clearings.*

Malus pumila Mill. — *Pyrus Malus* of auth. — COMMON APPLE. — Occasional in old clearings and orchards.*

Aronia arbutifolia (L.) Ell. var. **atropurpurea** (Britton) Schn. — *Pyrus arbutifolia* (L.) L.f. var. *atropurpurea* (Britton) Robinson. — *Aronia atropurpurea* Britton. — RED CHOKEBERRY. — Common on boggy pond shores and occasional in upland thickets. Flowers in early summer; fruit maturing in July.

Aronia melanocarpa (Michx.) Britton. — *Pyrus melanocarpa* (Michx.) Willd. — BLACK CHOKEBERRY. — Common in dry

rocky upland woods. Also found on the boggy island in Tamarack Pond. Flowers in spring; fruit maturing late in July.

Amelanchier canadensis (L.) Medic. — SHAD BUSH. — Common in dry upland woods, and occasional in the cove forest. Also found on the boggy island in Tamarack Pond. Flowers in early spring.

Crataegus macrosperma Ashe. — HAWTHORN. — Occasional in the meadow and scrub oak associations on the hill-tops, and in openings in the slope woods. Flowers in spring.

Rubus odoratus L. — FLOWERING RASPBERRY or THIMBLEBERRY. — Occasional to common in dry thickets at the borders of woods and along roadsides. Found flowering in the latter part of June.

Rubus idaeus L. var. **strigosus** (Michx.) Maxim. — *R. strigosus* Michx. — *R. idaeus* var. *aculeatissimus* of auth. — RED RASPBERRY. — Common in damp thickets. Flowers early in summer; fruit matures late in July.

Rubus occidentalis L. — BLACK RASPBERRY. — Occasional in damp thickets. Flowers early in summer; fruit matures in July.

Rubus hispidus L. — Common to abundant in damp thickets. In flower early in July.

Rubus frondosus Bigel. — Occasional in roadside thickets in dry rocky slope woods. Found with flowers and immature fruit early in July.

Rubus allegheniensis Porter. — BLACKBERRY. — Common in roadside thickets, and occasional in the slope and cove woods. Flowers early in summer; immature fruit collected early in July.

Fragaria virginiana Duchesne. — WILD STRAWBERRY. — Common on rather dry roadside banks and in clearings. Occasional in dry, open, hill-top woods. Flowers in spring.

Potentilla arguta Pursh. — *Drymocallis agrimonioides* (Pursh) Rydb. — Occasional or rare in grassy hill-top meadows. Flowers in mid-summer.

Potentilla norvegica L. var. **hirsuta** (Michx.) Lehm. — *P. monspeliensis* of auth. — CINQUEFOIL. — Common in damp thickets, clearings, and waste places. Found with flowers and maturing fruit late in July.

Potentilla argentea L. — SILVERY CINQUEFOIL. — Apparently rare, and seen thus far only in rock crevices on the shore of Sutherland Pond. Flowers in June.

Potentilla simplex Michx. — *P. canadensis* L. var. *simplex* (Michx.) T. & G. — Common in rather dry woods and clearings. Flowers in early summer.

Potentilla canadensis L. — *P. pumila* of auth. — See Rhod. **33**: 180-91 (1931). — CINQUEFOIL. — Occasional to common in old fields and clearings. Flowers in spring.

Potentilla recta L. — CINQUEFOIL. — Occasional to common as a weed in clearings and along roadsides. Flowers in mid-summer.*

Geum canadense Jacq. var. **camporum** (Rydb.) Fern. & Weatherby. — See Rhod. **24**: 47 (1922). — Occasional in damp thickets and meadows. In flower about mid-summer.

Geum laciniatum Murr. var. **trichocarpum** Fern. — *G. virginianum* L. var. *Murrayanum* Fern. — See Rhod. **37**: 292-3 (1935). — AVENS. — Occasional in damp thickets and meadows. Flowers in early summer.

Agrimonia gryposepala Wallr. — AGRIMONY. — Occasional to common in rather dry meadows and thickets. Found flowering early in July.

Rosa palustris Marsh. — *R. carolina* of auth. — SWAMP ROSE. —Occasional in swampy thickets. In flower about mid-summer.

Rosa carolina L. — *R. humilis* of auth. — DWARF ROSE or LOW PASTURE ROSE. — Common in roadside thickets and old clearings. Flowers in early summer.

Prunus pumila L. var. **susquehanae** (Willd.) Jaeg. — *P. susquehanae* Willd. — *P. cuneata* Raf. — DWARF CHERRY. — Common in the scrub oak and meadow associations of the hill-tops, but not found elsewhere in the Forest. Flowers in spring; fruit maturing about mid-summer.

Prunus pennsylvanica L.f. — PIN CHERRY. — Common in dry roadside thickets and on hill-tops. Flowers in May.

Prunus virginiana L. — CHOKE CHERRY. — Occasional in upland fence-row thickets and rocky woods. Flowers in spring; fruit mature early in August.

Prunus serotina Ehrh. — WILD BLACK CHERRY. — Common in dry woods, thickets, and clearings. Flowers in spring; fruit maturing about mid-summer.

LEGUMINOSAE

Baptisia tinctoria (L.) R. Br. — WILD INDIGO. — Occasional on dry upland roadsides. Found with maturing fruit late in July.

Melilotus alba Desr. — WHITE SWEET CLOVER. — Occasional as a weed at roadsides and in old clearings. Flowers in summer.*

Melilotus officinalis (L.) Lam. — YELLOW SWEET CLOVER. — Occasional as a roadside weed. Flowers about mid-summer.*

Trifolium pratense L. — RED CLOVER. — Occasional to common in moist meadows and roadsides. Flowers in summer.*

Trifolium hybridum L. —ALSIKE CLOVER. — Common in meadows and roadways.*

Trifolium agrarium L. — YELLOW, or HOP CLOVER. — Common to abundant in rather dry meadows and thickets. Flowers in summer.*

Robinia Pseudo-Acacia L. — BLACK LOCUST. — Common on dry roadsides and in old clearings. Flowers in spring.

Desmodium nudiflorum (L.) DC. — *Meibomia nudiflora* (L.) Ktze. — TICK TREFOIL. — Occasional to common in rather dry woods. Flowers in late summer.

Desmodium acuminatum (Michx.) DC. — *D. grandiflorum* (Walt.) DC. — *Meibomia grandiflora* (Walt.) Ktze. — See Rhod. **38**: 96-7 (1936). — Occasional to common in rather dry upland woods. Flowers in mid-summer.

Desmodium rotundifolium (Michx.) DC. — *Meibomia Michauxii* Vail. — Occasional in dry upland woods, mainly on southerly slopes. Flowers in late summer.

Desmodium bracteosum (Michx.) DC. — *Meibomia bracteosa* (Michx.) Ktze. — Occasional in dry rocky woods, principally on high slopes with southern exposure. Collected with flowers and maturing fruit early in August.

Desmodium paniculatum (L.) DC. — *Meibomia paniculata* (L.) Ktze. — Occasional in dry upland woods. Found with flowers and maturing fruit late in August.

Lespedeza violacea (L.) Pers. — Occasional in dry upland woods, particularly on south exposures. Found flowering in mid-September.

Lespedeza intermedia (Wats.) Britton. — *L. frutescens* of

auth. — See Rhod. **26**: 29 (1924). — Occasional in dry upland woods and roadways. Flowers in late summer.

Lespedeza hirta (L.) Hornem. — BUSH CLOVER. — Occasional in dry upland woods and roadways. Flowers in late summer.

Lespedeza capitata Michx. — Found thus far only in dry hill-top meadows.

Vicia Cracca L. — WILD VETCH. — Rare or occasional in upland thickets. In flower in June.

Apios tuberosa Moench. — GROUNDNUT. — Rare or occasional; found thus far only in the swampy woods near the lower end of Sutherland Pond.

Amphicarpa bracteata (L.) Fern. — *A. monoïca* L. — *Falcata comosa* of auth. — See Rhod. **35**: 276 (1933). — HOG PEANUT. — Common in rather rich soil of thickets and in cove and lower slope woods. Found flowering early in August.

OXALIDACEAE

Oxalis filipes Small. — YELLOW WOOD SORREL. — Occasional in woodland roadways and old clearings. Flowers throughout most of the summer.

Oxalis europaea Jord. — *O. corniculata* of auth. — Common in clearings and waste places. Flowers throughout most of the summer.

GERANIACEAE

Geranium maculatum L. — WILD GERANIUM, or CRANESBILL. — Common in most of the cove and lower slope woods, and in damp thickets. Flowers in early summer; fruit maturing in July.

Geranium Bicknellii Britton. — Occasional on roadside banks. Flowers in spring and early summer.

LINACEAE

Linum virginianum L. — YELLOW FLAX. — Rare or occasional on dry roadside banks. Found with maturing fruit late in August.

POLYGALACEAE

Polygala sanguinea L. — MILKWORT. — Occasional in damp soil of woodland roads or pond margins. In flower about midsummer.

Polygala verticillata L. — Apparently rare in the Forest, and found thus far only in the dry soil of woodland roadways. Found flowering late in August.

EUPHORBIACEAE

Acalypha virginica L. — THREE-SEEDED MERCURY. — Occasional on dry roadsides and other open ground. Found with maturing fruit late in August.

Euphorbia vermiculata Raf. — *E. hirsuta* of Am. auth.— SPURGE. — Common on dry roadsides and in waste places. Found with mature fruit late in August.

CALLITRICHACEAE

Callitriche palustris L. — WATER STARWORT. — Common in small pools and slow streams in the cove woods and in open meadows. Found flowering in July.

ANACARDIACEAE

Rhus typhina L. — STAGHORN SUMACH. — Common in clearings and roadside thickets, and in natural openings in the woods of slopes and hill-tops. Flowers in early summer.

Rhus glabra L. — SMOOTH SUMACH. — Common in old clearings and roadside thickets. In flower early in July.

Rhus copallina L. var. **latifolia** Engler. — See Rhod. **37**: 167-8 (1935). — DWARF SUMACH. — Common in the scrub oak and meadow associations of the hill-tops. Flowers in July.

Rhus Vernix L. — POISON SUMACH. — Common in boggy swamps, such as the island in Tamarack Pond. Found with immature fruit late in July.

Rhus Toxicodendron L. — POISON IVY, or POISON OAK. — Abundant in old fence-row thickets and on rocky banks. Also

abundant in cove and lower slope woods. Flowers in early summer.

AQUIFOLIACEAE

Ilex verticillata (L.) Gray. — BLACK ALDER, or WINTERBERRY. — Common in swampy thickets about the ponds and reservoirs. Found flowering early in July.

Nemopanthus mucronata (L.) Trel. — MOUNTAIN HOLLY. — Known thus far in the Forest only on the boggy island in Tamarack Pond and in the low woods south of Sutherland Pond. Flowers in spring.

CELASTRACEAE

Celastrus scandens L. — BITTERSWEET. — Occasional in thickets and fence-rows, also in rocky slope woods. Flowers in early summer; fruit maturing in late July and August.

STAPHYLEACEAE

Staphylea trifolia L. — BLADDER NUT. — Occasional in old fence-rows and slope woods. Found in fruit in the latter part of July.

ACERACEAE

Acer rubrum L. — RED MAPLE. — Common throughout most of the woods, and a predominant tree in parts of the cove timber. Flowers in early spring.

Acer saccharum Marsh. — SUGAR, or ROCK MAPLE. — Common in the slope and cove forests, and predominant in most of the latter. Flowers in spring.

Acer spicatum Lam. — MOUNTAIN MAPLE. — Apparently rare, and found thus far only in the rocky ravine of Black Rock Brook.

Acer pennsylvanicum L. — STRIPED MAPLE, MOOSEWOOD. — Common throughout most of the cove and slope woods. Flowers in spring.

BALSAMINACEAE

Impatiens biflora Walt. — SPOTTED TOUCH-ME-NOT. — Common in damp thickets and woods, and at swampy stream or pond margins. In flower about mid-summer.

RHAMNACEAE

Rhamnus cathartica L. — BUCKTHORN. — Occasional in thickets along roadsides or in old fence rows. Flowers in spring; immature fruit found late in June.*

Ceanothus americanus L. — NEW JERSEY TEA. — Common in open woods on the upper slopes and hill-tops. Mostly confined to south exposures. Found flowering in late June and early July.

VITACEAE

Vitis labrusca L. — NORTHERN FOX GRAPE. — Occasional to common in damp thickets and cove woods. Flowers early in summer.

Vitis aestivalis Michx. — SUMMER GRAPE. — Common in cove and slope woods. Flowers in early summer.

Parthenocissus quinquefolia (L.) Planch. — *Psedera quinquefolia* (L.) Greene. — VIRGINIA CREEPER, or WOODBINE. — Common throughout most of the wooded areas; most abundant on rocky lower slopes. Flowers in early summer.

TILIACEAE

Tilia americana L. — *T. glabra* of auth. — See Torreya **37**: 55-57 (1937). —LINDEN, or BASSWOOD. — Common to occasional in the cove and lower slope woods. Flowers early in summer; maturing fruit collected late in August.

GUTTIFERAE

Hypericum perforatum L. — COMMON ST. JOHN'S-WORT. — A common weed in meadows and along roadsides. Found flowering in late June and in July.*

Hypericum punctatum Lam. — Common in damp open places along trails and roads. In flower about mid-summer.

Hypericum gentianoides (L.) BSP. — ORANGE GRASS. — Occasional in small patches of soil on dry rocky hill-tops. Flowers in late summer.

Hypericum mutilum L. — Common in wet thickets and on pond margins. Found flowering about mid-summer.

Hypericum virginicum L. — *Triadenum virginicum* (L.) Raf. — PURPLE, or MARSH ST. JOHN'S-WORT. — Common in boggy swamps about the lower end of Sutherland Pond and on the island in Tamarack Pond. Found flowering in late July and in August.

CISTACEAE

Helianthemum Bicknellii Fern. — See Rhod. **21**: 36 (1919). —Occasional in grassy hill-top meadows. Flowers about mid-summer, maturing fruit found early in September.

Helianthemum canadense (L.) Michx. — FROSTWEED. — Occasional in dry hill-top meadows and thickets. Found flowering late in June.

Lechea villosa Ell. — PINWEED. — Occasional in the dry soil of old clearings. Found flowering about mid-summer.

Lechea intermedia Leggett. — Occasional to common in the dry soil of old clearings, trails, and hill-top meadows. Found flowering about mid-summer.

VIOLACEAE

Viola cucullata Ait. — MARSH BLUE VIOLET. — Common in wet thickets and meadows. Flowers in spring.

Viola latiuscula Greene. — BROAD-LEAVED BLUE VIOLET. — Occasional in damp shaded ravines. Flowers in spring.

Viola palmata L. — PALMATE VIOLET. — Occasional in dry upland woods. Flowers in spring.

Viola sororia Willd. — MEADOW BLUE VIOLET. — Rare or occasional in damp cove woods. Flowers in May.

Viola fimbriatula J. E. Smith. — Common to abundant in dry upland woods and at roadsides. Flowers in May.

Viola pallens (Banks) Brainerd. — WHITE VIOLET. — Common to abundant in swampy ground and along brook banks. Flowers in spring.

Viola blanda Willd. — WHITE VIOLET. — Occasional in damp mossy cove woods and thickets. Flowers early in spring.

Viola pubescens Ait. — STEMMED YELLOW VIOLET. — Occasional in rather dry rocky slope woods, mostly on northward exposures. Flowers in spring.

Viola conspersa Reichenb. — Dog Violet. — Occasional in dry open woods and thickets. Flowers in May.

THYMELAEACEAE

Dirca palustris L. — Leather-wood. — Apparently rare, and known thus far in the Forest only in woods in the valley of Canterbury Brook. Flowers in spring.

LYTHRACEAE

Decodon verticillatus (L.) Ell. var. **laevigatus** T. & G. — Swamp Loosestrife, or Water Willow. — Common on the boggy margins of Sutherland Pond and the island in Tamarack Pond. Flowers in late summer.

Lythrum Salicaria L. — Purple Loosestrife. — Common to abundant in marshy swamps and damp pond margins. Flowers in summer.*

NYSSACEAE

Nyssa sylvatica Marsh. — Black Gum, or Tupelo. — Occasional to common in swampy cove woods, and occasional on lower slopes. Flowers in spring.

MELASTOMACEAE

Rhexia virginica L. — Meadow Beauty. — Apparently rare, and found thus far only on a sandy shore at the northern end of Sutherland Pond. Found flowering in late July and early August.

ONAGRACEAE

Epilobium angustifolium L. — Fireweed. — Occasional in old clearings. In flower about mid-summer.

Epilobium coloratum Muhl. — Willow Herb. — Occasional in marshy places and roadside ditches. Flowers in summer.

Epilobium glandulosum Lehm. var. **adenocaulon** (Haussk.) Fern. — Willow Herb. — Common in open marshy places and roadside ditches. In flower about mid-summer.

Ludwigia palustris (L.) Ell. — Water Purslane. — Com-

mon on wet, muddy pond shores. Found flowering about mid-summer.

Oenothera biennis L. — Evening Primrose. — Common on dry roadsides and in waste places. Flowers in mid-summer.

Oenothera perennis L. — *Kneiffia perennis* (L.) Pennell. — Sundrops. — Occasional along upland wood roads. Found flowering in early summer.

Circaea latifolia Hill. — *C. lutetiana* of auth. — Enchanter's Nightshade. — Common in rich cove woods, mainly along streams. Found flowering in early summer.

ARALIACEAE

Aralia racemosa L. — Spikenard. — Occasional in rich woods, mostly in the coves. Flowers in mid-summer.

Aralia nudicaulis L. — Wild Sarsaparilla. — Common in most of the cove and slope woods. Flowers in spring.

Panax trifolium L. — Dwarf Ginseng. — Common in rich woods and thickets. Flowers in May.

UMBELLIFERAE

Hydrocotyle americana L. — Water Pennywort. — Common in the wet soil along woodland brooks. Flowers found about mid-summer.

Sanicula marilandica L. — Sanicle. — Occasional to common in woods and thickets. In fruit about mid-summer.

Osmorhiza Claytoni (Michx.) Clarke. — Sweet Cicely. — Common in damp ravine woods. Found fruiting late in June.

Cicuta maculata L. — Water Hemlock, Beaver Poison. — Occasional in roadside ditches and swampy places. Fruits maturing late in summer.

Cicuta bulbifera L. — Apparently rare, and found thus far only on the wet stony shore of Jim Pond. In flower about mid-August.

Sium suave Walt. forma **Carsonii** Fassett. — See Rhod. **23**: 113 (1921). — Water Parsnip. — Apparently rare and found thus far only on the margin of Cascade Brook, in Glycerine Hollow. Found flowering about mid-September.

Cryptotaenia canadensis (L.) DC. — HONEWORT. — Common in damp ravine woods. In flower late in June.

Zizia aurea (L.) Koch. — GOLDEN ALEXANDERS. — Occasional in rather dry slope woods. Fruits maturing about mid-summer.

Zizia cordata (Walt.) DC. — HEART-LEAVED ALEXANDERS. — Occasional in the dry soil of old clearings and roadways. Found with flowers and maturing fruit early in July.

Angelica villosa (Walt.) BSP. — Occasional along wood roads and in rather dry meadows. In flower about mid-summer.

Daucus Carota L. — WILD CARROT, or QUEEN ANNE'S LACE. — A common weed along roadsides and in dry fields and waste places. In flower about mid-summer.*

CORNACEAE

Cornus florida L. — FLOWERING DOGWOOD. — Common to abundant in cove and lower slope woods, where it is often a primary species in the shrub and small tree layer. Flowers in spring.

Cornus rugosa Lam. — *C. circinata* L'Her. — ROUND-LEAVED DOGWOOD. — Common in rich slope woods, mostly in the red oak association. Found with flowers and immature fruit late in June.

Cornus stolonifera Michx. — RED OSIER DOGWOOD. — Occasional along upland stream margins and roadside ditches. Flowers in spring; fruit mature in August.

Cornus racemosa Lam. — *C. paniculata* L'Her. — *C. candidissima* of auth. — PANICLED DOGWOOD. — Common in the meadows, thickets, and open woods of the hill-tops, and occasional in damp cove woods. Also occasional in old clearings. Flowers in early summer; fruit mature late in August.

CLETHRACEAE

Clethra alnifolia L. — SWEET PEPPERBUSH. — Abundant in wet woods and at peaty pond margins. In flower about mid-summer.

PYROLACEAE

Chimaphila maculata (L.) Pursh. — PIPSISSEWA, or SPOTTED WINTERGREEN. — Occasional in rocky slope woods, chiefly on northern exposures. In flower about mid-summer.

Pyrola elliptica Nutt. — SHINLEAF. — Common in rich cove woods. Flowers about mid-summer.

Pyrola rotundifolia L. var. **americana** (Sweet) Fern. — *P. americana* Sweet. — See Rhod. **22**: 122 (1920). — Apparently rare, and found thus far only in dry woods southwest of Sutherland Pond. Flowers in mid-summer.

Monotropa uniflora L. — INDIAN PIPE. — Occasional to common in rich woods. Found flowering in late June and early July.

Monotropa Hypopitys L. — *Hypopitys americana* (DC.) Small. — PINESAP. — Apparently rare, and found thus far only in rich woods on the northeast slope of Sackett Hill. In flower late in July.

ERICACEAE

Rhododendron viscosum (L.) Torr. — *Azalea viscosa* L. — CLAMMY AZALEA, or SWAMP HONEYSUCKLE. — Abundant on boggy pond margins. Flowers in late June and in July.

Rhododendron nudiflorum (L.) Torr. var. **roseum** (Loisel.) Wieg. — *R. canescens* of auth. — *Azalea periclymenoides* of auth. —*R. roseum* (Loisel.) Rehder. — PINK AZALEA. — Common to abundant in the cove and slope woods. It becomes a primary species in some of the chestnut oak stands. Flowers in spring and early summer.

Rhododendron maximum L. — GREAT LAUREL. — Apparently rare in the Forest, and mostly confined to shaded north slopes and ravines. Flowers in early summer.

Kalmia latifolia L. — MOUNTAIN LAUREL. — Common to abundant in slope and cove woods. It becomes a primary species in some of the chestnut oak stands. Flowers in early summer.

Kalmia angustifolia L. — SHEEP LAUREL. — Common in boggy swamps and along upland wood roads. Flowers in early summer.

Chamaedaphne calyculata (L.) Moench. — LEATHER LEAF. — Abundant in the mossy bogs on Sutherland and Tamarack Ponds. Flowers in spring.

Lyonia ligustrina (L.) DC. — *Xolisma ligustrina* (L.) Britton. — MALE BERRY, or WILD PRIVET. — Occasional in old upland clearings and fence-rows. Flowers in early summer.

Epigaea repens L. — TRAILING ARBUTUS, or MAYFLOWER. — Occasional in rather dry upland woods. Flowers in early spring.

Gaultheria procumbens L. — WINTERGREEN, or CHECKER-

BERRY. — Occasional in cove and hill-top woods. In flower about mid-summer.

Gaylussacia baccata (Wang.) C. Koch. — BLACK HUCKLEBERRY. — Abundant in the dry woods, thickets and meadows of the hill-tops and upper slopes. It becomes a primary species in some of the chestnut oak stands. Flowers in spring.

Vaccinium stamineum L. — *Polycodium stamineum* (L.) Greene. — SQUAW HUCKLEBERRY. — Occasional to common in old upland clearings and fence rows, and in dry woods on hill-tops and upper slopes. Flowers in spring.

Vaccinium pennsylvanicum Lam. — EARLY UPLAND BLUEBERRY. — Abundant in dry open woods and meadows on the hill-tops and upper slopes, and occasional at lower levels. A primary species in parts of the chestnut oak association. Flowers in early spring; fruit found maturing in late June or early July.

Vaccinium vacillans Kalm. — LOW BLUEBERRY. — Abundant on upper slopes and hill-tops, and occasional at lower levels. It is a primary species in parts of the chestnut, white, and scrub oak stands. Flowers in spring.

Vaccinium corymbosum L. — SWAMP, or HIGH BLUEBERRY. — Abundant in swamps and bogs, and common in damp woods. Flowers in spring.

Vaccinium corymbosum L. var. **pallidum** (Ait.) Gray. — Apparently rare or occasional and found thus far only in open woods near the top of a hill southwest of the White Oak Corner. Flowers in spring.

Vaccinium macrocarpon Ait. — *Oxycoccus macrocarpus* (Ait.) Pursh. — LARGE CRANBERRY. — Abundant in mossy bogs like that at the lower end of Sutherland Pond and on the island in Tamarack Pond. Flowers about mid-summer.

PRIMULACEAE

Lysimachia quadrifolia L. — Abundant in the dry woods and thickets of upper slopes and hill-tops, and occasional to common in the coves. In flower during late June and July.

Lysimachia terrestris (L.) BSP. — YELLOW LOOSESTRIFE. — Common on marshy pond shores. In flower about mid-summer.

Trientalis borealis Raf. — STAR FLOWER. — Apparently rare or occasional in rich cove woods. Flowers in spring.

Steironema ciliatum (L.) Raf. — FRINGED LOOSESTRIFE. — Common in damp thickets and meadows. In flower about midsummer.

OLEACEAE

Fraxinus americana L. — WHITE ASH. — Abundant in the cove woods, and common or occasional on the slopes. It becomes a primary species in some of the coves. Flowers in spring.

Fraxinus pennsylvanica Marsh. — RED ASH. — Apparently rare or occasional in rich cove woods. Flowers in spring.

Fraxinus nigra Marsh. — BLACK ASH. — Occasional in wet cove woods. Flowers in early spring.

Syringa vulgaris L. — COMMON LILAC. — Occasional about old house sites. Flowers in May.*

GENTIANACEAE

Gentiana crinita Froel. — FRINGED GENTIAN. — Occasional in damp meadows and thickets. Flowers early in September.

Gentiana clausa Raf. — CLOSED GENTIAN. — Occasional in damp meadows and thickets. Flowers in late summer.

Bartonia virginica (L.) BSP. — Rare or occasional in dry upland woods. Flowers in late summer.

Nymphoides lacunosum (Vent.) Fern. — *Trachysperma lacunosa* (Vent.) House. — FLOATING HEART. — Common in shallow water on the northwest side of Sutherland Pond but unknown elsewhere in the Forest. Flowers in late summer.

APOCYNACEAE

Apocynum androsaemifolium L. — SPREADING DOGBANE. — Occasional to common in dry woods and thickets on the tops and upper slopes of the hills. Also in old clearings and meadows. Found flowering in late June and in July.

Apocynum cannabinum L. — INDIAN HEMP. — Occasional along roadsides and around old clearings. In flower about midsummer.

ASCLEPIADACEAE

Asclepias phytolaccoides Pursh. — *A. exaltata* of auth. — POKE MILKWEED. — Occasional in damp roadside thickets and meadows. Found flowering late in June.

Asclepias incarnata L. — SWAMP MILKWEED. — Occasional to common on wet pond margins. In flower about mid-summer.

Asclepias quadrifolia Jacq. — Rare or occasional, in dry upland woods. Flowers in June.

CONVOLVULACEAE

Convolvulus sepium L. — HEDGE BINDWEED, or WILD MORNING-GLORY. — Occasional in roadside thickets. Flowers in midsummer.

Cuscuta Gronovii Willd. — COMMON DODDER. — Common in damp thickets and meadows. Flowers in late summer.

BORAGINACEAE

Myosotis laxa Lehm. — FORGET-ME-NOT. — Common along damp stream beds and springy places in the woods. Found flowering in late June and in July.

Echium vulgare L. — BLUEWEED, or BLUE THISTLE. — A common weed along dry gravelly roadways. In flower during late June and in July.*

VERBENACEAE

Verbena urticaefolia L. — WHITE VERVAIN. — Common in old clearings and along dry roadsides. In flower during the latter part of the summer.

Verbena hastata L. — BLUE VERVAIN. — Occasional to common in damp meadows and along open streams. In flower about mid-summer.

LABIATAE

Scutellaria lateriflora L. — SKULLCAP. — Occasional to common in swamps and on pond shores. Flowers during the latter half of the summer.

Nepeta Cataria L. — CATNIP. — A common weed of roadsides and waste places. Flowers in middle and late summer.*

Prunella vulgaris L. — HEAL-ALL, or SELF-HEAL. — Common in meadows and along wood roads. In flower during mid-summer.

Leonurus Cardiaca L. — MOTHERWORT. — A weed around old clearings and along roadsides. Flowers in middle and late summer.*

Hedeoma pulegioides (L.) Pers. — PENNYROYAL. — Occasional to common in dry roadways and old clearings. Flowers in the latter part of the summer.

Satureja vulgaris (L.) Fritch. — *Clinopodium vulgare* L. — BASIL. — Occasional in old clearings and at roadsides. Also occasional in dry slope woods with southern exposure. In flower about mid-summer.

Origanum vulgare L. — WILD MARJORAM. — Occasional in roadside thickets. Found flowering late in July.*

Pycnanthemum flexuosum (Walt.) BSP. — MOUNTAIN MINT. — Common in thickets about an old clearing just north of Tamarack Pond, but not seen elsewhere in the Forest. Found in flower about mid-July.

Cunila origanoides (L.) Britton. — *Mappia origanoides* (L.) House. — DITTANY. — Occasional in dry open woods on the higher slopes, and apparently confined to southern exposures. Flowers in late summer.

Lycopus uniflorus Michx. — BUGLE WEED. — Common in swamps and on pond shores. Also in wet cove woods. In flower during the latter part of the summer.

Mentha arvensis L. var. **glabrata** (Benth.) Fern. — WILD MINT. — Occasional on marshy pond shores. Flowers in mid-summer.

Collinsonia canadensis L. — HORSE BALM, or STONE-ROOT. — Common in rich woods of coves and lower slopes, and in damp roadside thickets. In flower about mid-summer.

SOLANACEAE

Solanum Dulcamara L. — EUROPEAN BITTERSWEET. — Occasional or common in wet thickets on pond margins. Found flowering about mid-summer.*

SCROPHULARIACEAE

Verbascum Thapsus L. — COMMON MULLEIN. — Common in dry thickets, roadsides and waste places. In flower about midsummer.*

Verbascum Blattaria L. — MOTH MULLEIN. — Occasional in dry fields and waste places. Flowers in June and July.*

Linaria vulgaris Hill. — *L. Linaria* (L.) Karst. — BUTTER-AND-EGGS, or YELLOW TOADFLAX. — A common weed in fields and waste places. Flowers in summer.*

Chelone glabra L. — TURTLEHEAD. — Common in damp meadows and roadside thickets. Flowers in late summer.

Mimulus ringens L. — MONKEY FLOWER. — Common in wet thickets and along marshy streams in the coves. Found flowering in late July and August.

Veronica americana Schwein. — AMERICAN BROOKLIME. — Occasional in swampy ground. Found flowering in July.

Veronica scutellata L. — MARSH SPEEDWELL. — Common on marshy pond margins. Found flowering in July and August.

Veronica officinalis L. — COMMON SPEEDWELL. — Occasional to common in rich cove woods. Flowers in early summer.

Aureolaria pedicularia (L.) Raf. var. **intercedens** Pennell. — *Gerardia pedicularia* L. var. *intercedens* Pennell. — Occasional in dry open woods and along upland wood roads. Flowers in August.

Aureolaria virginica (L.) Pennell. — *Gerardia flava* of Gray's Man. — DOWNY FALSE FOXGLOVE. — Occasional in open woods and thickets. In flower early in July.

Aureolaria flava (L.) Farwell. — *Gerardia virginica* of Gray's Man. — *A. glauca* of auth. — SMOOTH FALSE FOXGLOVE. — Common in old clearings, and in cove and lower slope woods. Flowers in July, a little later than the preceding.

Gerardia tenuifolia Vahl. — *Agalinus tenuifolia* (Vahl.) Raf. — Occasional in grassy places along upland wood roads. Flowers in late summer.

Pedicularis canadensis L. — LOUSEWORT, or WOOD BETONY. — Common along dry, upland wood roads. Flowers in spring.

Melampyrum lineare Desr. subsp. **latifolium** (Muhl.) Beauv. — COW WHEAT. — Occasional to common in rather dry slope woods. Found flowering in late June.

OROBANCHACEAE

Epifagus virginiana (L.) Bart. — *Leptamnium virginianum* (L.) Raf. — BEECHDROPS. — Rare in the Forest, and found only under beech trees, upon whose roots it is parasitic. Flowers in late summer and fall.

Conopholis americana (L.f.) Wallr. — SQUAWROOT, or CANCER-ROOT. — Apparently rare, and found only on a dry wooded slope in the southern part of the Forest. Apparently parasitic on oaks. Flowers in early summer.

LENTIBULARIACEAE

Utricularia minor L. — BLADDERWORT. — Fragments somewhat doubtfully determined thus were found floating in Sutherland Pond.

PLANTAGINACEAE

Plantago Rugelii Dcne. — PLANTAIN. — Common on dry roadsides and in old fields and waste places. Flowers in summer.

Plantago lanceolata L. — ENGLISH PLANTAIN. — Common in old fields and waste places. Flowers in summer.*

RUBIACEAE

Cephalanthus occidentalis L. — BUTTONBUSH. — Common on wet pond margins and in the wetter parts of cove woods. Found flowering in July.

Mitchella repens L. — PARTRIDGE BERRY. — Occasional in rather dry upland woods. Flowers in late June or early July.

Galium lanceolatum Torr. — WILD LIQUORICE. — Common in rich slope woods. Found flowering in late June.

Galium triflorum Michx. — SWEET-SCENTED BEDSTRAW. — Occasional to common in wet springy places in the woods or along wood roads. In flower about mid-summer.

Galium Mollugo L. — Occasional in old fields and meadows. Flowers in June and July.*

Galium tinctorum L. — See Rhod. **37**: 443-5 (1935). — Occasional to common in damp thickets and on marshy pond mar-

gins. Found flowering in late June, and maturing its fruits late in July.

Galium trifidum L. — Common in boggy swamps such as the island in Tamarack Pond. Found flowering late in July.

CAPRIFOLIACEAE

Sambucus canadensis L. — Common Elder. — Occasional to common in damp thickets along roadsides, old fence-rows, and pond margins. Flowers in early summer; fruits maturing in July.

Sambucus pubens Michx. — *S. racemosa* of auth. — Red-berried Elder. — Occasional in damp thickets. Flowers in May.

Viburnum acerifolium L. — Maple-leaved Viburnum. — Abundant in most of the slope and cove woods, where it is usually a primary species in the shrub layer. Flowers in early summer.

Viburnum affine Bush ex Schn. var. **hypomalacum** Blake. — Downy Arrow-wood. — Abundant in the white oak-hickory and scrub oak associations on the hill-tops, where it is usually a primary species in the shrub layer. It is rarely found at lower levels, and then mostly on southerly slopes. Found with maturing fruit about mid-summer.

Viburnum dentatum L. — Arrow-wood. — Occasional in cove and lower slope woods; abundant in swamps and old clearings which have grown up to thickets. Flowers in early summer.

Viburnum cassinoides L. — Withe-rod, or Wild Raisin. — Common in boggy swamps such as the island in Tamarack Pond. Flowers in early summer; fruit maturing late in July.

Viburnum Lentago L. — Nannyberry, or Sheepberry. — Common in peaty swamps on the uplands and occasional in wet cove woods. Flowers in spring; fruit maturing about mid-July.

Viburnum prunifolium L. — Black Haw. — Occasional in thickets around old clearings, and also in damp cove woods. Flowers in spring.

Lonicera dioica L. — Honeysuckle. — Occasional in dry woods on the upper slopes and hill tops. Flowers in spring.

Diervilla Lonicera Mill. — *D. Diervilla* (L.) MacM. — Bush Honeysuckle. — Common in rather dry slope woods, and in hill-top meadows and thickets. Found flowering late in June.

CAMPANULACEAE

Campanula rotundifolia L. — BLUEBELL. — Occasional to common on rocky hill-tops. In flower in late June and in July.

LOBELIACEAE

Lobelia cardinalis L. — CARDINAL-FLOWER. — Common along running brooks, usually in shady cove woods. Found flowering early in August.

Lobelia spicata Lam. — Occasional to common in damp springy places in the upland woods and thickets, usually along old wood roads. Found flowering in late June.

Lobelia inflata L. — INDIAN TOBACCO. — Common in dry clearings and along roadsides. Flowers in late July and August.

Lobelia Dortmanna L. — WATER LOBELIA. — Known in the Forest only in the shallow water on the northeast side of Sutherland Pond, where it is rooted in a sandy-gravelly bottom. Found with flowers and immature fruit late in July.

COMPOSITAE

Eupatorium purpureum L. — JOE-PYE WEED. — Common in damp meadows and roadside thickets. Flowers in the latter part of the summer.

Eupatorium sessilifolium L. — UPLAND BONESET. — Found in the Forest only in dry upper slope woods with southern exposure. Flowers in the latter part of the summer.

Eupatorium perfoliatum L. — BONESET, or THOROUGHWORT. — Common in damp meadows and roadside thickets. Flowers in the latter part of the summer.

Eupatorium urticaefolium Reichard. — WHITE SNAKEROOT. — Occasional in rather damp ravine woods. In flower late in July.

Solidago caesia L. — Common to abundant in roadside thickets, and in nearly all of the woodland associations. Flowers in late August.

Solidago bicolor L. — PALE GOLDEN-ROD. — Common in dry woods on the upper slopes of the hills. Flowers late in August.

Solidago puberula Nutt. — Common in dry roadside meadows and thickets. Flowers in late August.

Solidago arguta Ait. — Common to abundant in roadside thickets and meadows, and common in rather dry slope woods. Flowers in late summer.

Solidago juncea Ait. — Common along roadsides and in dry clearings. Occasional in the scrub oak and meadow associations on the hill-tops. Flowers in the latter part of July, and is one of the earliest golden-rods to bloom.

Solidago odora Ait. — *S. suaveolens* of auth. — SWEET, or ANISE-SCENTED GOLDENROD. — Occasional in dry upland woods and along old wood roads. Flowers late in July.

Solidago rugosa Mill. — Common in dry roadside thickets and meadows. Flowers late in August.

Solidago canadensis L. — Occasional to common in meadows, clearings, and roadside thickets. Flowers in late summer.

Solidago graminifolia (L.) Salisb. var. **Nuttallii** (Greene) Fern. — Occasional in roadside thickets and meadows. In flower in August.

Aster divaricatus L. — Common in roadside meadows and thickets, and in the cove and lower slope woods. Flowers late in July.

Aster Schreberi Nees. — Occasional to common on dry banks along wood roads. In flower late in July.

Aster macrophyllus L. — Common to abundant on damp roadside banks and in most of the slope and hill-top woods. Occasional in the cove woods. Flowers late in July.

Aster novae-angliae L. — NEW ENGLAND ASTER. — Common in damp meadows and roadside thickets. Flowers early in September.

Aster patens Ait. — Occasional to common along dry upland trails, and in the scrub oak and meadow associations of the hill-tops. Flowers in late August.

Aster Lowrieanus Porter. — Common along dry upland wood roads and trails. Flowers in the latter part of August.

Aster pilosus Willd. var. **demotus** Blake. — See Rhod. **28**: 65 (1926), and **32**: 136-40 (1930). — Occasional to common in dry thickets and on dry roadsides and trails. Flowers in late August.

Aster lateriflorus (L.) Britton. — Occasional in rather damp soil along upland roads and trails. In flower late in August.

Aster paniculatus Lam. — Occasional in damp thickets. Flowers in late August.

Aster puniceus L. var. **lucidulus** Gray. — PURPLE-STEMMED ASTER. — Occasional at swampy pond margins. Flowers early in September.

Aster umbellatus Mill. — Common in damp roadside thickets and trails, and occasional in wet cove woods. In flower early in August.

Aster linariifolius L. — Occasional on dry roadsides; and common in thickets and meadows on the tops of the hills. In flower early in September.

Aster acuminatus Michx. — Common in rich woods on the lower slopes and in coves. Flowers in the latter part of August.

Erigeron pulchellus Michx. — ROBIN'S PLANTAIN. — Occasional in rather dry open places. Flowers in spring.

Erigeron annuus (L.) Pers. — DAISY FLEABANE. — A common weed in fields, roadways and waste places. Found flowering in late June and in July and August.

Erigeron ramosus (Walt.) BSP. — DAISY FLEABANE. — Common as a weed in old clearings, roadways, and waste ground. Flowers in summer.

Erigeron canadensis L. — *Leptilon canadense* (L.) Britton. — HORSEWEED. — Occasional along roadsides and in waste places. Flowers in late summer.

Sericocarpus asteroides (L.) BSP. — WHITE-TOPPED ASTER. — Occasional to common in dry open woods and along upland wood roads. In flower early in July.

Antennaria plantaginifolia (L.) Richards. — Common in rather dry slope woods and old clearings. Flowers in spring.

Antennaria neodioica Greene. — PUSSY TOES. — Occasional in dry meadows. Flowers in spring.

Antennaria neglecta Greene. — Occasional in damp meadows. Flowers in May.

Anaphalis margaritacea (L.) Benth. and Hook. — PEARLY EVERLASTING. — Occasional in dry thickets and roadways. In flower early in August.

Gnaphalium obtusifolium L. — *G. polycephalum* Michx. — EVERLASTING. — Occasional in dry stony thickets. In flower in late August.

Gnaphalium uliginosum L. — CUDWEED. — Occasional in damp

muddy places, usually along wood roads. In flower about mid-summer.

Ambrosia artemisiifolia L. var. **elatior** (L.) Descourtils. — See Rhod. **37**: 184-5 (1935). — COMMON RAGWEED. — Occasional to common on dry roadsides and in old clearings. Flowers in late summer.

Rudbeckia hirta L. — BLACK-EYED SUSAN. — Common on dry roadsides and in clearings. Flowers in late June and July.

Helianthus divaricatus L. — WILD SUN-FLOWER. — Common along dry wood roads, and occasional in dry woods on the upper southern slopes of the hills. In flower about mid-July.

Helianthus decapetalus L. — Common in rather damp roadside thickets and meadows. In flower about mid-July.

Bidens frondosa L. — BEGGAR'S TICKS. — Common at upland pond margins and in damp cove woods. Flowers in late August.

Bidens connata Muhl. var. **petiolata** (Nutt.) Fern. — BEGGAR'S TICKS. — Occasional to common at upland pond margins. Flowers in late summer.

Bidens cernua L. — STICK-TIGHT. — Occasional on upland pond margins. Flowers in late summer or early fall.

Galinsoga ciliata (Raf.) Blake. — Occasional in waste places, usually in rich soil. Flowers about mid-summer.*

Achillea Millefolium L. — YARROW. — Occasional to common in roadside meadows and waste places. Flowers throughout most of the summer.

Chrysanthemum Leucanthemum L. var. **pinnatifidum** Lecoq and Lemotte. — DAISY. — A common weed in fields and waste places. Flowers in early and mid-summer.*

Tussilago Farfara L. — COLTSFOOT. — Occasional in disturbed clayey soils. Flowers in early spring.*

Erechtites hieracifolia (L.) Raf. var. **intermedia** Fern. — See Rhod. **19**: 24-7 (1917). — FIREWEED. — Common in rather rich upland thickets and wood roads. Flowers in late August.

Senecio obovatus Muhl. — RAGWORT. — Common in rich cove woods. Flowers in early summer.

Arctium minus (Hill.) Bernh. — BURDOCK. — A common weed about clearings and waste places. Flowers in late summer.*

Cirsium lanceolatum (L.) Hill. — BULL THISTLE. — Occasional in the dry soil of clearings and roadsides. Flowers in the latter part of the summer.*

Cirsium arvense (L.) Scop. — CANADIAN THISTLE. — A weed in damp meadows and waste places. Found flowering late in July.*

Hieracium aurantiacum L. — ORANGE HAWKWEED, or DEVIL'S PAINT-BRUSH. — An occasional weed in old clearings. Flowers in early summer.*

Hieracium pratense Tausch. — KING DEVIL. — A weed along upland roadways, and occasional in rich slope woods. Flowers in early summer.*

Hieracium venosum L. — RATTLESNAKE-WEED. — Occasional to common in rather dry slope woods. Flowers in early summer.

Hieracium paniculatum L. — Occasional along upland wood roads. In flower about mid-August.

Krigia biflora (Walt.) Blake. — *K. amplexicaulis* Michx. — *Cynthia virginica* (L.) D. Don. — CYNTHIA. — Apparently rare or occasional in moist woods or open ground. Flowers in spring.

Krigia virginica (L.) Willd. — DWARF DANDELION. — Apparently rare or occasional in hill-top meadows. Flowers in June.

Taraxacum palustre (Lyons) Lam. & DC. var. **vulgare** (Lam.) Fern. — See Rhod. **35**: 380 (1933). — COMMON DANDELION. — Occasional as a weed in waste places. Flowers in spring.*

Lactuca canadensis L. — WILD LETTUCE. — Occasional to common in clearings and at roadsides. Found flowering in late July and August.

Lactuca canadensis L. var. **latifolia** O. Ktze. — See Rhod. **22**: 9 (1920). — Similar to the preceding in habitat and flowering time.

Prenanthes trifoliolata (Cass.) Fern. — *Nabalus trifoliolatus*, Cass. — RATTLESNAKE ROOT. — Common along upland wood roads, and in cove and lower slope woods. Flowers early in August.

Part III

LICHENS OF THE BLACK ROCK FOREST

By Lucy C. Raup

During the summers of 1936 and 1937 the writer collected lichens in Black Rock Forest, Cornwall-on-the-Hudson, N. Y. The collection is not a large one for the region does not hold a large number of either species or individuals in this group. Most of the lichens found were either on rocks, dead logs or soil.

The material was determined at Farlow Herbarium, Harvard University, and was not only compared with the large general herbarium there, but also with the specimens in the Tuckerman Herbarium. A few sterile specimens have not been included in the list.

The nomenclature in the list follows that given in "Catalogus Lichenum Universalis" by A. Zahlbruckner. In a few cases the binomials are not those of "The Lichen Flora of the United States" by Bruce Fink, the most comprehensive recent publication on North American lichens. In such cases Fink's names are given as synonyms.

A recognition set of specimens will be placed at the Black Rock Forest Laboratory, a duplicate set in Farlow Herbarium and also one in the private herbarium of the writer.

GRAPHIDACEAE

Opegrapha varia Pers. — Common on dry and weathered wood.

CHRYSOTHRICACEAE

Crocynia membranaceae A. Zahl. — *Amphiloma lanuginosum* (Hoffm.) Nyl. — Common on rocks and the bases of trees in moist shady places.

DIPLOSCHISTACEAE

Diploschistes scruposus Norm. — *Urceolaria scruposa* (Schreb.) Ach. — Very common on rocks on the upper slopes. A primary species on high exposed rocks.

LECIDIACEAE

Lecidea albocoreulescens Ach. — Common on boulders.

Bacidia umbrina Bausch. — Widely distributed on rocks.

Rhizocarpon petraeum Mass. — On boulders and exposed bed rock on hill-tops and upper slopes.

CLADONIACEAE

Baeomyces roseus Pers. — Common on bare soil.

Cladonia rangiferina (L.) Web. — Occasional on ground.

Cladonia sylvatica (L.) Hoffm. — On ground.

Cladonia bacillaris Nyl. — Occasional to common on logs and old stumps.

Cladonia cristatella Tuck. — Common to abundant on ground, dead logs and bases of trees.

Cladonia uncialis (L.) Web. f. **dicraea** Wain. — Occasional on ground.

Cladonia uncialis f. **obtusata** Wainio. — On the ground.

Cladonia furcata var. **racemosa** Floerke. — Occasional to common on the ground.

Cladonia squamosa (Scop.) Hoffm. — Common on ground and dead logs.

Cladonia gracilis (L.) Willd. — Intermingled with mosses on the ground.

Cladonia subcariosa (Nyl.) Wainio. — Occasional to common on ground and dead logs.

Cladonia pyxidata (L.) Fr. — Common on ground and dead wood.

Cladonia coniocraea (Floerke) Wainio. — Occasional to common on old logs and stumps.

Cladonia verticillata Hoffm. — Occasional on the ground.

GYROPHORACEAE

Gyrophora Muhlenbergii Ach. — Very common on exposed bed rock. A primary species on high exposed cliffs.

Umbilicaria pustulata (L.) Hoffm. — Similar to the last.

ACAROSPORACEAE

Biatorella clavus Th. Fr. On boulders and exposed bed rock.

PANNARIACEAE

Hydrothyria venosa Russ. — Common on rocks in brooks.

PELTIGERACEAE

Peltigera canina Willd. — Occasional on ground.

LECANORACEAE

Lecanora polytropa Rabh. — Primary species on exposed rocks on upper slopes.

PARMELIACEAE

Parmelia conspersa f. **isidiata** Anzi. — On rocks.

Parmelia saxatilis Ach. — Common on tree trunks.

Parmelia perlata Ach. — Widely distributed on rocks.

Cetraria Oakesiana Tuck. — Common on trees.

Cetraria islandica (L.) Ach. — Common in rock crevices.