

**Information sources for reconstructing the
vegetation of Philadelphia, lower Bucks, and
Delaware Counties, Pennsylvania, around
the time of European settlement**

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For the
Pennsylvania Natural Heritage Program
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2 December 2008

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Part 1. Historical documents

Indian burning around the Delaware Bay, 1632

Background

Captain David Pietersz de Vries (1593–1662) was a navigator from Hoorn, Holland, patroon of the company that founded the Dutch colony of Zwaanendael in 1631 at present-day Lewes, Delaware. He left the colony of about 30 residents for a return trip to Holland, during which time the man he left in charge got into a quarrel with a particular clan of Indians. Despite the efforts of other Indians to quell the dispute, it escalated until the aggrieved clan massacred the entire colony. De Vries sailed back in December 1632 to see if the colony and relations with the Native American neighbors could be salvaged.

Interpretation of text

There are many eyewitness accounts of deliberate use of fire on the landscape by Indians in many parts of the Americas, but this may be the only one from the territory of the Lenape, the main inhabitants of the Philadelphia area around the time of European contact. Documentation exists from several sources suggesting that Indians in the mid-Atlantic region conducted burns most likely to improve game habitat, encourage the growth of certain fire-enhanced sources of food such as blueberries, huckleberries, blackberries, and raspberries, and extend visibility, which would have made it easier to hunt, travel, and maintain “homeland security.” One of the consequences was a relative abundance of grasslands, meadows, and shrublands covering perhaps 1% or 2% of the total land area around the time of European settlement, comparable to the amount of land in wetland vegetation (Latham 2005).

Original text excerpts

From historian Benjamin Ferris’s book *A History of the Original Settlements on the Delaware, From Its Discovery by Hudson to the Colonization Under William Penn* (Ferris 1846, p. 23):

The ensuing year, 1632, De Vries returned to the Delaware. Before leaving the Texel he had by some means heard of the melancholy end of his colony. He arrived on our coast in the early part of the winter, and long before they saw the land, knew they were near the coast, “by the odour of the under-wood, which at this time of the year is burned by the Indians, in order to be less hindered in their hunting.”

From David Pieterszen De Vries’s 1655 memoir, *Korte Historiae ende Journaels Aenteyckeninge* (Myers 1912, p. 15):

The 2d, threw the lead in fourteen fathoms, sandy bottom, and smelt the land, which gave a sweet perfume, as the wind came from the northwest, which blew off the land, and caused these sweet odors. This comes from the Indians setting fire, at this time of year, to the woods and thickets, in order to hunt; and the land is full of sweet-smelling herbs, as sassafras, which has a sweet smell.

Meadows (marshes?) and Indian cornfields along the lower Delaware River, 1634

Background

Captain Thomas Yong (1579–1636?) was an English adventurer/entrepreneur whose life's mission at age 54 became the quest for a “northwest passage” through North America from the Atlantic to the Pacific. In 1633, after petitioning for and being granted permission by King Charles I, he launched an expedition. His first hypothesis was that the Delaware River (which he named the Charles River in honor of the king) led to the Great Lakes where one or more river outlets in turn led to the “North Ocean.” He may have been the first European to describe in writing the landscape and people of what is now southeastern Pennsylvania.

Interpretation of text

Yong's statement that “a ship of 300 Tonnes may saile up within three leagues of the rockes” verifies that he and his crew explored the Delaware River at least as far upstream as the falls at Trenton, which includes all of the river frontage of lower Bucks, Philadelphia, and Delaware Counties. The only native plants he mentioned by name — grapes and wild hops — seem to reflect a fermented beverage bias.

Original text excerpt

From “A breife Relation of a voyage lately made by me Captayne Thomas Yong, since my departure from Virginia, upon a discovery, which I humbly present to the Right Ho^{ble} Sr Francis Windebanke, knight, Principall Secretary of State to his Ma^{tie}” (Myers 1912, pp. 47-48), describing the lands along the lower Delaware River and its major tributaries:

The river is broad and deepe, and is not inferior to any in the North of America, and a ship of 300 Tonnes may saile up within three leagues of the rockes. . . . The soyle is sandy and produceth divers sorts of fruites, especially grapes, which grow wild in great quantity, of which I have eaten sixe severall sorts, some of them as good as they are ordinarilly in Italy, or Spaine... The earth being fruitfull is covered over with woods and stately timber, except only in those places, where the Indians had planted their corne. The Countrey is very well replenished, with deere and in some places store of Elkes. The low grounds of which there is great quantitie excellent for meadows and full of Beaver and Otter. . . . Heere are also great store of wild hops yet excellent good and as faire as those in England . . .

Upland grasslands or meadows inland from the Delaware River, 1683

Background

Thomas Paskell, also spelled Paschall (1634–1718), a pewterer in Bristol, England, purchased 500 acres in what is now Angora, West Philadelphia and moved there with his family in late summer, 1682.

Interpretation of text

Paskell's letter contains the earliest unambiguous reference to grasslands, meadows or savannas in Philadelphia, lower Bucks or Delaware Counties (or anywhere in Pennsylvania): “I know a man together with two or three more, that have happened upon a piece of Land of some Hundred Acres, that is all cleare, without Trees, Bushes, Stumps, that may be Plowed without let, the

farther a man goes into the Country the more such Land they find. There is also good Land, full of Large and small Trees, and some good Land, but few Trees on it.”

Original text excerpt

Letter of 31 January 1683 from Thomas Paskell to a friend in Chippenham, England (Myers 1912, pp. 253-254), describing the Pennsylvania colony, then limited to parts of present-day Philadelphia, lower Bucks, and Delaware Counties:

Here are Gardens with all sorts of Herbs, and some more then in England, also Goose-beries and Roasetrees, but what other Flowers I know not yet: Turnips, Parsnips, and cabbages, beyond Compare. Here are Peaches in abundance of three sorts I have seen rott on the Ground, and the Hogs eat them, they make good Spirits from them, also from Come and Cherries, and a sort of wild Plums and Grapes, and most people have Stills of Copper for that use. Here are Apples, and Pears, of several sorts, Cherries both Black and Red, and Plums, and Quinces; in some places Peach Stones grow up to bear in three Years: the Woods are full of Oakes, many very high and streight, many of them about two foot through, and some bigger, but very many less; A Swead will fell twelve of the bigger in a day; Here are brave Poplar, Beach, Ash, Lyme-trees, Gum-trees, Hickary-trees, Sasafras, Wallnuts, and Chesnuts, Hazel, and Mullberies: Here growes in the Woods abundance of Wortle-beries or Whorts [blueberries and huckleberries], Strawberies and Blackberies, better then in England, as also three sorts of Grapes and Plums; Here is but few Pine-trees, and Ceder; Here is good Firestone [iron pyrites] plenty enough in most places: and the Woods are full of runs of water. I have lately seen some Salt, very good to salt meat with, brought by an Indian out of the Woods: they say there is enough of it: but for Minnerals or Mettals, I have not seen any, except it be Marcasite [iron pyrites], such as they make Vitriol or Copperis with in England. Here are Beavers, Rackoons, Woolves, Bears, a sort of Lyons, Polecatts, Mushratts, Elks, Mincks, Squirrills of several sorts and other small Creatures, but none of these hurt unless surprised: also Rattle Snakes and black Snakes, but the Rattle Snaks I have not seen, though I have rambled the Woods much these three Months, since the beginning of September. ... The Land is generally good and yet there is some but ordinary and barren ground. Here are Swamps which the Sweads prize much, and many people will want: And one thing more I shall tell you, I know a man together with two or three more, that have happened upon a piece of Land of some Hundred Acres, that is all cleare, without Trees, Bushes, Stumps, that may be Plowed without let, the farther a man goes into the Country the more such Land they find. There is also good Land, full of Large and small Trees, and some good Land, but few Trees on it. ...

Vacant Indian fields, 1684

Background

William Penn (1644–1718), founder and proprietor of the English province of Pennsylvania, first set foot in his North American landholdings in October 1682. This was nearly 40 years after the first European settlement in what is now Pennsylvania by Swedes and Finns and 18 years after the English had replaced the Dutch as military claimants of the European settlements along the mid-Atlantic coast, including the area that was to become Penn’s province. Despite several decades of prior European settlement, however, Native Americans still outnumbered the sparse European population. Penn’s arrival inaugurated a dramatic increase in immigration rates.

Interpretation of text

The first sentence of the excerpt is the most revealing. It corroborates Paskell's mention (see previous item) of scattered grasslands, meadows and savannas in and around Philadelphia County, which in all likelihood predated European settlement. Penn's brief list of the common tree species was echoed and elaborated by the observations of Pehr Kalm over 60 years later (see *Pehr Kalm's observations, 1748–1749*, below).

Original text excerpt

Letter 9 January 1684 from William Penn to the Earl of Arran (Dunn and Dunn 1982, p. 513), describing the Pennsylvania colony, then limited to parts of present-day Philadelphia, lower Bucks, and Delaware Counties:

The land is generally good, well water'd & not So thick of wood as immagin'd; there are also many open places that have been old indian feilds. The trees that grow here, are the Mulberry white & read, walnut, black, gray & Hickery; Poplar, Cedar, Cyprus, chesnut, Ash, Sarsafrax, gum, pine, Spruce, oake, black white red, Spanish chesnut & Swamp, w^{ch} has a leafe like a willow, and is most lasting. The food, the woods yeild, is your Elks, deer, Racoons, Beaver, Rabbets, Turkeys, Phesants, heath-birds, Pidgeons & Patredge innumerably; we need no setting dogs to Ketch, they run by droves into the house in Cold weather. Our Rivers have also plenty of excellent fish & water fowl as Sturgeon, Roe shad, Herring, cadfish, or flatheads, sheeps heads, Roach & Perch; & trout in inland Streames. of foule, the Swan, white, gray, & black goose & brands, the best duck & teal I ever eate & the Snipe & Curloe with the Snow bird, are also excellent.

The Aire is sweet & clear, w^{ch} makes a screen & steady sky as in the more southern parts of france. our Summers & winters are commonly once in three years in extreames; but the winters Seldom last above ten weeks & rarely begin till the latter end of december. the days are above two hours longer, & the Sun much hotter here then with you, w^{ch} makes some recompense for the sharp nights of the winter season, as well as the woods that make cheap & great fires.

we have of graine, wheat, maize, Rye, Barly, oates, severall excellent sorts of beans & pease; pumkens, water & musmellons, all english roots & Garden stuff; good fruit, & excellent Sider. The Peach we have in divers Kinds, & very good, & in great abundance. the vine (of severall sorts, & the signe wth us of rich land) is very fruitfull, & tho not so sweet as some I have eaten in Europe, yet it makes a good wine, & the worst, good vinegar; I have observed three Sorts. the Great grape, that has green, red & black, all ripe on the same tree. the muskedell, & black little grape, which is the best, & may be improv'd to an excellent wine. thes are spontaneous.

Vacant Indian fields at East Falls, 1684

Background

Paul A. W. Wallace, in researching the late prehistoric-early colonial Allegheny Path from present-day Philadelphia to Pittsburgh, found reference to what may have been its eastern terminus in a 1684 survey.

Interpretation of text

The "Vacant Indian Feilds" were apparently just east of where U.S. Route 1 (Roosevelt Expressway) crosses the Schuylkill River.

Original text excerpt

The words of an anonymous surveyor labeling a property survey map (Wallace 1965, p. 19):

... in a survey dated “13 of May 1684” ... “Mapp of Swan Swanson and his two Brothers land near [east of] ye ffalls of Skeolkill on ye S E side thereof ...” It shows, as approaching the river through “Vacant Indian Feilds,” “One Inden Road to Netopcomb or ye ffalls of Shoolkill.”

Grassy oak woodlands, 1685

Background

Thomas Budd, about whom little is known, wrote what is basically a real estate promotional brochure in 1685 and had it published by Philadelphia’s first printer for distribution in England.

Interpretation of text

Budd’s is the earliest mention of vegetation in or near Philadelphia with an abundant growth of one or more native grass species. If accurate, the description could be interpreted as a grassy savanna, perhaps similar in appearance to the longleaf pine–wiregrass savannas of the southern Atlantic and Gulf of Mexico coastal plains or the oak savannas of the Midwest.

Original text excerpt

Describing and perhaps exaggerating the positive attributes of the real estate in Penn’s province (Budd 1685, p. 34):

... the Trees grow but thin in most places, and very little under-Wood. In the Woods groweth plentifully a course sort of Grass, which is so proving that it soon makes the Cattel and Horses fat in the Summer, but the Hay being course, which is chiefly gotten on the fresh Marshes, the Cattel loseth their Flesh in the Winter and become very poor, except we give them Corn: But this may be remydyed in time, by draining of low rich Land, and by plowing of it, and sowing it with English-Grass-seed, which here thrives very well. The Hogs are fat in the Woods when it is a good Mast-Year.

Pehr Kalm’s observations, 1748–1749

Background

Pehr Kalm (1716–1779) was a Swedish-Finnish explorer, botanist, naturalist, agricultural economist, and a student of Carl von Linné (Carolus Linnaeus), who engaged him in 1747 on behalf of the Royal Swedish Academy of Sciences to make botanical observations in North America. Kalm arrived in Pennsylvania in 1748, befriended Benjamin Franklin and John Bartram (North America’s first native-born botanist of European descent), and settled until 1751 at Raccoon, a Swedish-Finnish community just across the Delaware River from Philadelphia in New Jersey, now called Swedesboro. He spent most of his North American stay in and around Philadelphia but his diaries (Benson 1937) also describe his travels in other parts of Pennsylvania and New Jersey and to New York and Quebec.

His diaries mention over 300 species of plants (also many kinds of animals, fungi, and minerals) by their Linnaean binomials, but mainly to describe their appearance, the ways in which they were used by people, or any adverse effects on people. However, some entries describe plants

species' habitat relations and the types of vegetation he encountered. In most cases, the geographical locations of his descriptions are clear, but sometimes while describing a species in one location he generalized about its occurrence elsewhere. The excerpts included here are those that appear to refer with the least ambiguity to present-day Philadelphia County and neighboring portions of Bucks and Delaware Counties.

Note that for Kalm the place name *Philadelphia* referred, not to the present-day 13-county metropolitan area including parts of four states or the 135-square-mile county (boundary finalized in 1784) and city (consolidated with the county in 1854), but to a small town on the banks of the Delaware River. In the mid-18th century the town covered roughly 1 square mile, corresponding to the present neighborhoods of Old City, Society Hill, and the east end of Center City. Thus, when he wrote “near Philadelphia” Kalm would have meant within a few miles of the town and well within the present limits of Philadelphia County.

Summary and interpretation of text describing vegetation in the immediate vicinity of the town of Philadelphia

Upland forest canopy and subcanopy trees were white oak, black oak, scarlet oak, southern red oak, northern red oak, chestnut oak, “three or four varieties” of hickory, flowering dogwood, tuliptree, black cherry, blackgum, American chestnut, black walnut, wild plum, American elm, sassafras, white ash, persimmon, sweet crabapple, hop-hornbeam, American hornbeam, American beech, redbud, basswood, honeylocust, and pawpaw. Oaks were more plentiful than American chestnut.

Upland trees of restricted distribution were sweetgum “near springs” and “near pools” (vernal pools?), butternut “on hills near rivers,” eastern red-cedar “in a dry poor soil,” sassafras “in a loose soil mixed with sand,” “*Pinus Americana*, Pennsylvania fir tree [most likely eastern hemlock]; on the north side of mountains and in valleys,” and “*Pinus taeda*, the New Jersey fir tree [probably pitch pine misidentified], on dry sandy heaths.”

Upland shrubs and vines were black raspberry, “grape vines of several kinds,” “*Azalea lutea* [*periclymenoides*], the American upright honey-suckle,” “*Vaccinium* . . . , a species of whortleberry shrub” (may have referred to lowbush blueberry, *V. pallidum*, or black huckleberry, or both), poison-ivy, greenbrier, and witch-hazel.

Upland shrubs of restricted distribution were leatherwood (“on hills, near swamps and marshes”) and mountain-laurel (“It succeeds best on the side of hills, especially on the north side, where a brook passes by; therefore on meeting with some steep places (on hills) towards a brook, or on steep hillsides facing marshes, you are sure to find the *Kalmia*. But it frequently stands among beech trees.”).

Atlantic white-cedar formed thick, monospecific stands in “numerous” swamps “in some parts of Pennsylvania” but was headed toward extirpation owing to overexploitation for shingles and fences, lack of replanting or any kind of management, and the very slow growth rate of the species.

Other swamp forests' canopies and subcanopies consisted of red maple, willow oak, ash (black ash, green ash, or both), sweetgum, and sweet-bay magnolia. American holly was rare and scattered in swamp forests. Shrubs in wet areas or “low places” included highbush blueberry (or possibly dangleberry), winterberry, box-elder, wild plum, black currant, spicebush, American elder, smooth alder, poison sumac, buttonbush, and “currants,” most likely *Amelanchier canadensis*.

Riverbank and floodplain trees mentioned specifically by Kalm were American sycamore and river birch.

Trees and shrubs mentioned as characterizing old fields, pastures, fencerows, and “corn fields” were smooth sumac, American chestnut, black walnut, greenbrier, red mulberry, and hackberry.

Species in upland forests that were apparently much more abundant in the 18th century than now include persimmon, red mulberry, butternut, and wild plum (*Prunus americana*). Species in other habitats that Kalm reported as abundant in the area but that are now rare or absent include lupine, Indian paintbrush (“The *Bartsia* [*Castilleja*] *coccinea* grew in great abundance on several low meadows”), sheep-laurel (“*Kalmia angustifolia* was now everywhere in flower. It grows chiefly on sandy heaths, or on dry poor grounds, where few other plants thrive; it is common in Pennsylvania ...”), and Atlantic white-cedar.

Kalm focused on grasses in his descriptions of Pennsylvania in only three passages (although he named several species in recounting his travels in New York and Quebec). He interviewed an old man who recalled, in the late 1600s, “grass in the woods which grew very thick, and was everywhere two feet high” but had become “much thinner at present.” Kalm attributed its decline to overgrazing by cattle, theorizing “most grasses here are annuals, and do not for several years in succession shoot up from the same root as our Swedish grasses. They must sow themselves every year, because the last year’s plant dies away every autumn. The great numbers of cattle hinder this sowing, as the grass is eaten before it can produce flowers and seed.” Kalm mentioned only one native grass in Pennsylvania by species: “*Andropogon bicorne*, a grass which grows in great plenty here, and which the English call Indian grass and the Swedes wildgrass.” Unfortunately this is a misidentification; *Andropogon bicornis* L. is a tropical American species, which superficially most resembles, in the southeastern Pennsylvania native flora, *A. glomeratus*, but is typically much taller (Clayton et al. 2008). Kalm may have been referring to *A. gerardii*, *Sorghastrum nutans*, or other local members of the tribe Andropogoneae. In another passage he described grass management by burning: “The leaves which dropped last autumn had covered the ground three or four inches in depth. As this seemed to hinder the growth of the grass, it was customary to burn it in March, or at the end of that month (according to the old style), in order to give the grass the opportunity of growing up. I found several spots burnt in this manner to-day [12 April 1749].” At some length following these sentences Kalm made clear his disapproval of the practice.

In several passages Kalm mentioned sandy heaths in Pennsylvania but he mentioned only a few species in connection with this habitat type, mainly lupine, sheep-laurel, and orange-grass. For instance, in describing a trip from Philadelphia to Bristol, somewhere in Northeast Philadelphia or adjacent lower Bucks County “...we perceived for the space of four English miles nothing else, except a very poor soil on which the *Lupinus perennis* grew plentifully ...” Later he wrote, “I often found it thriving on very poor sandy fields, and on heaths, where no other plants will grow.”

Free-roaming pigs probably caused some of the earliest and most severe damage to wetland and forest understory vegetation. In describing a journey through southern Delaware County he wrote, “The swine now went about in great herds in the oak woods ...” Recounting conversations with old-timers, Kalm reported that wapato (*Sagittaria latifolia*) was “said to have been almost destroyed by hogs, which were exceedingly greedy for them. The cattle are very fond of their leaves.” He noted that arrow-arum or tuckahoe (*Peltandra virginica*) “grows in moist ground and swamps. Hogs are very fond of the roots, and grow very fat by feeding on them. Therefore, they often visit the places where these roots grow, and they are frequently seen rooting up the mud, and falling with their whole body into the water, so that only a little of the

back part is out of the water. It is therefore very plain, that these roots must have been extirpated in places which are frequented by hogs.”

Kalm also mentioned the growing impact of cattle grazing on forest understories. “This country does not afford any green pastures like the Swedish ones; the woods are the places where the cattle must collect their food. . . . The trees stand far apart, but the ground between them is not covered with greensod, for there are but few kinds of grass in the woods, and the blades of it stand single and scattered. . . . Thus the cattle find very little grass in the forests and are forced to be satisfied with all kinds of plants which come in their way, whether they be good or bad food. I saw all spring long how the cattle bit off the tops and shoots of young trees and ate them; for no plants had come up and they stood in general but very thin, scattered here and there, as I have just mentioned. Hence you may easily imagine that hunger compels the cattle to eat plants which they would not touch, were they better provided for.” He mentioned in a few passages traveling through woods with little shrub growth, for instance, “The trees of the forest were tall but branchless below, so that it left a free view to the eye, and no underwood obstructed the passage between them.” This could have been the result either of cattle overgrazing or recent or repeated burning.

Aside from clearing, free-range livestock grazing, and deliberate burning, the colonists likely contributed to changes in the species composition of the wild lands around settlements early on by their own selective “grazing” and “browsing,” that is, by harvesting wild species regarded as useful—for medicine, food, fiber, building materials, or even because they were decorative or made the house smell pleasant—with little or no thought to sustaining or renewing the supply. Examples mentioned in the excerpts below include Atlantic white-cedar, pearly-everlasting, and orange-grass.

Original text excerpts

Pehr Kalm’s diary entry for 16 September 1748 (Benson 1937, p. 20), describing the town of Philadelphia:

The houses are covered with shingles. The wood for this purpose is taken from the *Cupressus thyoides* L. [*Chamaecyparis thyoides* (L.) Britton, Stearns & Poggenb.] or a tree which Swedes here call the “white juniper tree”, and the English “the white cedar”. Swamps and morasses formerly were full of them, but at present these trees are for the greatest part cut down and no attempt has yet been made to plant new ones.

Pehr Kalm’s diary entry for 18 September 1748 (Benson 1937, pp. 36-39), describing the vegetation around the town of Philadelphia:

In the morning I went with the Swedish painter, Mr. Hesselius, to the country seat of Mr. Bartram which is about four English miles to the south of Philadelphia, at some distance from the highway to Maryland, Virginia and Carolina. I had therefore the first opportunity here of getting an exact knowledge of the state of the country, which was a plain covered with all kinds of deciduous trees. The ground was sandy, mixed with clay. But the sand seemed to be in greater quantity. In some parts the wood was cut down and we saw the habitations of some country people, whose corn fields and plantations were round their farm houses. The wood was full of mulberry trees, walnut trees of several kinds, chestnut trees, sassafras and the like. Several sorts of wild vines clasped their tendrils round, and climbed up to the summits of the highest trees, and in other places they twined round the fences so thick that the latter almost sunk down under their weight. The persimmon, or *Diospyros Virginiana* L., grew in the marshy fields and about pools. Its little apples looked very well, but are not fit for eating before the frost has affected them and then they have a fine taste. Hesselius gathered some of them and desired my servant to taste of this fruit of

the land, but the poor credulous fellow had hardly bit into them when he felt the qualities they have before the frost has touched them, for they contracted his mouth so that he could hardly speak and got a very disagreeable taste. This disgusted him so much that he was with difficulty persuaded to taste of it during the whole of our stay in America, notwithstanding it loses all its acidity and acquires an agreeable flavor in autumn and towards the beginning of winter. For the fellow always imagined that though he should eat them ever so late in the year they would still retain the same obnoxious taste.

To satisfy the curiosity of those who are willing to know how the woods look in this country and whether or no the trees in them are the same as those found in our forests, I here inserted a small catalogue of those which grow wild in the woods nearest to Philadelphia. I exclude such shrubs as do not attain any considerable height. I shall put that tree first in order which is most plentiful and so on with the rest, and therefore trees which I have found but single, though near the town, will be last.

1. *Quercus alba*, the white oak in good ground.
2. *Quercus nigra*, or the black oak. [*Quercus velutina*]
3. *Quercus Hispanica*, the Spanish oak, a variety of the preceding. [*Quercus coccinea*, *Q. falcata*, or probably both]
4. *Juglans alba* [*Carya glabra*], hickory, a kind of walnut tree, of which three or four varieties are to be met with. [probably also *Carya cordiformis*, *C. ovata*, *C. tomentosa*]
5. *Rubus occidentalis*, or American blackberry shrub.
6. *Acer rubrum*, the maple tree with red flowers, in swamps.
7. *Rhus glabra*, the smooth leaved sumach, in the woods, on high glades and old corn fields.
8. *Vitis labrusca* and *vulpina*, grape vines of several kinds. [probably also included *Vitis aestivalis*, *V. riparia*]
9. *Sambucus Canadensis*, American elder tree, along the hedges and on glades.
10. *Quercus phellos*, the swamp oak, in morasses.
11. *Azalea lutea*, the American upright honey-suckle, in the woods in dry places. [synonym is *Rhododendron calendulaceum*, which has not been seen in the wild in Pennsylvania since the late nineteenth century; probably referred instead to *R. periclymenoides*]
12. *Crataegus Crus galli*, cockspur thorn (the Virginian azarole), in woods. [probably included *Crataegus crus-galli* and several other species]
13. *Vaccinium* ..., a species of whortleberry shrub. [may have referred to *Vaccinium pallidum*, *Gaylussacia baccata*, or both]
14. *Quercus prinus* [*montana*], the chestnut oak in good ground.
15. *Cornus florida*, the cornelian cherry, in all kinds of soil.
16. *Liriodendron tulipifera*, the tulip tree, in every kind of soil.
17. *Prunus Virginiana*, the wild cherry tree. [may have referred to *Prunus serotina* or included both species]
18. *Vaccinium* ..., a frutex swamp whortleberry, in good ground. [probably referred to *Vaccinium corymbosum*, possibly also *Gaylussacia frondosa*]

19. *Prinos verticillatus*, the winterberry tree in swamps. [*Ilex verticillata*]
20. *Platanus occidentalis*, the water-beech.
21. *Nyssa aquatica*, the tupelo tree; on fields and mountains. [*Nyssa sylvatica* misidentified]
22. *Liquidambar styraciflua*, sweet gum tree, near springs.
23. *Betula alnus*, alder, a variety of the Swedish; it was here but a shrub. [*Alnus serrulata*]
24. *Fagus castanea*, the chestnut tree, on corn fields, pastures and on wooded hills. [*Castanea dentata*]
25. *Juglans nigra*, the black walnut tree, in the same place with the preceding tree.
26. *Rhus radicans*, the twining sumach, climbed up the trees. [*Toxicodendron radicans*]
27. *Acer negundo*, the ash-leaved maple, in morasses and swampy places.
28. *Prunus domestica*, the wild plum tree.
29. *Ulmus Americana*, the white elm.
30. *Prunus spinosa* [*americana*], sloe shrub, in low places.
31. *Laurus sassafra* [*Sassafra albidum*], the sassafra tree, in a loose soil mixed with sand.
32. *Ribes nigrum*, the currant tree, grew in low places and in marshes. [probably *Ribes americanum*]
33. *Fraxinus excelsior*, the ash tree in low places. [habitat description suggests *Fraxinus pennsylvanica* or *F. nigra* misidentified; may also have included *F. americana*]
34. *Smilax laurifolia* [*rotundifolia* or *glauca*], the rough bindweed with the bay leaf, in woods and near fences.
35. *Kalmia latifolia*, the American dwarf laurel, on the northern side of hills.
36. *Morus rubra*, the mulberry tree on fields, hills and near the houses.
37. *Rhus* [*Toxicodendron*] *vernix*, the poisonous sumach, in wet places.
38. *Quercus rubra*, the red oak, but a peculiar variety.
39. *Hamamelis Virginica* [*virginiana*], the witch hazel.
40. *Diospyros Virginiana*, the persimmon.
41. *Pyrus* [*Malus*] *coronaria*, the anchor tree.
42. *Juniperus Virginiana*, the red juniper, in a dry poor soil.
43. *Laurus aestivalis* [*Lindera benzoin*], spice-wood in a wet soil.
44. *Carpinus ostrya* [*Ostrya virginiana*], a species of hornbeam in good soil.
45. *Carpinus betulus* [*caroliniana*], a hornbeam, in the same kind of soil with the former.
46. *Fagus sylvatica*, the beech, likewise in good soil. [*Fagus grandifolia* misidentified]
47. *Juglans cinerea*, a species of walnut tree on hills near rivers, called by the Swedes "butternutsträ."
48. *Pinus Americana*, Pennsylvania fir tree; on the north side of mountains and in valleys. [most likely *Tsuga canadensis*]

49. *Betula lenta*, a species of birch on the banks of rivers. [probably *Betula nigra* misidentified]
50. *Cephalanthus* [*Cephalanthus*] *occidentalis*, button wood, in wet places.
51. *Pinus taeda*, the New Jersey fir tree, on dry sandy heaths. [probably *Pinus rigida* misidentified]
52. *Cercis Canadensis*, the sallad tree, in good soil.
53. *Robinia pseudacacia* [*pseudoacacia*], the locust tree, on the corn fields.
54. *Magnolia glauca* [*virginiana*], the laurel-leaved tulip tree, in marshy soil.
55. *Tilia Americana*, the lime tree, in a good soil.
56. *Gleditsia triacanthos*, the honey locust tree, or three thorned acacia, in the same soil.
57. *Celtis occidentalis*, the nettle tree, in the fields.
58. *Annona muricata* [*Asimina triloba*], the custard apple, in a fertile soil.

Pehr Kalm's diary entry for 26 September 1748 (Benson 1937, p. 68), describing useful native or wild plants:

The *Sarothra* [*Hypericum*] *gentianoides* grows abundantly in the fields and under the bushes in a dry sandy ground near Philadelphia. It looks much like our whortleberry bushes when they first begin to grow green and when the points of the leaves are still red. ... It is reckoned a very good traumatic, and this quality Mr. Bartram himself experienced, for once being thrown and kicked by a vicious horse in such a manner as to have both his thighs greatly hurt, he boiled the *Sarothra* and applied it to his wounds. Thereupon it not only immediately appeased his pain, which before had been violent, but by its assistance he recovered in a short time.

Pehr Kalm's diary entry for 27 September 1748 (Benson 1937, p. 69), continuing his description of useful native plants:

The tree which the English here call persimmon, is the *Diospyros Virginiana* of Linné. It grows for the greatest part in wet places, round the water pits.

Pehr Kalm's diary entry for 28 September 1748 (Benson 1937, pp. 70-71), continuing his description of useful native plants:

The *Gnaphalium margaritaceum* [*Anaphalis margaritacea*] grows in astonishing quantities upon all uncultivated fields, glades, hills and the like. Its height varies with the soil and location. Sometimes it is very ramose and sometimes very small. It has a strong but agreeable smell. The English call it "life everlasting," for its flowers, which consist chiefly of dry, shining, silvery leaves (*Folia calycina*) do not change when dried. ... The English ladies are accustomed to gather great quantities of this life everlasting and to pick them with the stalks. For they put them into pots ... and place them as an ornament in the rooms. ... Mr. Bartram told me another use of this plant: a decoction of the flowers and stalks is used to bathe pained or bruised parts of the body, or they may be rubbed with the plant itself tied up in a thin cloth or bag.

Pehr Kalm's diary entry for 3 October 1748 (Benson 1937, pp. 79-80), describing a journey across what is now southwestern Philadelphia and southern Delaware County:

The mountains have an easy slope on all sides and the valleys are commonly traversed by brooks with crystal water. The greater part of the country is covered with several kinds of deciduous trees; for I scarcely saw a single tree of the evergreen variety except for a few red cedars. The trees of the forest were tall but branchless below, so that it left a free view to the eye, and no underwood obstructed the passage between them. It would have been easy in some places to have

gone under the branches with a carriage for a quarter of a mile, the trees standing at great distances from each other, and the ground being very level. In some spots little glades opened which were either meadows, pastures or grain fields; of the latter some were cultivated and others not. ...

All day long I saw a continual variety of trees; walnut trees of different sorts which were full of nuts; chestnut trees quite covered with fine chestnuts; mulberries, sassafras, liquidamber, tulip trees and many others.

Grapevines. Several species of vines grow wild hereabouts. They run up to the summits of the trees, their clusters of grapes and their leaves covering the stems. I even saw some young oaks five or six fathoms high whose tops were crowned with grape vines. ... The vines are principally seen on trees which stand single near grain fields or at the borders of wooded areas where the meadows, pastures and fields begin, and likewise along fences, where they cling with their tendrils round the trees that stand there. ...

Pehr Kalm's diary entry for 4 October 1748 (Benson 1937, p. 82), continuing across southern Delaware County:

... The grape vines climbed to the top of several trees and hung down on both sides. Other trees again were surrounded by the ivy (*Hedera* [*Parthenocissus*] *quinquefolia* L.) which with the same flexibility ascended to a great height. The *Smilax laurifolia* [*rotundifolia* or *glauca*] always joined with the ivy, and together with it twisted itself round the trees. ... Walnut and chestnut trees were common near the fences, in woods and on hills, and at present were loaded with their fruit. The persimmon was likewise plentiful near the roads and in the forests. ...

Pehr Kalm's diary entry for 5 October 1748 (Benson 1937, p. 86), at Chichester, southwestern Delaware County:

The *American brambles* (*Rubus occidentalis* L.) are here in great abundance. When a field is left uncultivated they are the first plants to appear on it, and I frequently observed them in such fields as are annually plowed and have grain sowed on them. For when these bushes are once rooted they are not easily extirpated. ... On some old land which had long been uncultivated there were so many bushes of this kind that it was very troublesome and dangerous walking among them. ...

Pehr Kalm's diary entry for 6 October 1748 (Benson 1937, pp. 87-88), describing a journey across what is now southern Delaware County:

From Chichester I went on towards Philadelphia. The oaks were the most plentiful trees in the wood. But there were several species of them, all different from the European ones. The swine now went about in great herds in the oak woods, where they fed upon the acorns which fell in great abundance from the trees. ... I seldom saw beech trees, but I found them quite the same as the European ones. ... The red maple, or *Acer rubrum*, is plentiful in these places. Its native location is chiefly swampy, wet places, in which the alder commonly is its companion.

Pehr Kalm's diary entry for 27 October 1748 (Benson 1937, pp. 116-117), describing a journey from Philadelphia to Bristol, on the Delaware River in Bucks County:

We now saw country estates on both sides of the road. We came into a lane bordered with pales [sic] on both sides and enclosing rather large cultivated fields. Next followed a wood, and we perceived for the space of four English miles nothing else, except a very poor soil on which the *Lupinus perennis* grew plentifully and succeeded well. I was overjoyed to see a plant thrive so well in these poor dry places, since it served to make such places useful. But I afterwards had the mortification to find that the horses and cows eat almost all other plants, save the lupine, which

was however very green, looked very luxuriant, and was extremely soft to the touch. Perhaps means may be found of making this plant palatable to cattle.

Pehr Kalm's diary entry for 2 November 1748 (Benson 1937, p. 132), describing roofing shingles in New York (the significance of this passage is in showing that Kalm knew *Pinus strobus* and called it white fir, making his *Pinus Americana* or Pennsylvania fir, mentioned elsewhere, most likely *Tsuga canadensis*):

... The roofs are commonly covered with tiles or shingles, the latter of which are made of the white fir tree, or *Pinus strobus* L., which grows further north in the country. The inhabitants are of the opinion that a roof made of these shingles is as durable as one made in Pennsylvania of the white cedar, or *Cupressus* [*Chamaecyparis*] *thyoides* L. ...

Pehr Kalm's diary entry for 20 November 1748 (Benson 1937, p. 175), describing the environs of his adopted hometown just across the Delaware River from Philadelphia in New Jersey:

... In all the parts of Pennsylvania where I have been, I have found but few fir trees; on the other hand, they are abundant in New Jersey, and especially in the lower part of that province. ...

Pehr Kalm's diary entry for 20 November 1748 (Benson 1937, pp. 176-177), describing mountain-laurel:

Laurel Trees. The spoon tree, which never grows to a great height, was seen to-day in several places. The Swedes here have named it thus, because the Indians used to make their spoons and trowels of its wood. In my cabinet of natural curiosities I have a spoon made of this wood by an Indian, who had killed many stags and other animals on the very spot where Philadelphia afterwards was built, for in his time that spot was yet covered with trees and shrubs. The English call this tree a "laurel" because its leaves resemble those of the *Laurocerasus*. Dr. Linné, because of the peculiar friendship and kindness with which he has always honored me has been pleased to call this tree, *Kalmia foliis ovatis, corymbis terminalibus, or Kalmia latifolia*. It succeeds best on the side of hills, especially on the north side, where a brook passes by; therefore on meeting with some steep places (on hills) towards a brook, or on steep hillsides facing marshes, you are sure to find the *Kalmia*. But it frequently stands among beech trees. The further up the north side of a mountain the *Kalmias* stand, the shorter they are. I have seen them not only in Pennsylvania and New Jersey but also in New York, but there they are scarcer. ...

Pehr Kalm's diary entry for 22 November 1748 (Benson 1937, pp. 180-181), describing native grasses:

Grass. Åke Helm was one of the most important Swedes in this place and his father came over to this country along with the Swedish Governor Printz; he was upwards of seventy years of age. This old man told us, that in his youth there was grass in the woods which grew very thick, and was everywhere two feet high, but that it was so much thinner at present that the cattle could hardly find food enough, and that therefore four cows now gave no more milk than one at that time. The causes for this change are easy to find. In the younger days of old Helm the country was little inhabited, and hardly a tenth part of the cattle kept which is there at present. A cow had therefore as much food at that time as ten now have. Further, most grasses here are annuals, and do not for several years in succession shoot up from the same root as our Swedish grasses. They must sow themselves every year, because the last year's plant dies away every autumn. The great numbers of cattle hinder this sowing, as the grass is eaten before it can produce flowers and seed. We need not therefore wonder that the grass is so thin on fields, hills and pastures in these provinces. This is likewise the reason why travellers in New Jersey, Pennsylvania and Maryland find many difficulties, especially in winter, to travel with their horses, for the grass in these provinces is not very abundant, the cattle having eaten it before it goes to seed. ...

Pehr Kalm's diary entry for 24 November 1748 (Benson 1937, pp. 184-185), describing American holly:

Holly. Holly, or *Ilex aquifolium* [*opaca*], grows in wet places, scattered in the forest, and belongs to the rare trees. ...

Pehr Kalm's diary entry for 22 January 1749 (Benson 1937, p. 238), describing Philadelphia fences:

... the fences about Philadelphia ... are made of red cedar; but it has been brought by water from Egg Harbor [New Jersey], where it grows in abundance. In the Philadelphia fences the posts stuck into the ground are made of the white cedar, or *Cupressus thyoides*, and the rails or poles which are laid between them of the red cedar or *Juniperus Virginiana*. Next to the cedar wood, oak and chestnut are reckoned best. Chestnut is commonly preferred, but it is not so plentiful as to be made into fences; in its stead they make use of several sorts of oak.

Pehr Kalm's diary entry for 17 March 1749 (Benson 1937, pp. 259-262), describing species commonly used by Native American residents of the Philadelphia area, and incidentally the impact of free-roaming pigs and other livestock on vegetation:

Hopniss or *Håpniss* was the Indian name of a wild plant, which they ate at that time. The Swedes still call it by that name and it grows in the meadows in good soil. The roots resemble potatoes, and are boiled by the Indians, who eat them instead of bread. Some of the Swedes at that time likewise ate this root for want of bread. Some of the English still eat it instead of potatoes. Mr. Bartram told me that the Indians who live farther in the country do not only eat these roots, which have as good taste as potatoes, but likewise take the peas which lie in the pods of this plant, and prepare them like common peas. Dr. Linne calls the plant *Glycine apios* [*Apios americana*].

Sagittaria. *Katniss* is another Indian name of a plant, the root of which they were also accustomed to eat, when they lived here. The Swedes still preserve this name. It grows in low, muddy and very wet ground. The root is oblong, commonly an inch and a half long, and one inch and a quarter broad in the middle; but some of the roots are as big as a man's fist. The Indians either boiled this root or roasted it in hot ashes. Some of the Swedes ate it with much relish at the time when the Indians were so near the coast; but at present none of them make any use of the roots. Nils Gustafson told me that he had often eaten these roots when he was a boy, and that he liked them very well at that time. He added that the Indians, especially the women, travelled to some islands, at about Whitsuntide, dug out the roots, and brought them home; and while they had them, they desired no other food. They were said to have been almost destroyed by hogs, which were exceedingly greedy for them. The cattle are very fond of their leaves. I afterwards got some of these roots roasted, and in my opinion they tasted good, though they were rather dry. The taste was nearly the same as that of potatoes. When the Indians come down to the coast and see the turnips of the Europeans, they likewise give them the name of *katniss*. The *katniss* is an arrow-head or *Sagittaria* [*latifolia*], and is only a variety of the Swedish arrow-head or *Sagittaria sagittifolia*, for the plant above the ground is entirely the same, while the root underground is much greater in the American than in the European variety. ...

Arum Virginicum [*Peltandra virginica*]. *Taw-ho* and *Taw-him* was the Indian name of another plant, the root of which Indians eat. Some of them likewise call it *Tuckáh*; but most of the Swedes still knew it by the name of *Taw-ho*. It grows in moist ground and swamps. Hogs are very fond of the roots, and grow very fat by feeding on them. Therefore, they often visit the [wet] places where these roots grow, and they are frequently seen rooting up the mud, and falling with their whole body into the water, so that only a little of the back part is out of the water. It is therefore very plain, that these roots must have been extirpated in places which are frequented by hogs. The

roots often grow to the thickness of a man's thigh. When they are fresh, they have a pungent taste, and are reckoned a poison in that fresh state. Nor did the Indians ever venture to eat them raw, but prepared them in the following manner: they gathered a great heap of these roots, dug a great long hole, sometimes two or three fathoms and upwards in length, into which they put the roots, and covered them with the earth that had been taken out of the hole; they made a great fire above it, which burnt till they thought proper to remove it; and then they dug up the roots and consumed them with great avidity. These roots, when prepared in this manner, I am told, taste like potatoes. The Indians never dry or preserve them, but always dig them fresh out of the marshes, when they want them. This *Taw-ho* is the *Arum Virginicum*, or Virginian wake-robin. ...

Golden Club. *Taw-kee* is another plant, so named by the Indians who eat it. Some of them call it *Taw-kim*, and others *Tackvim*. The Swedes always call it by the name of *Taw-kee*. The plant grows in marshes, near moist and low grounds, and is very plentiful in North America. The cattle, hogs and stags, are very fond of the leaves in spring; for they are some of the earliest. The leaves are broad, like those of the *Convallaria*, or the Lily of the Valley, green on the upper side, and covered with very minute hair, so that they look like fine velvet. The Indians pluck the seeds, and keep them for eating. They cannot be eaten fresh or raw, but must be dried. The Indians were forced to boil them repeatedly in water, before they were fit for use; and then they ate them like peas. When the Swedes gave them butter or milk, they boiled or broiled the seeds in it. Sometimes they employ these seeds instead of bread; and they taste like peas. Some of the Swedes likewise ate them; and the old men among them told me, they liked this food better than any of the other plants which the Indians formerly made use of. The *Taw-kee* is the *Orontium aquaticum*.

Huckleberries. Bilberries were likewise a very common dish among the Indians. They are called huckleberries by the English here, and belong to the various species of *Vaccinium*, which are all of them different from our Swedish bilberry bush, though their berries, in regard to color, shape, and taste, are so similar to the Swedish bilberry that they are with difficulty distinguished from each other. The American ones grow on shrubs, which are from two to four feet high; and there are some species which are above six feet in height. The Indians formerly plucked them in abundance every year, dried them either in the sunshine or by the fireside, and afterwards prepared them for eating in different manners. ...

Pehr Kalm's diary entry for 27 March 1749 (Benson 1937, p. 269), describing Indian corn cultivation (note: *Andropogon bicornis* L. is a tropical American species, which superficially most resembles, in the southeastern Pennsylvania native flora, *A. glomeratus*, but is typically much taller [Clayton et al. 2008]; Kalm may have been referring to *A. gerardii*, *Sorghastrum nutans* or other local members of the tribe Andropogoneae):

... After they had reaped the corn, they kept it in holes under ground during winter; they seldom dug these holes deeper than a fathom, and often not so deep; at the bottom and on the sides they put broad pieces of bark. If bark could not be had, the *Andropogon bicorne*, a grass which grows in great plenty here, and which the English call Indian grass and the Swedes wildgrass, supplied the want of the former. ...

Pehr Kalm's diary entry for 12 April 1749 (Benson 1937, pp. 279-280), describing grass management by burning (and expressing his disapproval of the practice):

Reckless Burning. The leaves which dropped last autumn had covered the ground three or four inches in depth. As this seemed to hinder the growth of the grass, it was customary to burn it in March, or at the end of that month (according to the old style), in order to give the grass the opportunity of growing up. I found several spots burnt in this manner to-day; but if it be useful one way, it does a great deal of damage in another. All the young shoots of several trees were

burnt with the dead leaves, which diminishes the wood and timber considerably; and in places where the dead leaves had been burnt for several years in succession the old trees only were left, which being cut down, there remained nothing but a large field, and without any wood. At the same time all sorts of trees and plants were consumed by the fire, or at least deprived of their power of budding. Now, a great number of the plants and most of the grasses here are annuals; their seeds fall between the leaves, and by that means are burnt. This is another cause of universal complaint that grass is much scarcer at present in the woods than it was formerly. A great number of dry and hollow trees are burnt at the same time, though they could serve as fuel in the houses, and by that means spare part of the forests. The upper mould likewise burns away in part by that means, not to mention several other inconveniences with which this burning of the dead leaves is attended. To this purpose the government of Pennsylvania has lately published an edict which prohibits this burning; but everyone does as he pleases and this prohibition meets with a general censure.

Pehr Kalm's diary entry for 17 April 1749 (Benson 1937, p. 284), describing leatherwood:

Leatherwood. The *Dirca palustris*, or moose-wood, is a little shrub which grows on hills, near swamps and marshes, and is now in full blossom. ... The bark of this shrub was used for ropes, baskets, etc. by the Indians, while they lived among the Swedes. ...

Pehr Kalm's diary entry for 20 April 1749 (Benson 1937, p. 286), apparently describing *Amelanchier canadensis*, despite the misnomers in both common and Linnaean names:

Currants. The English and Swedes of America give the name of currants to a shrub which grows in wet ground and near swamps, and which is now in blossom; its flowers are white, have a very agreeable fragrance and grow in oblong bunches; the fruit is very good eating, when it is ripe; the style is thread-shaped (*filiformis*), and shorter than the stamen; it is divided in the middle, into five parts, or stigmata. Dr. Linné calls it *Crataegus*, and Dr. Gronovius calls it a *Mespilus*.

Pehr Kalm's diary entry for 26 April 1749 (Benson 1937, pp. 288-289), describing the impact of cattle grazing on forest understories:

The Lupine. The *Lupinus perennis* is abundant in the woods, and grows equally well in good soil and in poor. I often found it thriving on very poor sandy fields, and on heaths, where no other plants will grow. Its flowers, which commonly appear in the middle of May, make a fine show by their purple hue. I was told, that the cattle eat these flowers very greedily; but I was sorry to find very often that they were not so fond of it, as it is represented, especially when they had anything else to eat; and they seldom touched it notwithstanding its fine green color and its softness. The horses eat the flowers, but leave the stalks and leaves. If ever the cattle eat this plant in spring it is because of necessity and hunger, which give it a relish. This country does not afford any green pastures like the Swedish ones; the woods are the places where the cattle must collect their food. The ground in the woods is quite even with gently rising knolls. The trees stand far apart, but the ground between them is not covered with greensod, for there are but few kinds of grass in the woods, and the blades of it stand single and scattered. The soil is very loose, partly owing to the dead leaves which cover the ground during a great part of the year. Thus the cattle find very little grass in the forests and are forced to be satisfied with all kinds of plants which come in their way, whether they be good or bad food. I saw all spring long how the cattle bit off the tops and shoots of young trees and ate them; for no plants had come up and they stood in general but very thin, scattered here and there, as I have just mentioned. Hence you may easily imagine that hunger compels the cattle to eat plants which they would not touch, were they better provided for. However, I am of the opinion that it would be worth while to make use of this lupine to improve dry sandy heaths, and, I believe, it would not be absolutely impossible to find out the means of making it agreeable to the cattle.

Pehr Kalm's diary entry for 1 May 1749 (Benson 1937, p. 291), describing Indian paintbrush:

The Bartsia [Castilleja] coccinea grew in great abundance on several low meadows. Its flower buds were already tinged with a beautiful scarlet which adorned the meadows. ...

Pehr Kalm's diary entry for 1 May 1749 (Benson 1937, p. 292), describing sweetgum:

Sweet Gum Tree. The *Liquidambar styraciflua*, or sweet gum tree, grows in the woods, especially in wet soil, in and near pools. ... This tree grows to a great thickness, and its height rivals that of the tallest firs and oaks. As it grows higher, the lower branches die and drop, and leave the trunk smooth and straight, with a great crown at the very summit. The seeds are contained in round, dentated cones, which drop in autumn. It is therefore not particularly pleasant to dance barefooted under these trees. ...

Pehr Kalm's diary entry for 4 May 1749 (Benson 1937, pp. 294-295), describing crabapple:

The Crab Apple. Crab trees are a species of wild apple trees, which grow in the woods and glades, but especially on little hillocks, near rivers. In New Jersey the tree is rather scarce; but in Pennsylvania it is plentiful. ...

Pehr Kalm's diary entry for 5 May 1749 (Benson 1937, pp. 296), describing azalea (the significance of this passage is in showing that Kalm's earlier use of the name *Azalea lutea* did not refer to its usual synonym, *Rhododendron calendulaceum*, but was almost certainly a misidentification of the much more common *R. periclymenoides*):

Wild Honeysuckle. The mayflowers, as the Swedes call them, were plentiful in the woods wherever I went to-day; especially on a dry soil, or one that is somewhat moist. The Swedes have given them this name, because they are in full blossom in May. Some of the Swedes and the Dutch call them *Pinxterbloem* (Whitsunday flowers), as they really are in blossom about Whitsuntide. The English call them wild honeysuckle, and at a distance they have some similarity to the honeysuckle or *Lonicera*. Dr. Linné and other botanists call it an *Azalea*. Its flowers were now open, and added a new ornament to the woods, being little inferior to the flowers of the honeysuckle and *Hedysarum*. They are arranged in a circle round the stem's extremity, and have either a dark red or a light red color; but, by standing for some time the sun bleaches them, and at last they become whitish. I know not why Colden calls them yellow. The height of the bushes is not always the same. Some are as tall as a full grown man, and taller, others but low, and some are not above a palm from the ground, though all full of flowers. The people have not yet found that this plant may be applied to any practical use; they only gather the flowers and put them in pots, because they are so beautiful. ...

Pehr Kalm's diary entry for 5 May 1749 (Benson 1937, pp. 298-300), describing Atlantic white-cedar swamps:

"White Cedar." A tree which grows in the swamps here, and in other parts of America, goes by the name of the white juniper tree. ... It always grows in wet ground or swamps: it is therefore difficult to get to it, because the ground between the little hillocks is full of water. The trees stand both on the hillocks and in the water: they grow very close together, and have straight, thick and tall trunks; but their numbers have been greatly reduced. In places where they are left to grow up, they grow as tall and as thick as the tallest fir trees. ...

Its Habitat and Uses. The marshes where these trees grow are called cedar swamps, which are numerous in New Jersey, and likewise in some parts of Pennsylvania and New York. ... the inhabitants here, are not only lessening the number of these trees, but are even extirpating them entirely. People are here (and in many other places) in regard to wood, bent only upon their own present advantage, utterly regardless of posterity. By these means many swamps are already quite

destitute of cedars, having only young shoots left; and I plainly observed by counting the circles of the trunk [tree rings], that they do not grow up very quickly, but require a great deal of time before they can be cut for timber. It is well known that a tree gets only one circle every year; a trunk eighteen inches in diameter, had one hundred and eight circles round the thicker end; another seventeen inches in diameter, had a hundred and sixteen; and another, two feet in diameter had one hundred and forty-two circles upon it. Thus nearly eighty years of growth is required before a white cedar raised from seed can be used for timber.

Pehr Kalm's diary entry for 6 May 1749 (Benson 1937, pp. 304), describing greenbrier:

Smilax laurifolia [*rotundifolia*] was superabundant in all the swamps near this place. Its leaves were now beginning to come out, for it sheds them all every winter. It climbs up along trees and shrubs, and runs across from one tree or bush to another. By this means it shuts up the passage between the trees, fastening itself everywhere with its cirrhi or tendrils, so that it is with the utmost difficulty one can force a passage in the swamps and woods where it is plentiful. The stalk towards the bottom is full of long spines, which are as strong as those of a rosebush. They catch hold of clothes and tear them. This troublesome plant may sometimes bring you into imminent danger when botanizing or going into the woods, for, not to mention that one's clothes must be absolutely ruined by its numberless spines, it occasions a deep shade in the woods, by crossing from tree to tree so often. This forces you to stoop, and even to creep on all fours through the little passages which are left close to the ground, and then you cannot be careful enough to prevent a snake (of which there are large numbers here) from darting into your face. The stalk of the plant is the same color as that of young rosebushes. It is green and smooth between the spines, so that a stranger might take it to be a kind of thorn in winter, when the leaves are gone. It is therefore called "green thorn" by the Swedes.

Pehr Kalm's diary entry for 28 May 1749 (Benson 1937, pp. 319), describing sheep-laurel:

Dwarf Laurel. The *Kalmia angustifolia* was now everywhere in flower. It grows chiefly on sandy heaths, or on dry poor grounds, where few other plants thrive; it is common in Pennsylvania, but particularly in New Jersey and the province of New York; it is scarce in Canada ...

Pehr Kalm's diary entry for 26 November 1749 (Benson 1937, pp. 642), recounting a conversation with John Bartram about wild rice:

Fol. Avoine. When I talked with him about *Fol. avoine* (*Zizania aquatica*, Indian rice), he told me he thought this to be that tall, thick grass which grows here in brooks and other bodies of water and has long, grain-bearing seeds. The Indians had formerly gathered these seeds for food. Now they are eaten by a bird which is described and pictured in Catesby's Ornithology and is called the ricebird (bobolink). ...

John Harshberger's description of "primeval" forest types and comments on early colonial era natural meadows, 1904

Background

Dr. John William Harshberger (1869–1929), professor of botany at the University of Pennsylvania from 1893 until his death in 1929, had a strong interest in geology, ecology, and biogeography, unlike most of his predecessors in the position back to Dr. Adam Kuhn (1741–1817), the first botany professor in America (Harshberger 1899), whose primary field was medicine and whose interest in botany was chiefly utilitarian.

“Primeval” remnants of “mixed-deciduous-forest formation”

Part of John Harshberger’s “phyto-geographic sketch” introducing his description of the prevailing forest species composition (Harshberger 1904, p. 141; see Appendix A):

Originally the forest covered most of the surface of southeast Pennsylvania. In some places, notably on the Wissahickon creek within the confines of Fairmount Park and in areas on Crum creek, the primeval forest still remains. Mr. J. Howard Lewis, Sr., and his progenitors have preserved inviolate a large tract of timber along Crum creek, which the surrounding country settled by patent in 1681 and 1682 has been cleared of its timber for many years. A study of such preserves shows the character of the original forest. ...

Harshberger listed 175 species of vascular plants as characteristic of the “primeval” remnants of the “mixed-deciduous-forest formation” in extreme southeastern Pennsylvania (Table 1). Several of these are now on the list of species of special conservation concern in the state:

- *Amelanchier canadensis*, coastal plain shadbush—TU
- *Commelina virginica*, Virginia dayflower—PX
- *Cypripedium parviflorum* var. *parviflorum*, yellow lady’s-slipper—PE
- *Quercus falcata*, southern red oak—PE
- *Ranunculus fascicularis*, early buttercup—PE
- *Scutellaria serrata*, showy skullcap—PE

One of the most remarkable things about Harshberger’s list is that it includes only five nonnative species (*Commelina communis*, Asiatic dayflower; *Lysimachia nummularia*, creeping-charlie; *Ornithogalum umbellatum*, star-of-Bethlehem; *Barbarea vulgaris*, common wintercress; and *Ranunculus ficaria*, lesser celandine).

Table 1. John Harshberger’s list of vascular plant species of “primeval” forest remnants (Harshberger 1904, pp. 143-146; see Appendix A). The nomenclature has been updated to conform with Rhoads and Block (2007). Harshberger’s classification of the species into seven growth-form categories is preserved.

species	common name(s)	Harshberger’s notes on distribution
DOMINANT TREES		
<i>Acer negundo</i>	box-elder	along the banks of streams
<i>Acer rubrum</i>	red maple, swamp maple	along the banks of streams
<i>Acer saccharinum</i>	silver maple	
<i>Acer saccharum</i>	sugar maple, rock maple	
<i>Betula nigra</i>	river birch	along the banks of streams
<i>Carpinus caroliniana</i>	American hornbeam, ironwood	along the banks of streams
<i>Carya glabra</i>	pignut hickory	
<i>Carya ovata</i>	shagbark hickory	
<i>Castanea dentata</i>	American chestnut	
<i>Celtis occidentalis</i>	hackberry, sugarberry	
<i>Diospyros virginiana</i>	persimmon	
<i>Fagus grandifolia</i>	American beech	along the banks of streams
<i>Fraxinus americana</i>	green ash, red ash	

species	common name(s)	Harshberger's notes on distribution
<i>Juglans cinerea</i>	butternut	
<i>Juglans nigra</i>	black walnut	
<i>Juniperus virginiana</i>	eastern red-cedar	barren places and rocky outcrops
<i>Liquidambar styraciflua</i>	sweetgum	
<i>Liriodendron tulipifera</i>	tuliptree, yellow-poplar	
<i>Ostrya virginiana</i>	hop-hornbeam	
<i>Platanus occidentalis</i>	American sycamore, buttonwood, planetree	along the banks of streams
<i>Prunus pensylvanica</i>	pin cherry, fire cherry	
<i>Quercus alba</i>	white oak	
<i>Quercus coccinea</i>	scarlet oak	
<i>Quercus falcata</i>	southern red oak	
<i>Quercus montana</i>	chestnut oak	
<i>Quercus palustris</i>	pin oak	along the banks of streams
<i>Quercus rubra</i>	northern red oak	
<i>Salix nigra</i>	black willow	along the banks of streams
<i>Sassafras albidum</i>	sassafras	along the banks of streams
<i>Ulmus americana</i>	American elm, white elm	

SECONDARY TREE SPECIES

<i>Acer pensylvanicum</i>	moosewood, striped maple	
<i>Amelanchier canadensis</i>	coastal plain shadbush	
<i>Cercis canadensis</i>	redbud, Judas-tree	
<i>Cornus florida</i>	flowering dogwood	
<i>Corylus americana</i>	American filbert, hazelnut	
<i>Hamamelis virginiana</i>	witch-hazel	
<i>Morus rubra</i>	red mulberry	
<i>Staphylea trifolia</i>	bladdernut	

SHRUBS

<i>Alnus serrulata</i>	smooth alder	
<i>Euonymus americanus</i>	hearts-a-bursting, strawberry-bush	
<i>Euonymus atropurpureus</i>	wahoo	
<i>Gaylussacia baccata</i>	black huckleberry	drier forest soils
<i>Kalmia latifolia</i>	mountain-laurel	drier forest soils
<i>Lindera benzoin</i>	spicebush	
<i>Rhododendron periclymenoides</i>	pinxter-flower	
<i>Sambucus canadensis</i>	American elder	open thickets on alluvial soil
<i>Vaccinium stamineum</i>	deerberry	drier forest soils

species	common name(s)	Harshberger's notes on distribution
<i>Viburnum acerifolium</i>	maple-leaved viburnum	
<i>Viburnum dentatum</i>	southern arrow-wood	
<i>Viburnum prunifolium</i>	black-haw	
LIANAS		
<i>Celastrus scandens</i>	American bittersweet	
<i>Parthenocissus quinquefolia</i>	Virginia-creeper, woodbine	
<i>Smilax glauca</i>	catbrier, cat-greenbrier	
<i>Smilax rotundifolia</i>	common greenbrier, bullbrier	
<i>Toxicodendron radicans</i>	poison-ivy	
<i>Vitis aestivalis</i>	summer grape, pigeon grape	
<i>Vitis labrusca</i>	fox grape	
<i>Vitis riparia</i>	frost grape	
<i>Vitis vulpina</i>	frost grape	
HERBACEOUS VINES		
<i>Dioscorea villosa</i>	wild yam, colic-root	along streams
<i>Echinocystis lobata</i>	prickly cucumber, wild balsam-apple	along streams
<i>Menispermum canadense</i>	moonseed	along streams
<i>Sicyos angulatus</i>	bur cucumber	along streams
HERBACEOUS FOREST-FLOOR PLANTS OFTEN OCCURRING IN PATCHES		
<i>Adiantum pedatum</i>	northern maidenhair	
<i>Aquilegia canadensis</i>	wild columbine	rocky outcrops in the woods
<i>Asarum canadense</i>	wild ginger	
<i>Asplenium rhizophyllum</i>	walking fern	rocky outcrops in the woods; rare in the region
<i>Caulophyllum thalictroides</i>	blue cohosh	
<i>Claytonia virginica</i>	spring-beauty	
<i>Commelina nudiflora</i> [<i>C. communis</i> misidentified?]	Asiatic dayflower	along streams in the woods
<i>Commelina virginica</i>	Virginia dayflower	along streams in the woods
<i>Dicentra cucullaria</i>	Dutchman's-breeches	
<i>Dryopteris carthusiana</i>	spinulose wood fern	
<i>Dryopteris marginalis</i>	marginal wood fern	
<i>Epifagus virginiana</i>	beechdrops	along streams in the woods
<i>Epigaea repens</i>	trailing-arbutus	
<i>Erythronium americanum</i>	yellow trout-lily	
<i>Eutrochium purpureum</i>	joe-pye-weed	along streams in the woods
<i>Floerkea proserpinacoides</i>	false-mermaid	along streams in the woods
<i>Gaultheria procumbens</i>	teaberry, checkerberry wintergreen	

species	common name(s)	Harshberger's notes on distribution
<i>Heracleum lanatum</i>	cow-parsnip	along streams in the woods
<i>Heuchera americana</i>	alum-root	rocky outcrops in the woods
<i>Hybanthus concolor</i>	green violet	
<i>Hydrophyllum virginianum</i>	Virginia waterleaf	
<i>Impatiens capensis</i>	jewelweed, spotted touch-me-not	along streams in the woods
<i>Impatiens pallida</i>	pale jewelweed, pale touch-me-not	along streams in the woods
<i>Lobelia cardinalis</i>	cardinal-flower	along streams in the woods
<i>Lysimachia nummularia</i>	creeping-charlie, moneywort	along streams in the woods
<i>Mertensia virginica</i>	Virginia bluebell, Virginia cowslip	
<i>Ornithogalum umbellatum</i>	star-of-Bethlehem	along streams in the woods
<i>Pedicularis canadensis</i>	forest lousewort, wood-betony	
<i>Phegopteris hexagonoptera</i>	broad beech fern	
<i>Pilea pumila</i>	clearweed, coolwort, richweed	along streams in the woods
<i>Podophyllum peltatum</i>	mayapple, mandrake	
<i>Polemonium reptans</i>	spreading Jacob's-ladder	along streams in the woods
<i>Polypodium virginianum</i>	common polypody, rockcap	rocky outcrops in the woods
<i>Polystichum acrostichoides</i>	Christmas fern	
<i>Saxifraga virginiana</i>	early saxifrage	rocky outcrops in the woods
<i>Thalictrum dioicum</i>	early meadow-rue	
<i>Thalictrum pubescens</i>	tall meadow-rue	along streams in the woods
<i>Tradescantia virginiana</i>	spiderwort, widow's-tears	
<i>Triosteum perfoliatum</i>	horse-gentian	
<i>Valerianella chenopodiifolia</i>	goose-foot corn-salad	along streams in the woods

HERBACEOUS FOREST-FLOOR PLANTS USUALLY OCCURRING SPARSELY

<i>Actaea racemosa</i>	black snakeroot, black cohosh
<i>Allium tricoccum</i>	ramp, wild leek
<i>Anemone americana</i>	liverleaf
<i>Aralia nudicaulis</i>	wild sarsaparilla
<i>Arisaema dracontium</i>	green-dragon
<i>Arisaema triphyllum</i>	jack-in-the-pulpit
<i>Barbarea vulgaris</i>	common wintercress, yellow rocket
<i>Botrychium virginianum</i>	rattlesnake fern
<i>Cardamine concatenata</i>	toothwort
<i>Carex pensylvanica</i>	Pennsylvania sedge
<i>Chelone glabra</i>	turtlehead
<i>Chimaphila maculata</i>	pipsissewa, spotted wintergreen

species	common name(s)	Harshberger's notes on distribution
<i>Collinsonia canadensis</i>	horse balm, stoneroot	
<i>Corallorhiza odontorhiza</i>	autumn coralroot, small-flowered coralroot	
<i>Cynoglossum virginianum</i>	wild comfrey	
<i>Cypripedium acaule</i>	pink lady's-slipper, pink moccasin-flower	
<i>Cypripedium parviflorum</i> var. <i>parviflorum</i>	yellow lady's-slipper, yellow moccasin flower	rare in the region
<i>Cypripedium parviflorum</i> var. <i>pubescens</i>	large yellow lady's-slipper, large yellow moccasin-flower	rare in the region
<i>Dichanthelium dichotomum</i>	forked panic grass	
<i>Dichanthelium microcarpon</i>	small-fruited panic grass	
<i>Erigeron pulchellus</i>	robin's-plantain	
<i>Eurybia macrophylla</i>	bigleaf aster	
<i>Galearis spectabilis</i>	showy orchis	rare in the region
<i>Galium aparine</i>	bedstraw, cleavers, goosegrass	
<i>Galium triflorum</i>	sweet-scented bedstraw	
<i>Geranium maculatum</i>	wood geranium	
<i>Geranium maculatum</i>	wood geranium	
<i>Hieracium gronovii</i>	queendevil	
<i>Hieracium scabrum</i>	rough hawkweed	
<i>Hieracium venosum</i>	rattlesnake-weed	
<i>Hydrastis canadensis</i>	goldenseal	rare in the region
<i>Hypoxis hirsuta</i>	yellow star-grass	
<i>Laportea canadensis</i>	wood-nettle	
<i>Lilium canadense</i>	Canada lily	
<i>Liparis liliifolia</i>	lily-leaved twayblade	rare in the region
<i>Lobelia siphilitica</i>	great blue lobelia	
<i>Luzula multiflora</i>	field woodrush	
<i>Maianthemum racemosum</i>	false Solomon's-seal, Solomon's-plume	
<i>Medeola virginiana</i>	Indian cucumber-root	
<i>Mitella diphylla</i>	bishop's-cap, miterwort	
<i>Monotropa uniflora</i>	Indian-pipe	
<i>Orobanche uniflora</i>	broom-rape, cancer-root	
<i>Osmorhiza longistylis</i>	anise root	
<i>Oxalis stricta</i>	common yellow wood-sorrel	
<i>Oxalis violacea</i>	violet wood-sorrel	
<i>Panax trifolius</i>	dwarf ginseng	
<i>Phryma leptostachya</i>	lopseed	
<i>Polygonatum biflorum</i>	Solomon's-seal	
<i>Prunella vulgaris</i>	heal-all, self-heal	

species	common name(s)	Harshberger's notes on distribution
<i>Pyrola americana</i>	wild lily-of-the-valley	
<i>Ranunculus abortivus</i>	small-flowered crowfoot	
<i>Ranunculus fascicularis</i>	early buttercup, tufted buttercup	
<i>Ranunculus ficaria</i>	lesser celandine, pilewort	
<i>Sanguinaria canadensis</i>	bloodroot, red puccoon	
<i>Scutellaria serrata</i>	showy skullcap	
<i>Silene stellata</i>	starry campion	
<i>Smilax herbacea</i>	carrion-flower	
<i>Solidago bicolor</i>	silver-rod, white goldenrod	
<i>Solidago caesia</i>	bluestem goldenrod, wreath goldenrod	
<i>Symphyotrichum laeve</i>	smooth blue aster	
<i>Thalictrum thalictroides</i>	rue anemone, windflower	
<i>Thaspium trifoliatum</i>	meadow-parsnip	
<i>Tiarella cordifolia</i>	foamflower	
<i>Trientalis borealis</i>	star-flower	
<i>Uvularia grandiflora</i>	large-flowered bellwort	
<i>Uvularia perfoliata</i>	bellwort	
<i>Uvularia sessilifolia</i>	sessile-leaved bellwort	
<i>Viola blanda</i>	sweet white violet	
<i>Viola labradorica</i>	American dog violet	
<i>Viola palmata</i>	early blue violet	
<i>Viola pedata</i>	birdfoot violet	
<i>Viola pubescens</i>	downy yellow violet	
<i>Viola villosa</i> [<i>V. hirsutula</i> misidentified?]	southern wood violet	

“Hemlock formation”

Part of John Harshberger's “phyto-geographic sketch” describing eastern hemlock forest stands (Harshberger 1904, pp. 149-150; see Appendix A):

This formation occurs on the sloping hillsides and precipitous banks of streams and is developed notably on Wissahickon and Crum creeks. ... The forest of hemlocks consists in a few places of a pure growth without the admixture of any other tree species, but usually associated with the hemlock, *Tsuga Canadensis* (L.) Carr. the botanist finds the beech, *Fagus Americana* and red maple, *Acer rubrum*. ... On the floor of the forest in places *Lycopodium lucidulum* Michx. [*Huperzia lucidula*] forms an association (*Lycopodium* association). The laurel, *Kalmia latifolia* L., occurs in the drier soils and forms a thicket (*Kalmia* association). *Mitchella repens* L. carpets the ground (*Mitchella* association) and *Viola rotundifolia* Michx. is a character-plant with which grows *Peramium* [*Goodyera*] *pubescens* (Willd.) MacM., *Cinna latifolia* (Trev.) Griseb., *Hieracium paniculatum* L., and in late summer *Aster divaricatus* L. [*Eurybia divaricata*]. In many places, the hemlock, *Tsuga Canadensis*, forms an element in the mixed-deciduous-forest

formation. When such is the case, it is found in isolated patches usually of a few trees near the water-courses on steep hillsides. It forms then an association (*Tsuga* association) and with *Lycopodium lucidulum* [*Huperzia lucidula*] are found three other species, viz., *Lycopodium annotinum* L., *L. clavatum* L., and *L. obscurum* L. (*L. dendroideum* Michx.), which grow near the hemlocks. ...

Lack of data on the species composition of early colonial era “open glades and natural meadows”

Part of John Harshberger’s “phyto-geographic sketch” introducing a section on the flora of uncultivated fields (Harshberger 1904, p. 151; see Appendix A):

From early historic accounts of the region, the original forest was interspersed with open glades and natural meadows where for some edaphic reason the trees did not grow. These areas (such as we have left in the “Indian clearing” near Lima, Delaware County, and in the Playwicky clearing in Bucks County) were settled upon first, and with the exception of the areas above mentioned [under “serpentine-barren treeless formation”] we have no natural openings that have not been altered by the hand of man. The botanist, therefore, has no data upon which to base a statement of the plant covering of such open, treeless areas.

Part 2. Present-day reference sites

A few remnants of intact native vegetation in Pennsylvania's Atlantic coastal plain and the band of the Piedmont adjoining the Fall Line provide further evidence of the composition of pre-European-settlement plant communities. They harbor native species that were overlooked by Pehr Kalm and John Harshberger and they may give clues, notoriously missing from most historical records, about the relative abundances of species. Most such sites are in lower Bucks County, with a few in Philadelphia and Delaware Counties. Reference sites are invaluable in reconstructing historical vegetation as a basis for ecosystem restoration. They also are the best remaining source for local genotypes of native species. Richness of rare species is a hallmark of a good reference site; the number and abundance of species that are rare or declining in the region are rough measures of "ecosystem integrity" or relative lack of catastrophic change resulting from 350 years of post-European-settlement influences. The following list is not exhaustive, but it includes many of the best remaining fragments of intact native vegetation in extreme southeastern Pennsylvania (see also *Part 3, Tinicum Marsh and freshwater intertidal marshes*, below).

Black Ditch County Park

Source: Rhoads and Block 1999, p. 21

Location: Bristol Township, Bucks County

Communities:

- sweetgum–oak coastal plain forest
- coastal plain mesic meadow

Plant species of special concern:

- bushy broomsedge (*Andropogon glomeratus*)
- coastal plain joe-pye-weed (*Eutrochium dubium*)
- Virginia-willow (*Itea virginica*)
- willow oak (*Quercus phellos*)
- southern red oak (*Quercus falcata*)
- Maryland meadow-beauty (*Rhexia mariana*)

Delhaas Woods, in Silver Lake Park (a county park)

Source: Rhoads and Block 1999, pp. 23-24

Location: Bristol Township, Bucks County

Communities:

- sweetgum–oak coastal plain forest
- coastal plain mesic meadow
- red maple–magnolia coastal plain palustrine forest
- red maple–highbush blueberry palustrine woodland
- coastal plain sphagnum bog (including 14 *Sphagnum* species)

Plant species of special concern:

- bushy broomsedge (*Andropogon glomeratus*)
- Bull's sedge (*Carex bullata*)

- slender sea-oats (*Chasmanthium laxum*)
- capitate spike-rush (*Eleocharis olivacea*)
- round-leaved eupatorium (*Eupatorium rotundifolium*)
- coastal plain joe-pye-weed (*Eutrochium dubium*)
- golden pert (*Gratiola aurea*)
- swamp dog-hobble (*Leucothoe racemosa*)
- sweetbay magnolia (*Magnolia virginiana*)
- long-leaved panic grass (*Panicum longifolium*)
- Easton's witchgrass (*Panicum spretum*)
- spotted pondweed (*Potamogeton pulcher*)
- willow oak (*Quercus phellos*)
- Maryland meadow-beauty (*Rhexia mariana*)
- eastern blue-eyed-grass (*Sisyrinchium atlanticum*)
- long-leaved aster (*Symphotrichum novi-belgii*)
- possumhaw (*Viburnum nudum*)
- coast violet (*Viola brittoniana*)
- netted chain fern (*Woodwardia areolata*)

Five Mile Woods (a county park)

Source: Rhoads and Block 1999, p. 25

Location: Lower Makefield Township and Falls Township, Bucks County

Communities:

- sweetgum–oak coastal plain forest
- bottomland oak–hardwood palustrine forest
- vernal pond

Plant species of special concern:

- bushy broomsedge (*Andropogon glomeratus*)
- round-leaved eupatorium (*Eupatorium rotundifolium*)
- soapwort gentian (*Gentiana saponaria*)
- grass-leaved rush (*Juncus biflorus*)
- swamp dog-hobble (*Leucothoe racemosa*)
- crane-fly orchid (*Tipularia discolor*)
- possumhaw (*Viburnum nudum*)

Neshaminy State Park

Source: Rhoads and Block 1999, p. 28

Location: Bensalem Township and Bristol Township, Bucks County

Communities:

- freshwater tidal marsh (see *Part 3, Tinicum Marsh and freshwater intertidal marshes*, below)
- black willow scrub/shrub wetland
- sweetgum–oak coastal plain forest
- sand plain grassland

Plant species of special concern:

- swamp beggar's-ticks (*Bidens bidentoides*)

- smartweed dodder (*Cuscuta polygonorum*)
- Walter's barnyard grass (*Echinochloa walteri*)
- little-spike spike-rush (*Eleocharis parvula*)
- round-leaved eupatorium (*Eupatorium rotundifolium*)
- American holly (*Ilex opaca*)
- sand jointweed (*Polygonella articulata*)
- willow oak (*Quercus phellos*)
- long-lobed arrowhead (*Sagittaria calycina*)
- subulate arrowhead (*Sagittaria subulata*)
- wild bean (*Strophostyles umbellata*)
- purple sand-grass (*Triplasis purpurea*)
- wild rice (*Zizania aquatica*)

Snipes Woods (privately owned)

Source: Rhoads and Block 1999, p. 50

Location: Falls Township, Bucks County

Communities:

- sweetgum–oak coastal plain forest (with abundant sweet pepperbush, *Clethra alnifolia*)
- red maple–magnolia coastal plain palustrine forest

Plant species of special concern:

- white fringe-tree (*Chionanthus virginicus*)
- round-leaved eupatorium (*Eupatorium rotundifolium*)
- swamp dog-hobble (*Leucothoe racemosa*)
- foxtail clubmoss (*Lycopodiella alopecuroides*)
- sweetbay magnolia (*Magnolia virginiana*)
- willow oak (*Quercus phellos*)
- netted chain fern (*Woodwardia areolata*)

Rohm and Haas Woods (privately owned)

Source: Rhoads and Block 1999, p. 33; unpublished data, Natural Lands Trust

Location: Bristol Township, Bucks County

Communities:

- sweetgum–oak coastal plain forest
- red maple–magnolia coastal plain palustrine forest (with abundant sweet pepperbush, *Clethra alnifolia*)
- cat-tail marsh
- pickerel-weed–arrow-arum–arrowhead wetland
- coastal plain mesic meadow
- freshwater tidal marsh (see *Part 3, Tinicum Marsh and freshwater intertidal marshes*, below)

Plant species of special concern:

- coastal plain shadbush (*Amelanchier canadensis*)
- slender sea-oats (*Chasmanthium laxum*)
- round-leaved eupatorium (*Eupatorium rotundifolium*)
- forked rush (*Juncus dichotomus*)

- swamp dog-hobble (*Leucothoe racemosa*)
- southern bog clubmoss (*Lycopodiella appressa*)
- sweetbay magnolia (*Magnolia virginiana*)
- willow oak (*Quercus phellos*)
- subulate arrowhead (*Sagittaria subulata*)
- eastern blue-eyed-grass (*Sisyrinchium atlanticum*)
- possumhaw (*Viburnum nudum*)
- coast violet (*Viola brittoniana*)
- netted chain fern (*Woodwardia areolata*)
- wild rice (*Zizania aquatica*)

Martin Forest, in Smedley Park (a county park)

Source: Latham et al. 2003, pp. 19, 22-23, 57-58, 100-101

Location: Springfield Township, Delaware County (owned and leased to Delaware County by Swarthmore College)

Communities:

- hemlock (white pine)–red oak–mixed hardwood forest (old-growth)
- tuliptree–beech–maple forest (old-growth)

Note: This is one of the “primeval” forest sites that John Harshberger wrote about in his 1904 “phyto-geographic sketch of extreme southeastern Pennsylvania” (Harshberger 1904; see pp. 18-25, above).

Crum Woods, on the campus of Swarthmore College

Source: Latham et al. 2003, pp. 21-23, 57-58, 61-62, 91-92, 96-100

Location: Nether Providence Township and Borough of Swarthmore, Delaware County

Communities:

- dry oak–heath forest (mature; includes native stands of chestnut oak, *Quercus montana*)
- dry oak–mixed hardwood forest (mature)
- red oak–mixed hardwood forest (mature)
- tuliptree–beech–maple forest (mature)
- sycamore–(river birch)–boxelder floodplain forest/woodland
- red maple–mixed shrub palustrine woodland (includes native stands of honeylocust, *Gleditsia triacanthos*, balsam poplar, *Populus balsamifera*)

Plant species of special concern:

- buttonbush dodder (*Cuscuta cephalanthii*; historical record)
- southern red oak (*Quercus falcata*)
- New York aster (*Symphyotrichum novae-belgii*; historical record)
- tawny ironweed (*Vernonia glauca*; historical record)

Native grassland, in a township park

Source: unpublished data, Natural Lands Trust

Location: confidential; 10 miles from the center of Philadelphia, overlying Wissahickon schist

Communities:

- oligotrophic grassland

Plant species of special concern:

- Elliott's beardgrass (*Andropogon gyrans*)
- white thoroughwort (*Eupatorium album*)
- little ladies'-tresses (*Spiranthes tuberosa*)

Pink Hill, in the John J. Tyler Arboretum

Source: Latham 2008, pp. 7-22

Location: Middletown Township, Delaware County

Communities:

- serpentine grassland
- serpentine gravel-forb community

Plant species of special concern:

- colic-root (*Aletris farinosa*; historical record)
- arrow-feather three-awn (*Aristida purpurascens*)
- Indian paintbrush (*Castilleja coccinea*; historical record)
- annulus panic grass (*Dichantherium annulum*; historical record)
- Heller's witchgrass (*Dichantherium oligosanthes*)
- annual fimbry (*Fimbristylis annua*; historical record)
- soapwort gentian (*Gentiana saponaria*; historical record)
- Appalachian groundsel (*Packera anonyma*)
- showy skullcap (*Scutellaria serrata*; historical record)
- spring ladies'-tresses (*Spiranthes vernalis*; historical record)
- serpentine aster (*Symphyotrichum depauperatum*)

Johnsons Corner Woods (privately owned)

Source: Davis et al. 1992, pp. 80-81

Location: Bethel Township and Concord Township, Delaware County

Communities:

- sweetgum-oak coastal plain forest
- oligotrophic grassland
- coastal plain sphagnous bog(?)

Plant species of special concern:

- 5 species mentioned but not listed in Davis et al. 1992

Part 3. Tinicum Marsh and freshwater intertidal marshes

Historical extent of the wetlands at Tinicum

Background

There can be little doubt that, at around the time of European contact, the most salient non-matrix vegetation feature in what is now southeastern Pennsylvania was Tinicum Marsh. Historically it was probably the largest wetland complex in unglaciated Pennsylvania. Despite its enormous size, little has been found in writing about it from the colonial period. It was undoubtedly a seasonal Mecca for Lenape and earlier Native American residents, who would have found waterfowl and other food resources in great plenty; however, little pertinent archaeological evidence has been found to date (A. D. Marble & Company 2004), in all probability because the site has been so thoroughly disturbed by post-European-settlement sedimentation, diking, deliberate filling, waste disposal, borrow-pit excavation, and major construction projects including shipyards, residential neighborhoods, the Philadelphia International Airport, and I-95. The name Tinicum is shortened from the Lenape *matennekonk* or *matinicum*, “at the island” (Donehoo 1928). It originally referred to a settlement on the westernmost of a group of islands within the Tinicum Marsh complex, the site of the original Swedish and later, Dutch, seat of colonial government; with the filling of tidal marshes over the last 350 years this island is now continuous with the mainland and covered by the towns of Essington and Lester (formerly Corbindale).

U.S. Geological Survey maps, 1898

The earliest relatively accurate map of the full extent of wetlands at Tinicum may be the 15¹/₂-minute U.S. Geological Survey topographic quadrangles “Chester, Pennsylvania and New Jersey” and “Philadelphia, Pennsylvania and New Jersey,” both published in 1898 (see Figure 1). An estimate of the total area at Tinicum of contiguous tidal and non-tidal wetlands from these maps is 6,000–7,000 acres, roughly 1,500–2,000 acres of which was shown on the map as tidal marsh.

Thomas Holme’s survey map of the Province of Pennsylvania, 1687

A 1687 survey map of the entire province of Pennsylvania by Thomas Holme shows a substantially larger area—perhaps 11,000 acres—of contiguous wetlands around the confluence of the Schuylkill River with the Delaware, including the marshes around Tinicum and about half of present-day South Philadelphia (Holme 1687). The discrepancy between this map and the U.S. Geological Survey maps is probably due to some combination of a lower level of accuracy in the earlier map and the extent by 1898 of ditching, draining, diking, and filling in with soil and rock from building-site excavations, river dredge spoil, ships’ ballast, and other sources.



Figure 1. The Tincum Marsh area in 1898 (portions of the 15½-minute topographic quadrangles "Chester, Pennsylvania and New Jersey" and "Philadelphia, Pennsylvania and New Jersey," U.S. Geological Survey, Washington, D.C.)

Table 2. Vascular plant species verified historically at Tinicum Marsh and now of special conservation concern in Pennsylvania

taxon	PABS status	collection date	Rhoads and Block (2007) common name(s)	U.S.D.A. PLANTS database common name	family
<i>Chamaecyparis thyoides</i>	PX	?	Atlantic white-cedar	Atlantic white cedar	Cupressaceae
<i>Agalinis paupercula</i>	PE	1900	small-flowered false-foxglove	smallflower false foxglove	Orobanchaceae
<i>Aletris farinosa</i>	PE	1902	colic-root	white colicroot	Melanthiaceae
<i>Carex bullata</i>	PE	1903	bull sedge	button sedge	Cyperaceae
<i>Dichanthelium scoparium</i>	PE	1899, 1901	velvety panic grass	velvet panicum	Poaceae
<i>Gentiana saponaria</i>	PE	1864, 1866	soapwort gentian	harvestbells	Gentianaceae
<i>Juncus scirpoides</i>	PE	1866	sedge rush, scirpus-like rush	needlepod rush	Juncaceae
<i>Panicum longifolium</i>	PE	1902	long-leaved panic grass	redtop panicgrass (<i>P. rigidulum</i> var. <i>pubescens</i>)	Poaceae
<i>Quercus falcata</i>	PE	1903	southern red oak	southern red oak	Fagaceae
<i>Scleria muhlenbergii</i>	PE	1865, 1906	reticulated nut-rush	Muehlenberg's nutrush	Cyperaceae
<i>Spiranthes vernalis</i>	PE	1899	spring ladies'-tresses	spring lady's tresses	Orchidaceae
<i>Juncus biflorus</i>	PT	1865	grass rush	bog rush	Juncaceae
<i>Lycopodiella appressa</i>	PT	1864, 1874	appressed bog clubmoss	southern bog clubmoss	Lycopodiaceae
<i>Magnolia virginiana</i>	PT	1900	sweet-bay magnolia	sweetbay	Magnoliaceae
<i>Oxypolis rigidior</i>	PT	1910	cowbane, water-dropwort	stiff cowbane	Apiaceae
<i>Woodwardia areolata</i>	PT	1863	netted chain fern	netted chainfern	Polypodiaceae
<i>Xyris torta</i>	PT	1866, 1901	yellow-eyed-grass	slender yelloweyed grass	Xyridaceae
<i>Andropogon glomeratus</i>	PR	1906	broom-sedge	bushy bluestem	Poaceae
<i>Zizania aquatica</i>	PR	1866, 1873	wild-rice	annual wildrice	Poaceae
<i>Cyperus lancastricensis</i>	TU	1906	umbrella sedge	manyflower flatsedge	Cyperaceae
<i>Dichanthelium villosissimum</i>	TU	1902	long-haired panic grass	whitehair rosette grass	Poaceae
<i>Rhynchospora recognita</i>	TU	1865, 1866	beak-rush	globe beaksedge	Cyperaceae
<i>Rosa virginiana</i>	TU	1900	wild rose, pasture rose	Virginia rose	Rosaceae
<i>Solidago uliginosa</i>	TU	1901	bog goldenrod	bog goldenrod	Asteraceae
<i>Veratrum virginicum</i>	TU	1903	bunchflower	Virginia bunchflower	Melanthiaceae

John Harshberger's description of Philadelphia and Delaware County tidal marshes around the end of the nineteenth century

Background

Dr. John William Harshberger (1869–1929), professor of botany at the University of Pennsylvania from 1893 until his death in 1929, had a strong interest in geology, ecology, and biogeography. He published what is probably the earliest detailed floristic description of Pennsylvania's tidal marshes in 1904 (Harshberger 1904, pp. 135-140; see Appendix A).

Summary of text

Harshberger described the marshes and their zonation into distinctive species assemblages according to the soil surface elevation relative to mean high tide, in an era before the higher zones were thoroughly invaded by *Phragmites australis* ssp. *australis* and many other nonnative invasive plants. His description included marshes along the Delaware and Schuylkill Rivers in Philadelphia and Delaware Counties, but the most detailed account was of a relatively undisturbed area of tidal marsh near the western end of the Tinicum Marsh complex between the mouths of Crum Creek and Darby Creek, three miles west of the Philadelphia County-Delaware County line (see Harshberger 1904, Figure 1). A boardwalk connecting a lighthouse to the mainland traversed the marsh, allowing him to observe and describe around a dozen community types within the marsh (descriptions in Harshberger 1904, pp. 136-139 and Figures 2, 3, and 4).

Historical herbarium records of present-day species of special concern at Tinicum Marsh

Further evidence for the original plant species composition of the wetlands at Tinicum Marsh is provided by herbarium records of plants collected there from the mid-19th–early 20th centuries (Table 2). These data are from the Pennsylvania Flora Project database and were provided by Dr. Tim Block, Director of Botany, Morris Arboretum of the University of Pennsylvania.

Ann Rhoads on present-day tidal marsh reference sites

Dr. Ann Rhoads, Senior Botanist, Pennsylvania Flora Project, and emerita Director of Botany, Morris Arboretum of the University of Pennsylvania, knows Pennsylvania's tidal marshes better than anyone else. As a consultant to the Pennsylvania Natural Heritage Program documenting the status of rare plants and as co-author of the *Natural Areas Inventory of Bucks County* (Rhoads and Block 1999), she has visited and recorded observations on the floristics and overall condition of every remaining tidal marsh, most or all of them multiple times from the early 1980s through 2008. In response to a recent request to rank the tidal marshes in terms of their species diversity and current condition, she reported the following (pers. comm., 21 November 2008; phrasing and sequence are slightly reorganized):

The best remaining sites are along the bank of the Neshaminy Creek at Neshaminy State Park (Rhoads and Block 1999, p. 28), a site on the Delaware River in Falls Township next to Pennsbury Manor known as Quaker Penn (township) Park, Bristol Marsh (Rhoads and Block 1999, p. 38), and the Pennsylvania side of Little Tinicum Island.

The Neshaminy State Park site includes areas on both sides of State Road on the downstream side of the creek. There is a large area of *Phragmites* inserted between the good parts. Species I saw there this year include *Bidens bidentoides*, *Bidens laevis*, *Lycopus rubellus*, *Zizania aquatica*, *Heteranthera multiflora*, *Amaranthus cannabinus*, and *Sagittaria subulata*. This marsh has the best examples of high marsh and low marsh.

Quaker Penn Park has a very robust tidal marsh with lots of *Zizania aquatica*, *Amaranthus cannabinus*, *Bidens bidentoides*, *Bidens laevis*, *Sagittaria subulata*, and *Heteranthera multiflora*, etc. Unfortunately a non-native (*Cyperus serotinus*) is also well established.

Bristol Marsh, located at the mouth of Otter Creek at the site of the terminus of the Delaware Canal behind Mill Street in Bristol, Bucks County, also has abundant native tidal marsh rarities. I saw *Lycopus rubellus*, *Bidens laevis*, *Schoenoplectus smithii*, *Heteranthera multiflora*, *Amaranthus cannabinus*, *Sagittaria subulata*, and *Sagittaria calycina* there this year.

The Pennsylvania [northern] side of Little Tinicum Island has a well-developed marsh including high marsh and low marsh (high marsh is not inundated except at exceptionally high tides, whereas low marsh is under water at every high tide). The Pennsylvania side of Little Tinicum Island is protected as the shipping channel is on the New Jersey [southern] side of the island. Jack Holt and Janet Ebert recently rediscovered *Elatine americana* at Little Tinicum Island.

My observation is that riverbank areas that are exposed to commercial shipping get eroded to the extent that tidal marsh vegetation cannot survive. In the past 25 years or so I have seen tidal marsh disappear from the Delaware River bank in Neshaminy State Park. Only around the corner in the Neshaminy Creek does it persist. The lagoons at Pennypack on the Delaware may provide enough protection for marsh vegetation to become established. One of the problems, I believe is that when there is constant erosion from the wakes of passing ships the crust of algae and other microorganisms that cover the ground and provide a seed bed are be eroded away. In some sites even the fine sediments are gone and the riverbank is down to coarse gravel.

A restored tidal marsh is located just below the mouth of the Pennypack Creek on the Delaware in a recently created riverfront park. It contains two tidal lagoons, which are defined by old piers that jut into the river. The lagoons contain an excellent diversity of tidal marsh rarities including *Zizania aquatica*, *Bidens bidentoides*, *Bidens laevis*, *Heteranthera multiflora*, *Sagittaria subulata*, and *Amaranthus cannabinus*. Some of the non-native invasive species are there too, like *Lobelia chinensis*.

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Appendix A.

Reprint of John W. Harshberger's "A phyto-geographic sketch of extreme southeastern Pennsylvania" (1904, *Bulletin of the Torrey Botanical Club* 31: 125-159)

A phyto-geographic sketch of extreme southeastern Pennsylvania

JOHN W. HARSHBERGER

TOPOGRAPHY

The area considered in this phyto-geographic survey comprises the region of Pennsylvania drained by Wissahickon creek, lower Schuylkill river, Cobbs creek, Darby creek, Crum creek, Ridley creek and Chester creek, extending to the divide between Chester creek and the lower Brandywine. It is part of the well-characterized Piedmont plateau in the Atlantic drainage system, and comprises the district situated south and southeast of the range of hills formed by the Laurentian syenites. All of the streams mentioned, with the exception of the Wissahickon, the Brandywine, which heads in the low limestone of the Chester valley, and the Schuylkill, which rises in the mountains, take their rise to the east and southeast of the divide formed by the range of hills that owe their origin to the resistance of the Laurentian syenite rocks to erosion, from the earliest geologic time. The Wissahickon, the Schuylkill and the Brandywine flow from the low limestone Chester valley and through gneiss gorges on their way to the Delaware river. In the case of the Wissahickon, the act is startlingly bold, because accomplished by a small stream.

It may be stated here briefly that when the gorges of the Wissahickon, the Schuylkill and the Brandywine were made, Chester valley was at a much higher level. Its soft limestone rocks were dissolved faster than the gneiss, hence the width of the Chester valley and other limestone valleys compared with the narrow valleys cut in the harder gneissic rock. Cobbs, Darby, Crum, Ridley and Chester creeks rise upon, or on the eastern slopes of the Laurentian ridge which extends in a general southwestern direction from beyond the Delaware at Trenton to West Chester, Chester county, Pennsylvania. This ridge, reaching a general elevation of 300-500 feet, marks the boundary of the limestone Chester and Whitemarsh valleys, crosses the Schuylkill below Norristown and widens in Chester county into a confused range of hills. The streams, just mentioned, flow generally southeastward into the

Delaware river, striking across several geologic formations. The Laurentian syenites are cut into by the headwater tributaries of these streams, which make gorges in the newer gneissic rocks of the region, finally flowing across the alluvial plain found along the Delaware river.

The shorter streams with less volume of water have not cut across the Laurentian divide, but they are and have been constantly at work widening and deepening their gorges, so that in the last few miles of their courses they often run practically at base-level, as indicated by the sluggishness of their flow. During their existence, these creeks, as well as the master-streams mentioned above, have been subjected to various vicissitudes through oscillations of the earth's surface. Several times their lower stretches have been subjected to depression and elevation. During periods of depression, their mouths have been drowned by the encroachment of the sea upon the preceding land-surface, the Delaware river becoming an estuary of the Atlantic ocean, with the deposit of sediments in the form of mud, sand and gravels. Nevertheless the streams of the region have been constantly at work reducing the country to a peneplain, eating away the sand and gravel deposited during submergence and leaving undisturbed patches to tell the tale of their former existence. During periods of subsidence, erosion has been less active, but during long periods of elevation the streams have been reawakened and started afresh into active earth-leveling.

The Piedmont plateau and the alluvial coastal strip in south-east Pennsylvania were, with the similar region in New Jersey, subjected to movements of the earth's surface. The following may be recognized as of importance in the consideration of the region from a phyto-geographic aspect :

1. The post-Triassic uplift and the subsequent development of the Schooley peneplain.
2. The Cretaceous subsidence and deposition.
3. The post-Cretaceous uplift.
4. The Miocene submergence and the deposition of the Miocene beds.
5. The post-Beacon-Hill submergence and the development of the pre-Pensauken peneplain.

6. The Pensauken submergence and the deposition of the Pensauken formation.

7. The post-Pensauken uplift and the erosion accomplished between this uplift and the last glacial epoch.

8. The last glacial epoch.

During the Pensauken submergence the land was depressed to such an extent as to drown the Delaware river at its lower end, allowing the sea to pass up its valley and over the peneplain which had been developed during the previous cycle of erosion, so that a broad sound was formed which connected Raritan bay with Delaware bay. The Delaware river entered the Pensauken sound at Trenton, and the Schuylkill river, Cobbs, Darby, Crum, Ridley and Chester creeks emptied into this sound, having their lower portions drowned through this submergence.

The mouth of the Delaware river during the post-Pensauken uplift was transferred to Delaware bay, the creeks above mentioned assumed their old relationship to the country and began again actively to erode their basins. This cycle of erosion lasted until the ice of the last glacial epoch invaded the northern portion of the state. The topography of the region under consideration was changed but little and what changes were brought about were due to the deposition of drift, which was far from uniform.*

These topographic and geologic facts have been mentioned somewhat at length, because they have strikingly influenced the vegetation of the country since Cretaceous times, when we have a great and sudden inswarming of the higher plants of modern types, at the close of the lower Cretaceous. The great feature of this period was its dicotyledonous forests. Thus the following genera of trees found in southeast Pennsylvania to-day date from the Cretaceous period: *Fagus*, *Liquidambar*, *Liriodendron*, *Salix*, *Quercus*, *Castanea*, *Betula*, *Alnus*, *Platanus*, *Sassafras*, *Diospyros*, *Juglans* and *Hicoria*. The botanical character of the Amboy clays of coastal New Jersey, influenced by the changes of elevation described above, will be seen from the following brief synopsis.†

* Cf. Salisbury, R. D. The physical geography of New Jersey. Geol. Surv. N. J. 4: — 1898. — Heilprin, A. Town geology. — Leslie, P. Final report, Pa. Geol. Surv. I. — Rand, T. D. Notes on the geology of southeastern Pennsylvania. Proc. Acad. Nat. Sci. Phila. 1900: 160-338. 1900.

† Dawson, J. W. The geological history of plants. 204.

The angiosperms form about seventy species, which include three of *Magnolia*, four of *Liriodendron*, three or four of *Salix*, three of *Celastrorhynchium*, one of *Celastrus*, four or five of *Aralia*, two of *Sassafras*, one of *Cinnamomum*, one of *Hedera* (with leaves that are apparently identical with those described by Heer as belonging to *Andromeda*), *Cissites*, *Cornus*, *Diospyros*, *Eucalyptus*, *Ficus*, *Ilex*, *Juglans*, *Laurus*, *Menispermites*, *Myrica*, *Myrsine*, *Prunus*, *Rhamnus* and others.*

A statement of the above facts is proof that during the Tertiary period and up to its close a dense forest existed in north temperate and arctic latitudes. The northern portion of this forest and the tenderer species unable to withstand the nipping frosts were exterminated with the advance of the glaciers. South of the great terminal moraine, which reaches as far south as the Ohio river, but separated from it by a zone tenanted by arctic-alpine plants and other boreal species now found on mountain-tops and in the Hudsonian and Arctic belts of North America, the original Tertiary forest, minus such genera as *Eucalyptus*, *Ficus*, *Cinnamomum*, etc., persisted, reaching its greatest denseness in the region drained by the Tennessee river and its tributaries. One tongue of this forest of less denseness probably reached in a northeastward direction, as far north as a line following the windings of the west branch of the Susquehanna river to the Blue Ridge, thence along the Blue Ridge to the Schuylkill river, thence across to the southeast side of Great Valley and following the hills on the south side of Great Valley to the Delaware river.

Arbitrarily considered, all of the territory above this line and between it and the terminal moraine was a country influenced by the glacial cold. All of the country south of it, protected by the Allegheny mountains, the Blue Ridge and other ranges of hills to the eastward of the Schuylkill river, was covered by a forest composed in the main of those species of trees, not destroyed by the glacial cold, that had existed in this region, and also in the far north prior to the advent of the last glacial epoch. Comparing the northern remnant of the magnificent Tertiary forest with the southern remnant of this forest in the region drained by the Tennessee

* Knowlton, F. H. A catalogue of the Cretaceous and Tertiary plants of North America. Bull. U. S. Geol. Surv. No. 152. 1898.

river, and in the southern Appalachian mountains, generally speaking, it lacks many of the peculiar arboreous and herbaceous species which characterize the flora of the south and which have their nearest living representatives in the flora of eastern China and Japan.

With the retreat of the great ice-sheet, the region once covered by the ice was restocked by trees and herbs derived from three main sources of supply : (1) Scandinavia, (2) Hudsonian zone of the Glacial period, (3) Appalachian forests (north and south). The Scandinavian plants migrated eastward during the inter-glacial period and tenanted the moraines, nunataks and arctic strip of territory throughout the later glacial epoch. With the retreat of the glaciers, they migrated northward with the ice sheet, or they persisted on the tops of high mountains which existed as nunataks during the ice age, or they remained as boreal islands in sphagnum-bogs, or in cold and shaded ravines. A northward migration of Hudsonian species and of Appalachian species in concentric waves also took place at the close of the Glacial period.*

The action of the several uplifts and depressions of the earth's surface described was most profound upon this forest, the history of which has been traced. With every submergence of the lower portions of the creeks of the region and of the Delaware river, the forest in the area of submergence was destroyed, or if existing on the higher grounds, was subjected to such extensive changes of level, as to highly modify its character and the distribution of the component species. Many species were crowded together by the change of level and the wearing away of the strata to which they had become adapted, for " if we suppose the earlier Mesozoic uplands to be the seat of the existing dicotyledons, then by the lowering of the surface by gradual consumption of the interstream areas, these forms must have been brought into conflict with the flora of the lowlands and thereby forced into a contest for supremacy." †

Xerophytes of the hillsides and rock exposures (such as ser-

* Cf. Adams, C. C. Post-Glacial origin and migrations of the life of the north-eastern United States. Jour. Geol. 1 : 303. S 1903.

† Woodworth, J. B. The relation between baseleveling and organic evolution. Am. Geol. 14 : 231. O 1894.

pentine)* are replaced by mesophytes, which thrive in rich alluvial soils ; mesophytes, by the wearing away of the soil and the formation of cliffs, by xerophytes, such as exist on the serpentine barrens of southeast Pennsylvania ; hydrophytes replace mesophytes, when an area becomes too wet for the tenancy of ordinary plants. Thus, if we apply such principles to the study of our region, southeastern Pennsylvania, the dry ground formed by the post-Cretaceous uplift was the seat of a dense mesophytic forest, by erosion mesophytes of the plain were replaced by xerophytes of the hillside, and by a still more pronounced base-leveling process, the xerophytes were again replaced by mesophytes. When the submergence occurred and the forest was drowned, a series of hydrophytes filled the tidal estuaries to be replaced by terrestrial plants at the next uplift.

Shull † gives an interesting case in point. The distribution of *Isoetes saccharata* Engelm. along Chesapeake bay is explained by the geomorphic movements of the coastal plain. The present elevation of land is such that the water of the bay is fresh about ten kilometers below the mouth of the Susquehanna river. During periods of greater elevation the water was fresh farther to the south. When the land was so elevated that the water was fresh at the mouth of the Potomac river, favorable habitats along the shore of the bay must have been occupied by the progenitors of the colonies of *Isoetes saccharata* which now occur in the upper estuarine portion of the tributary rivers. As the land sank and the rivers were ponded farther and farther from their mouths, new areas became adapted to the growth of *Isoetes*, and new colonies were formed. Simultaneously the colonies furthest down stream were destroyed by the advance of salt water. In this way there came to be, instead of a single colony or group of colonies at the head of Chesapeake bay, as many distinct colonies as there were ponded tributaries. So long as the land continued to sink, the successful reproduction was on the up-stream side, and destruction followed *pari-passu* on the down-stream side until the present con-

* Harshberger, J. W. Flora of the serpentine barrens of southeast Pennsylvania. Science, II. 18 : 339-343. II S 1903.

† Shull, G. H. Geographic distribution of *Isoetes saccharata*. Bot. Gaz. 36 : 199. S 1903.

dition of widely separated colonies was brought about. In periods of elevation the reverse process must have taken place, and the many distinct areas must have been merged again into one. As we find *Isoetes saccharata* Engelm. nowhere else than in Chesapeake bay and *Isoetes riparia* Engelm. nowhere else than in Delaware bay, it seems fair to assume that the physiographic changes mentioned above as controlling the distribution of the former species have influenced the distribution of *Isoetes riparia* along Delaware bay in a somewhat similar manner.

We can picture to ourselves the manner in which the area uplifted from the water was tenanted by various species of dry-land plants. The process may have been gradual, permitting the gradual adjustment of the newly implanted vegetal covering, or it may have been sudden, followed by an inrush of species. Lange* describes an interesting case, illustrating the latter process.

The establishment of vegetation upon the flood-plain of the Delaware river may best be studied on islands formed by the deposition of silt about some obstacle in the river. A bar originates. The first vegetation consists largely of annuals, then come willows, and finally a characteristic flood-plain forest. The red maple (*Acer rubrum*) appears, then poplars and the ash (*Fraxinus Americana*). Gradually the plain becomes dry enough to permit the development of a true mesophytic forest. Some such stages were passed through by the vegetation of southeastern Pennsylvania with each uplift following a process of depression. The same forces are at work now that were active in past geologic time, and the same laws are in operation which then controlled the distribution of plants.

The history of the upland plant associations is somewhat different from that of the lowland. In tracing the genetic development of these associations, we must consider especially the vegetation of the creek ravines. Cowles† has described the origin of the vegetation of clay ravines. None of this class of ravines are found typically developed in southeastern Pennsylvania. Rock-gorges are common and are occupied by all of the streams that drain the region under consideration. The physical nature of the gneissic

*Lange, D. *Revegetation of Trestle Island.* Minn. Bot. Stud. 2: 621. 1901.

†Cowles, H. C. *The physiographic ecology of Chicago and vicinity.* Bot. Gaz. 31: 88. 1901.

and syenitic rocks excludes landslide action and lateral cutting is relatively slow, as compared with ravines formed in clay. Thus the conditions are much more favorable for the growth of plants in a rock-gorge than in a clay ravine. Rock-gorges are shady and often the rocks drip with water and are, therefore, carpeted with mosses, ferns and liverworts. Shade-loving plants abound, whose leaves are broad and thin. The stages of development pass more slowly in rock-gorges. With the gradual widening of the cañon, however, the character of the flora undergoes a slow change, so that the vegetal covering is never stable, but constantly shifting, now of one appearance and with the lapse of time and change of physiographic conditions of another.

The character of the soil conditions, therefore, influences the particular kind of vegetation, so that we may have with the same exposure of light, heat and moisture a different flora, if the superficial soil deposits are different. Recent work* appears to show that, contrary to opinions that have long been held, there is no obvious relation between the chemical composition of the soil as determined by methods of analysis used and the yield of crops, but that the chief factor determining yield is the physical condition of the soil under suitable climatic conditions. The rainfall determines the productiveness of a country. Temperature and rainfall together are one of the most important natural resources of a country.

Clearly, therefore, the distribution of species does not depend so much upon the chemical character of two different strata,† but it is because one geologic area has advanced further in its life history than the other. The vegetation, for example, of a clay hill to-day will be seen on a sand hill in the future. The laws that control changes in the plant covering of a country are, therefore, plainly physiographic. Wherever hills are being eroded, valleys widened, rivers deepened, waterfalls eliminated, lakes filled, or coastal plains enlarged, there must be a constant change in the plant societies, or a succession in definite order of plant groups.

* Whitney, M. and Cameron, F. K. The chemistry of the soil as related to crop production. U. S. Dept. Agric. Bureau Soils, Bull. 22: — 1903.

† Cowles, H. C. The influence of the underlying rocks on the character of the vegetation. Bull. Am. Bureau Geog., Je-1901.

PLANT FORMATIONS AND ASSOCIATIONS

Southeastern Pennsylvania is a region of hills, of valleys, of meadows and of rocky ravines sloping down in general from the Laurentide hills to the Delaware river.

It represents an original table-land whose general elevation was about 500 feet above tide-level. Originally the surface, hills as well as river-plain above the fresh-water marshes which line the Delaware river, was covered by a dense forest of trees. Since the settlement of the country the most desirable land has been under cultivation, and many flourishing manufacturing towns, as Philadelphia, Chester, Conshohocken and Norristown, are found partly on the river-plain and partly situated on the rolling hills formed by the newer gneissic rocks. Culturally speaking, several kinds of land may be distinguished, such as river-land, marsh-land, city- and town-land, farm- and cultivated land, uncultivated woodland, uncultivated barren land, and abandoned farm-land.

Botanically considered, the following ecologic plant formations and associations may be distinguished, and these are determined approximately by the character of the areas above mentioned.

A. UNCULTIVATED.

AQUATIC-PLANT FORMATION.—The rivers and creeks of our region, especially in their lower courses, have smooth stretches of water in which grow a number of aquatic species. These species in the tidal estuaries are usually of the larger sort and are well adapted to grow in water where there is a change of level between low and high tide of about three feet. In many of the streams, the tidal flow is of considerable strength and the current established, therefore, influences the distribution of the vegetation to a marked extent. Where the flow is less strong and swift, there the material in the form of mud and silt is deposited and upon this alluvial material aquatic plants take root and gradually raise the level of these areas by catching and holding fresh deposits of silt. The result is a tidal marsh intersected by numerous meandering channels through which the tidal water ebbs and flows.

In the Schuylkill river above the dam at Fairmount is such a deposit of silt. *Vallisneria spiralis* L. forms a pure association of such extent as seriously to interfere with the navigation of the

river by pleasure craft (*Vallisneria* association). In some of the smaller streams and in ponds formed in artificial depressions, *Philotria Canadensis* (Michx.) Britton (*Elodea Canadensis* Michx.) abounds. A fine growth of this plant, the water-weed, is found in an abandoned quarry-hole at Leiperville, Pa., and another in a small stream near Horticultural Hall, Fairmount Park (*Elodea* association). The spatterdock, *Nymphaea advena* Soland. (*Nuphar advena* Ait. f.) is probably the commonest aquatic plant that grows in the tidal portions of the streams of southeast Pennsylvania. It covers acres of mud ground and stretches as a pure association for miles along the Delaware and Schuylkill rivers (*Nuphar* association). Associated with it in shallower water the pickerel-weed, *Pontederia cordata* L., abounds, forming in places pure associations. This interesting plant with trimorphic flowers is most abundant on the New Jersey side of the Delaware river (*Pontederia* association). The duckweeds are found in the ditches and ponds of the region. This is true especially of the district in South Philadelphia known as the Neck. The agricultural land, kept in a high state of fertility by the application of city manurial waste, is intersected by numerous ditches where abound *Spirodela polyrhiza* (L.) Schleid., *Lemma minor* L., *Wolffia Brasiliensis* Wedd., and *Wolffia Columbiana* Karst. (*Lemma* association). *Orontium aquaticum* L., the goldenclub, is also a plant that forms in places ecologic groups (*Orontium* association). The water-chinquapin, *Nelumbo lutea* (Willd.) Pers., twenty-five years ago existed in the region of the "Neck." With the spread of the city southwest, the plant was destroyed.

POND-PLANT FORMATION. — There are no ponds or lakes of any size natural to southeastern Pennsylvania; all that now exist are artificial. Some of them occupy depressions from which clay has been taken for bricks; others occupy the bottoms of rock quarries, while still others have been formed by the damming of streams. The only natural ponds are of small size and are rather pools formed in a depression near some perennial spring. The ecologist finds in such natural pools, or along their edges, a collection of species that seem to give character to them, such as *Chrysosplenium Americanum* Schwein. (*Chrysosplenium* association), *Veronica Americana* Schwein., *Typha latifolia*

L., *Philotria Canadensis* (Michx.) Britton, *Acorus Calamus* L., *Iris versicolor* L., *Myriophyllum verticillatum* L., *Spirodela polyrhiza* (L.) Schleid., *Cardamine bulbosa* (Schreb.) B. S. P. (*C. rhomboidea* DC.), *C. rotundifolia* Michx., *Caltha palustris* L., *Myosotis palustris* (L.) Lam., *Roripa palustris* (L.) Bess. (*Nasturtium palustre* DC.), *Roripa Nasturtium* (L.) Rusby (*Nasturtium officinale* R. Br.) (*Nasturtium* association), *Isuardia palustris* L. (*Ludwigia palustris* Ell.) and various algae, viz., *Spirogyra*, *Hydrodictyon*, *Conferva*, *Nitella*, *Oedogonium*, *Volvox*, *Euglena* and *Mesocarpus*.

TIDAL-MARSH-PLANT FORMATION. — This formation was studied along the Delaware and at the mouths of the Schuylkill river, Crum and Darby creeks. The most satisfactory place to study the ecologic disposition of the plants is at the mouth of Crum creek, where the botanist can take advantage of a wooden foot-bridge (two thousand feet long) constructed to connect a lighthouse with the mainland (FIG. 1). The tidal marshes have been formed by a variety of contributing forces. Material brought down by the rivers has been sorted and distributed over the tidal areas by the tides and currents of the streams that meet here. The location of these deposits and their superficial extent has depended upon the character, force and direction of the currents. Elaborate plans are in existence showing the currents of all the navigable streams in southeastern Pennsylvania. These may be consulted at the office of the United States engineer in charge of harbor improvements. The material is too abundant and the details too specialized to present in a paper of this character.

The banks of the streams influenced by tidal action are lined by thickets composed of *Platanus occidentalis* L., *Gleditsia triacanthos* L., *Alnus rugosa* (Du Roi) K. Koch, (*Alnus serrulata* Willd.), *Acer rubrum* L., *Salix alba* L., *Liquidambar styraciflua* L., *Fraxinus Americana* L., *Sambucus Canadensis* L., *Cephalanthus occidentalis* L., *Rosa lucida* Ehrh. with *Parthenocissus quinquefolia* (L.) Planch. (*Ampelopsis quinquefolia* Michx.) and *Rubus nigrobaccus* Bailey. The herbaceous associations of the woody plants mentioned are in this rich alluvial soil *Thalictrum polygamum* Muhl., *Heracleum lanatum* Michx., *Agrinonia parviflora* Soland., *Allium vineale* L., *Ambrosia trifida* L., *Impatiens biflora* Walt. (*I. fulva* Nutt). In mud near the bank, associations of the rose mallow,

Hibiscus Moscheutos L., occur, with occasional patches of the sensitive fern, *Onoclea sensibilis* L. Along the edges of the stream-banks in the shallow water grow *Clinopodium vulgare* L. (*Calamintha Clinopodium* Benth.), *Jussiaea diffusa* Forsk. (*J. repens* Sw.), *Sagittaria latifolia* Willd. (*S. variabilis* Engelm.), *Cicuta maculata* L., *Ludwigia alternifolia* L., *Stachys palustris* L. and *Asclepias incarnata* L. In the deeper water fringing the shore of the creeks, strips of wild rice, *Zizania aquatica* L. (*Zizania* association) and of *Nymphaea advena* Soland. (*Nuphar* association) are found.

The tidal marshes of the rivers Delaware and Schuylkill are extensive and may be in places one half a mile wide (FIG. 1). Several well-marked zonal areas of marsh vegetation are noticeable in making an ecologic survey. Some of the marshes have been diked. Others at high tide are flooded with water, and yet the ecologist can distinguish relative depths of water by the character of the vegetation alone (FIGS. 2, 3, 4). If one begins with the open channels of the creeks and ditches that intersect the marshes, the following zonal areas can be distinguished. In the deeper water along the channel, the reed-grass, *Zizania aquatica* (*Zizania* association) forms the outer fringe of vegetation (FIGS. 2, 3, 4, *A*, *AA*) and where it does not occur *Nymphaea advena* replaces it and forms a pure growth (*Nuphar* association) (FIGS. 2, 3, *E*). In July two colors of reed-grass are noticeable: a dark green mature form in deep water (FIGS. 2, 3, 4, *A*) and a light green immature growth of reed-grass inside of the dark green area (FIGS. 3, 4, *AA*). In the shallower water behind the reed-grass and spatterdock several associations of plants are seen. One area (FIG. 2, *J*) is characterized by the commingling of *Sagittaria latifolia*, *Impatiens biflora*, *Ambrosia trifida*, *Nymphaea advena*, with an occasional association of *Hibiscus Moscheutos* (FIG. 2, *H*) and on the drier area *Sambucus Canadensis* (FIG. 2, *KKK*, *KKKK*), *Cephalanthus occidentalis*, *Parthenocissus quinquefolia*, *Rubus nigrobaccus* and a few willows, *Salix alba* (FIGS. 2, 4, *W*). In other areas (FIG. 2, *O*) *Impatiens biflora*, *Rudbeckia laciniata* and *Sagittaria latifolia* occur, and on drier soil (FIG. 2, *M*) *Thalictrum polygamum* and *Heracleum lanatum*. As shown in FIG. 3, *D*, *Typha latifolia* forms a pure association (*Typha* association) surrounded by

Ambrosia trifida and *Sagittaria latifolia* (FIG. 3, BBB), in other areas this forms pure associations (FIGS. 3, 4, B) and in still other situations it is mixed with *Cicuta maculata* (*Sagittaria-Cicuta* association) (FIG. 3, F). *Cephalanthus occidentalis* always occurs in the drier soil of the tidal marshes and in a number of places

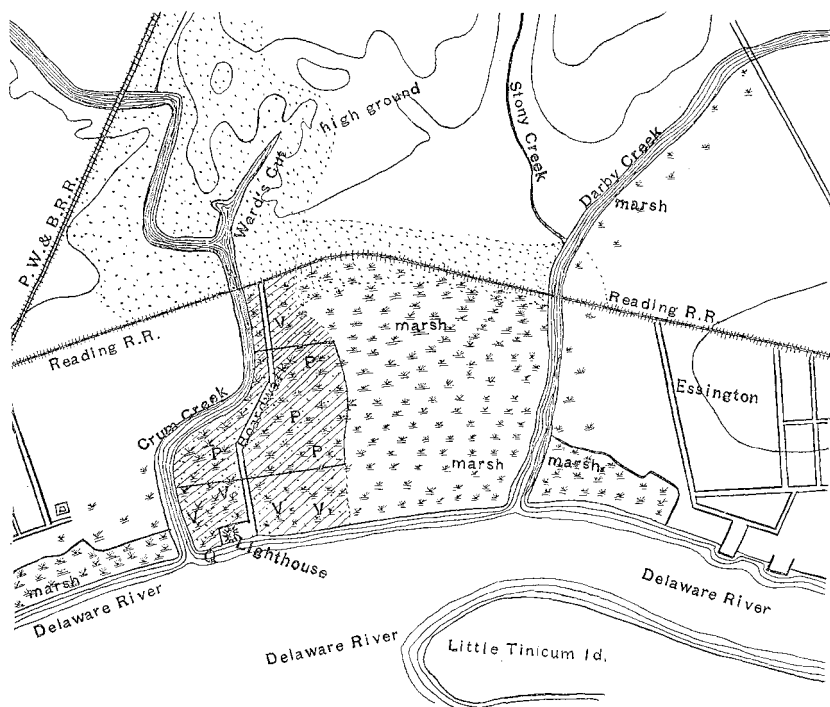


FIG. 1. Map showing position of tidal-marsh region surveyed. The area traversed is represented as the dotted portion of the map. The area surveyed ecologically is represented by the portion designated by the oblique lines (*V*). The area of the marsh (*P*) enlarged in figures 2, 3, and 4 is inclosed by the heavy lines. The position of the *Scirpus* association is shown at *Q*. The open river marsh (not diked) is indicated, as also the location of the high ground.

with it grow *Cornus Anomum* Mill. (*Cornus sericea* L.), *Sambucus Canadensis* L. (FIG. 2, S), *Stachys palustris* L. and *Convolvulus sepium* L. (*Calystegia Sepium* L.) (FIG. 3, K). Alluvial islands occur in the channels of the streams. These are at first covered by the spatterdock, and as the soil becomes drier through the building action of these plants, the spatterdock is replaced by other plants,

until the island becomes dry enough to support tree vegetation. The disposition of the several associations of plants can be studied best by reference to the graphic representations of plant distribution accompanying the text. The marshes have been drained in many cases sufficiently to raise marsh-grass for hay. The ditches of such converted marshes afford many interesting plants, such as

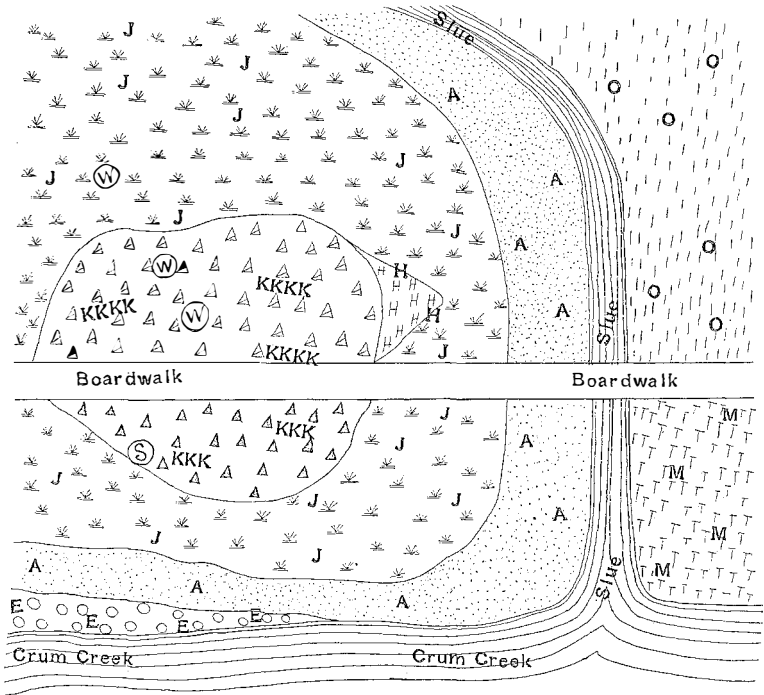


FIG. 2. Portion of tidal-marsh-plant formation shown in Fig. 1. *A*, area of *Zizania aquatica* L.; *E*, *Nuphar* association; *J*, *Sagittaria latifolia* Willd. and *Ambrosia trifida* L.; *KKK*, *Sambucus Canadensis* L., *Cephalanthus occidentalis* L. and *Rubus nigrobaccus* Bailey; *KKKK*, area occupied by willows, *W*, and *Sambucus Canadensis* L.; *H*, *Hibiscus Moscheutos* L.; *O*, *Impatiens biflora* Walt., *Rudbeckia latifolia* Willd. and *Sagittaria latifolia* Willd.; *M*, *Thalictrum polygamum* Muhl. and *Hieracium lanatum* Michx.

Spirodela polyrhiza (L.) Schleid., *Lemna minor* L., *Wolffia Brasiliensis* Wedd., *W. Columbiana* Karst. (*Lemna* association), *Pontederia cordata* L. (FIG. 4, *C*), *Asclepias incarnata* L., *Typha latifolia* L., *Sagittaria subulata* (L.) Buchenau (*S. pusilla* Nutt.), *S. rigida* Pursh (*S. heterophylla* Pursh), *S. latifolia* Willd., *Zizania aquatica*

L. and *Hibiscus Moscheutos* L. Outside of these associations and growing in the deeper water along the banks of the Delaware River is an association of *Scirpus lacustris* L. (*Scirpus* association) (FIG. 1, Q, near lighthouse).

SWAMP-PLANT FORMATION. — The swamps of the region under consideration are of three kinds, as determined by their origin: (1) Swamps that owe their origin to a stream flowing over a low,

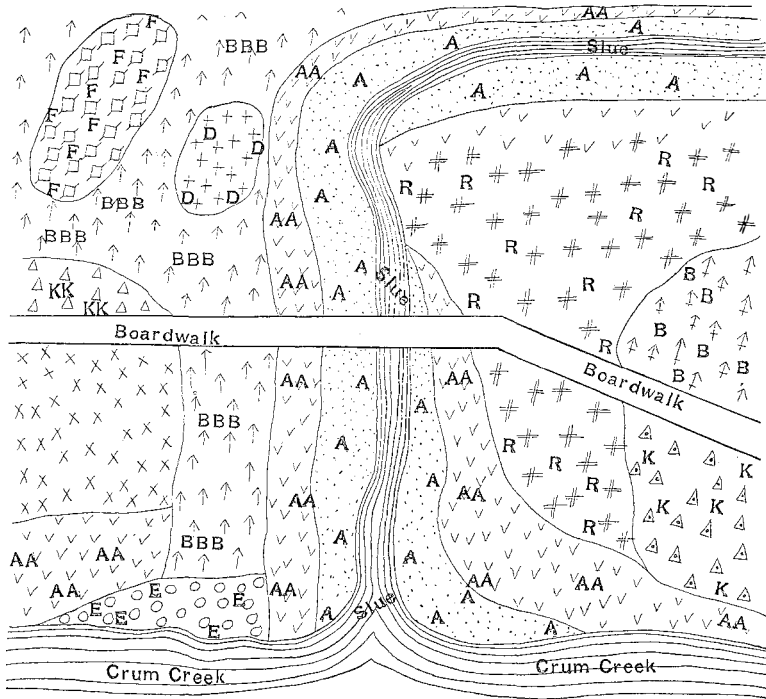


FIG. 3. Portion of the tidal-marsh-plant formation shown in Fig. 1. A, dark green *Zizania aquatica* L.; AA, light green *Zizania aquatica* L.; E, *Nuphar* association; B, *Sagittaria* association; BBB, *Sagittaria latifolia* Willd. and *Ambrosia trifida* L.; D, *Typha* association; F, *Cicuta-Sagittaria* association; K, *Convulvulus Sepium* L., *Sambucus Canadensis* L., *Cornus anonum* Mill. and *Cephalanthus occidentalis* L.; R, *Sagittaria latifolia* Willd. and *Rudbeckia laciniata* L.

flat area of country; (2) swamps due to underground springs; (3) swamps due to the collection of the drainage water of an area into a natural basin-shaped depression. True sphagnum bogs are not represented in southeastern Pennsylvania. This

does not exclude sphagnum mosses from the category of swamp plants, but bogs which owe their character to them are absent, and peaty deposits such as one finds associated with the sphagnum are entirely wanting. The swamp plants characteristic of the region may be enumerated in the following list: *Carex*, *Scirpus* and *Cyperus*, several species, *Onoclea sensibilis* L., *Osmunda*

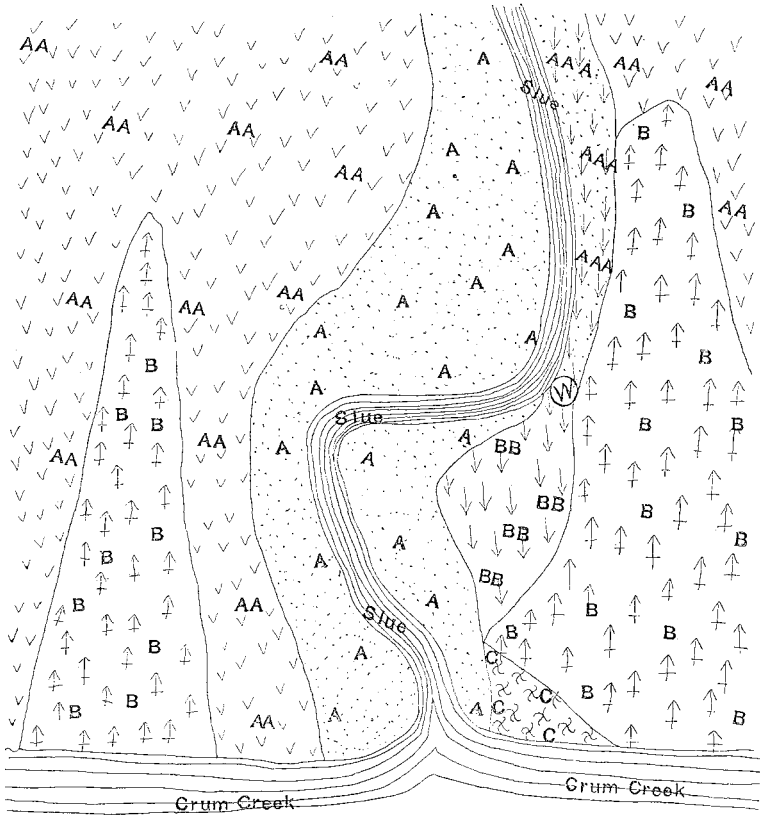


FIG. 4. Portion of tidal-marsh-plant formation shown in Fig. 1. *A*, dark green *Zizania aquatica* L.; *AA*, light green *Zizania aquatica* L.; *B*, *Sagittaria latifolia* Willd.; *BB*, *Sagittaria latifolia* Willd., a form with narrower leaves; *AAA*, dark and light green *Zizania aquatica* L., mixed; *W*, *Salix alba* L.; *C*, *Pontederia cordata* L.

regalis L., *O. Claytoniana* L., *O. cinnamomea* L., *Spathyema foetida* (L.) Raf., *Acorus Calamus* L., *Typha latifolia* L., *T. angustifolia* L., *Iris versicolor* L., *Carex squarrosa* L., *Veratrum viride* Ait., *Thalictrum polygamum* Muhl., *Impatiens biflora* Walt., *I.*

aurca Muhl., *Cardamine bulbosa* (Schreb.) B. S. P., *Drosera rotundifolia* L., *D. intermedia* Hayne, *Sarracenia purpurea* L., *Myosotis palustris* Withering, *Mimulus ringens* L., *Cicuta maculata* L., *Heracleum lanatum* Michx., *Lobelia syphilitica* L., *L. cardinalis* L., *Bidens laevis* (L.) B. S. P., *B. bipinnata* L., *B. frondosa* L., *Rudbeckia laciniata* L., *Eupatorium purpureum* L., *Heliopsis helianthoides* (L.) B. S. P., *Stachys palustris* L., *Alnus rugosa* (DuRoi) K. Koch, *Benzoin Benzoin* (L.) Coult., *Sambucus Canadensis* L., *Ilex verticillata* (L.) A. Gray.

The plants mentioned in the list fall naturally into several ecologic associations. Thus, we have the *Symplocarpus* association, consisting of *Spathyema foetida*, *Osmunda regalis*, *O. Claytoniana*, *O. cinnamomea*, *Cardamine bulbosa* and *Onoclea sensibilis*. The *Iris*, *Typha* and *Acorus* associations are clearly demarcated. *Heracleum lanatum* forms in swampy places a pure growth, as do also *Veratrum viride* and *Eupatorium purpureum* (*Heracleum*, *Veratrum*, *Eupatorium* associations). *Heliopsis helianthoides*, *Rudbeckia laciniata*, *Commelina Virginica*, *Polygonum sagittatum*, *Mentha spicata* and *Vernonia Novaeboracensis* are usually together in alluvial bottom lands at the mouths of streams where the soil is wet (*Heliopsis-Rudbeckia* association). In similar situations grow *Solidago rugosa* Mill., *Hydrocotyle umbellata* L., *Carduus lanceolatus* Hoffm. and *Lobelia syphilitica* L.

MIXED-DECIDUOUS-FOREST FORMATION. — Originally the forest covered most of the surface of southeast Pennsylvania. In some places, notably on the Wissahickon creek within the confines of Fairmount Park and in areas on Crum creek, the primeval forest still remains. Mr. J. Howard Lewis, Sr., and his progenitors have preserved inviolate a large tract of timber along Crum creek, while the surrounding country settled by patent in 1681 and 1682 has been cleared of its timber for many years. A study of such preserves shows the character of the original forest. The dominant and secondary forest trees grow on precipitous rocks, on declivitous hillsides, on the plateau surfaces left as a remnant of a former peneplain, on the creek bottoms of the region, where the trees reach their largest size, and on the Delaware river plain down to where the forest formation merges with the river marsh plant formation. All of the areas occupied by the cultivated-plant

formations recognized in this paper, as well as the roadside-plant formation, the pasture-field-plant formation, the ruderal-plant formation, part of the barren-plant formations and alluvial-soil-plant formations were covered by the original forest. This fact is mentioned because it illustrates how man has altered the character of the original plant formations. By the removal of the original forest, by the introduction of various cultivated plants and weeds, the long-established balance produced by the competition of the native species is rudely disturbed and exotic species come into conflict with the resident species and even the character of the undisturbed formations is altered by the injection of new species into them. However, enough of the virgin forest remains to permit a phyto-geographic survey. The original forest was a mesophytic one. It probably passed through various vicissitudes dependent upon the topographic changes, so that the xerophytic forest of the hillside was gradually replaced by a mesophytic forest. The tendency has been in the entire region to the culmination of the forest in the mesophytic type. The forest, of great original density, may be looked upon as the northeastern extension of the forest found developed in its highest character in the region drained by the Tennessee river and its tributaries and by streams arising in the southern Allegheny mountains and flowing eastward into the Atlantic. Arbitrarily, a line drawn from a point where the Ohio joins the Mississippi river, east to the Cumberland mountains and thence along the Allegheny mountains to the west branch of the Susquehanna river in Pennsylvania, then to the Blue Ridge and along it to the Schuylkill river, following the hills on the south side of the Great Valley to the Delaware river, represents the northern limit during glacial times of the forest which during the Miocene period extend north into the Arctic regions.

The northeastern extension of the forest of glacial times was much poorer in species than the mixed deciduous forest farther south. This was probably due to the killing of the less hardy species by the glacial cold. Only those species remained in the area mentioned that were hardy. These hardy species, therefore, represent the main constituent species of the present-day forest with the possible introduction of a few additional species that mi-

grated north from the denser forest that clothed the valleys and slopes of the southern Allegheny mountains.

The dominant trees of the forest that covered and still covers in patches southeastern Pennsylvania is composed of the following species: Tulip-poplar, *Liriodendron Tulipifera* L.; chestnut, *Castanea dentata* (Marsh.) Borkh. (*Castanea sativa Americana* Gray); black walnut, *Juglans nigra* L.; red oak, *Quercus rubra* L.; white oak, *Q. alba* L.; scarlet oak, *Q. coccinea* Wang.; chestnut oak, *Q. Prinos* L.; Spanish oak, *Q. digitata* (Marsh.) Sudw. (*Q. falcata* Michx.); beech, *Fagus Americana* Sweet (*F. ferruginea* Ait.); *Hicoria ovata* (Mill.) Britton (*Carya alba* Nutt.); hackberry, *Celtis occidentalis* L.; butternut, *Juglans cinerea* L.; sweet gum, *Liquidambar styraciflua* L.; persimmon, *Diospyros Virginiana* L.; white elm, *Ulmus Americana* L.; white ash, *Fraxinus Americana* L.; wild red cherry, *Prunus Pennsylvanica* L.f.; pignut, *Hicoria glabra* (Mill.) Britton (*Carya porcina* Nutt.); silver maple, *Acer saccharinum* L. (*Acer dasycarpum* Ehrh.); sugar maple, *Acer saccharum* Marsh. (*Acer saccharinum* Wang.); red maple, *Acer rubrum* L., buttonwood, *Platanus occidentalis* L.; small-fruited hickory, *Hicoria microcarpa* (Nutt.) Britton (*Carya microcarpa* Nutt.); and ironwood, *Ostrya Virginiana* (Mill.) Willd. These trees are found on a great variety of soils, but reach their greatest size on the dry alluvial soils of the creek and river bottoms. Thus the black walnut, tulip-poplar, white elm, buttonwood, red maple and silver maple reach their best development on such soils. The white oak, white ash, chestnut, etc., seem to grow equally well in the drier upland soils. The red cedar, *Juniperus Virginiana* L., on the other hand, seems to be confined to barren places and to rocky outcrops, while the trees that grow along the banks of the streams within the region comprise the red maple, *Acer rubrum* L.; the hornbeam, *Carpinus Caroliniana* Walt.; swamp oak, *Quercus palustris* DuRoi; buttonwood, *Platanus occidentalis* L.; box-elder, *Acer Negundo* L. (*Negundo aceroides* Moench); beech, *Fagus Americana* Sweet; *Sassafras Sassafras* (L.) Karst. (*S. officinale* Nees), and several birches and willows.

These trees form a dense canopy, and shade the forest floor, so that the secondary species, shrubs, sapling trees and herbs, must be tolerant of such dense shade. The dominant trees

reached great size in the primeval forest, for some are left which attest this. Thus are found white oaks six to eight feet in diameter, buttonwood trees six feet across, white pine five feet in diameter, beeches four feet, black walnut trees four to five feet, tulip-poplars six feet, sassafras trees two feet and a half. The secondary species tolerant of the shade are the dogwood, *Cornus florida* L., red mulberry, *Morus rubra* L., service berry, *Amelanchier Canadensis* (L.) Medic, bladdernut, *Staphylea trifolia* L., Judas-tree, *Cercis Canadensis* L., hazel, *Corylus Americana* Walt., witch hazel, *Hamamelis Virginiana* L., and striped maple, *Acer Pennsylvanicum* L., while as shrubs occur smooth alder, *Alnus rugosa* (Du Roi) K. Koch, spice-bush, *Benzoin Benzoin* (L.) Coulter, dockmackie, *Viburnum acerifolium* L., arrowwood, *Viburnum dentatum* L., stagbush, *Viburnum prunifolium* L., strawberry bush, *Euonymus Americanus* L., wahoo, *Euonymus atropurpureus* Jacq., and pinxter flower, *Azalea nudiflora* L. (*Rhododendron nudiflorum* Torr.); *Sambucus Canadensis*, the elder, also occurs in the region and at present is found usually in open places with alluvial soil forming thickets of some denseness. The laurel, *Kalmia latifolia* L., high-bush huckleberry, *Gaylussacia resinosa* (Ait.) Torr. & Gray and deerberry, *Polycodium stamineum* (L.) Greene (*Vaccinium staminum* L.), are found in the drier forest soils throughout the region. The lianes which grow upon the dominant and secondary forest trees are several grape-vines, *Vitis cordifolia* Michx., *V. labrusca* L., *V. aestivalis* Michx., *V. vulpina* L. (*V. riparia* Michx.), Virginia creeper, *Parthenocissus quinquefolia* (L.) Planch., poison ivy, *Rhus radicans* L., and several species of the genus *Smilax*. The climbing bittersweet, *Celastrus scandens* L., moonseed, *Menispermum Canadense* L., *Sicyos angulatus* L., wild-yam, *Dioscorea villosa* L., and wild balsam apple, *Micrampelis lobata* (Michx.) Greene (*Echinocystis lobata* Torr. & Gray) are climbing plants found along the courses of streams.

A peculiar type of this mixed deciduous forest is found on the serpentine rock formations of the region under consideration. The botanist can identify the serpentine areas, by the vegetation alone, for the species which are character-plants, although occurring elsewhere in the region, are here grouped together in such a manner and in such number, as to sharply delimit these areas from the

surrounding country. The dominant trees on the serpentine barrens are *Quercus alba* L., *Q. stellata* Wang., *Quercus Marylandica* Muench, *Acer rubrum* L., *Liriodendron Tulipifera* L., *Nyssa sylvatica* Marsh., *Juniperus Virginiana* L., *Castanea dentata* (Marsh.) Borkh., *Fagus Americana* Sweet, *Quercus rubra* L. and *Prunus serotina* Ehrh., while associated with these trees are *Sassafras Sassafras* (L.) Karst. *Rhus glabra* L., *Kalmia latifolia* L., *Salix tristis* Ait., *Cornus florida* L., *Viburnum dentatum* L., *Polycodium stamineum* (L.) Greene, *Gaylussacia resinosa* (Ait.) Torr. & Gray, *Viburnum acerifolium* L. and *Benzoin Benzoin* (L.) Coult. The lianes are *Vitis aestivalis* Michx., *Parthenocissus quinquefolia* (L.) Planch., *Rhus radicans* L., *Smilax rotundifolia* L. and *S. glauca* Walt.

The herbaceous plants of the forest floor are found in pure association, or they occur sparingly distributed along with other herbs that form together a mixed vegetation. The habitats of the different herbaceous associations are controlled by photic and edaphic conditions. Thus in the deep shade of the dominant trees, the botanist finds the following plants forming pure associations and each association may be distinguished by the generic name of the plant :

April. — *Asarum Canadense* L., *Bicuculla cucullaria* (L.) Millsp. (*Dicentra cucullaria* DC.), *Erythromum Americanum* Ker, *Claytonia Virginica* L., *Pedicularis Canadensis* L., *Epigaea repens* Lam., *Thalictrum dioicum* L.

May. — *Cubelium concolor* (Forst.) Raf. (*Solea concolor* Ging.), *Podophyllum peltatum* L., *Triosteum perfoliatum* L., *Tradescantia Virginiana* L., *Mertensia Virginica* (L.) DC., *Caulophyllum thalictroides* (L.) Michx., *Hydrophyllum Virginicum* L.

July. — *Gaultheria procumbens* L.

The following ferns are also found in pure association in the forest : *Adiantum pedatum* L., *Dryopteris spinulosa* (Retz) Kuntze, (*Aspidium spinulosum* Swartz), *Dryopteris marginalis* (L.) A. Gray (*Aspidium marginale* Swartz), *Dryopteris acrostichoides* (Michx.) Kuntze (*Aspidium acrostichoides* Sw.) and *Phegopteris Phegopteris* (L.) Underw. (*P. polypodioides* Fée).

Along the woodland streams, growing in the damp loamy soil of such situations and controlled by the amount of soil-moisture

present are a number of associations characterized by a single plant, as follows :

April. — *Floerkea proserpinacoides* Willd.

May. — *Polemonium reptans* L., *Valerianella chenopodifolia* (Pursh.) D.C., *Ornithogalum umbellatum* L., *Heracleum lanatum* Michx.

June. — *Lysimachia nummularia* L.

July. — *Impatiens biflora* Walt., *I. aurea* Muhl., *Thalictrum polygamum* Muhl., *Adickea punila* (L.) Raf. (*Pilea punila* Gray).

August. — *Leptanidium Virginianum* (L.) Raf. (*Epiphegus Virginiana* Bart.), *Lobelia cardinalis* L., *Commelina nudiflora* L. *C. Virginica* L.

September. — *Eupatorium purpureum* L.

The rocky outcrops in the woods consisting either of ledges or of angular boulders formed by frost action are covered by several well-characterized associations formed by pure growths of the following species :

Camptosorus rhizophyllus (L.) Link, *Polypodium vulgare* L.

April. — *Saxifraga Virginiensis* Michx., *Aquilegia Canadensis* L.

May. — *Heuchera Americana* L.

The herbaceous flora of the woods found on the serpentine areas of southeastern Pennsylvania has been discussed in a paper by the writer entitled "The flora of the serpentine barrens of southeast Pennsylvania."* As the facts have been presented there in some detail, it is hardly necessary to repeat the observations so recently published. The student is referred to that paper for an account of the distribution of the serpentine plants.

Besides these pure associations of plants found in the woods of southeast Pennsylvania occur a large number of species, rich in number of individuals, but scattered on the forest floor, separated from each other by spaces filled up with other characteristic woodland species, likewise isolated. These plants, therefore, form a mixed vegetation which covers the ground except where the pure associations of single species occur and give character to the herbaceous flora of such woodland areas. The following species may be included in this category. They are arranged, because of

* Science, II. 18: 339-343. 11 S 1903.

what follows, according to the months in which they appear in flower.

Botrychium Virginianum (L.) Swartz, *Asplenium Filixfoemina* (L.) Bernh.

April. — *Dentaria laciniata* Muhl., *Viola palmata* L., *Ranunculus abortivus* L., *Geranium maculatum* L., *Arisaema triphyllum* (L.) Torr., *Erigeron pulchellus* Michx. (*E. bellidifolium* Muhl.), *Sanguinaria Canadensis* L., *Hepatica Hepatica* (L.) Karst. (*H. triloba* Chaix.), *Syndesmon thalictroides* (L.) Morong (*Anemonella thalictroides* Spach), *Panax trifolia* L. (*Aralia trifolia* Decsne & Planch.), *Mitella diphylla* L., *Viola Labradorica* Schrank (*V. canina Muhlenbergii* Gray), *V. blanda* Willd., *V. villosa* Walt., *V. pedata* L., *Carex Pennsylvanica* Lam., *Barbarea Barbarea* (L.) MacM. (*B. vulgaris* R. Br., *Ranunculus fascicularis* Muhl.

May. — *Washingtonia longistylis* (Torr.) Britton (*Osmorrhiza longistylis* DC.), *Vagnera racemosa* (L.) Morong (*Smilacina racemosa* Desf.), *Viola pubescens* Ait., *Thalesia uniflora* (L.) Britton (*Aphyllon uniflorum* Gray), *Oxalis stricta* L. (*O. corniculata stricta* Sav.), *Uvularia sessilifolia* L. (*Oakesia sessilifolia* Watson), *Trientalis Americana* (Pers.) Pursh, *Salomonina commutata* (R. & S.) Britton (*Polygonatum giganteum* Dietr.), *Medeola Virginica* L., *Galeorchis spectabilis* (L.) Rydb. (*Orchis spectabilis* L.), *Hypoxis hirsuta* (L.) Coville (*H. erecta* L.), *Tiarella cordifolia* L., *Hydrastis Canadensis* L., *Thaspium trifoliatum aureum* (Nutt.) Britton (*T. aureum* Nutt.), *Aralia nudicaulis* L., *Cypripedium acaule* Ait., *Allium tricoccum* Ait., *Arisaema Dracontium* (L.) Schott, *Hieracium venosum* L., *Oxalis violacea* L., *Uvularia perfoliata* L., *Smilax herbacea* L., *Geranium maculatum* L., *Juncooides campestre* (L.) Kuntze (*Luzula campestris* DC.), *Ficaria Ficaria* (L.) Karst. (*Ranunculus Ficaria* L.).

June. — *Pyrola rotundifolia* L., *Galium triflorum* Michx., *Cynoglossum Virginicum* L., *Corallorhiza odontorhiza* Nutt., *Uvularia grandiflora* Smith, *Scutellaria serrata* Andrews, *Leptorchis liliifolia* (L.) Kuntze (*Liparis liliifolia* Richard), *Cypripedium hirsutum* Mill. (*C. pubescens* Willd.), *Cypripedium parviflorum* Salisb., *Hieracium Gronovii* L., *H. scabrum* Michx., *Chimaphila maculata* (L.) Pursh, *Galium aparine* L.

July. — *Cimicifuga racemosa* (L.) Nutt., *Urticastrum divarica-*

tum (L.) Kuntze (*Laportea Canadensis* Gaud.), *Chelone glabra* L., *Panicum dichotomum* L., *Lilium Canadense* L., *Monotropa uniflora* L., *Prunella vulgaris* L., *Silene stellata* Ait., *Phryma leptostachya* L.

August. — *Lobelia siphilitica* L., *Solidago bicolor* L., *Aster macrophyllus* L., *Panicum microcarpon* Muhl.

September. — *Aster lacvis* L., *Solidago caesia* L., *Collinsonia Canadensis* L.

All of these species are not found in a single wooded area. They are distributed in different combinations in southeastern Pennsylvania. Thus such local plants as *Cypripedium parviflorum*, *C. hirsutum*, *Camptosorus rhizophyllus*, *Galeorchis spectabilis*, *Hydrodrastis Canadensis* and *Leptorchis liliifolia* occur only in a few places in the region, but they are mentioned because they are plants which grow best in the deep shade formed by the crown of the dominant forest trees. The vegetal covering of the forest floor also differs with the season of the year, so that the spring flora is distinct from that of the summer flora, and the summer flora is distinct from the autumn flora. In the lists above this succession of floras is displayed, as far as the phenologic data at command will permit. The woodland species are most numerous in the spring, because the conditions are most favorable for their growth. Such plants as the bloodroot, wild ginger, May apple, windflower and lady's slipper abound. The summer flora of the woods is poorer in the number of species. Such plants as touch-me-not, cardinal lobelia, boneset, all-heal, etc., are found with a number of funguses, such as *Russula*, etc. The autumn flora of the forest consists of asters, golden-rods, mints, and a large number of toadstools and mushrooms, which feed saprophytically upon the humus of the soil composed of leaf-mold and rotted wood. The phenologic distribution of the woodland species is, therefore, quite as marked as their geographic habitat and controls associations of species in a most intimate manner. The seasonal sequence of species is one of the controlling factors in the struggle for existence. With the exception of the rivalry of the root and underground stem systems for ground-space, the spring plant may be said not to come into competition with the summer- and- autumn flowering species and conversely.

The mutual aid which plants show is quite as important in the grouping of associations, as the struggle for light and soil room. The beech-drop for example is dependent on the beech, and hence it is only found where the beech is an element of the forest. The Indian-pipe occurs only in woods where there is abundant humus, as also the majority of ericaceous plants provided with mycorrhiza. Certain funguses are dependent upon the material formed by the decay of certain other plants and they, therefore, abound only where this material is found. The fungous flora of a particular forest area comes and goes in an inexplicable manner. One season there will be an abundance of a particular species and during another season that species cannot be found, but will be replaced by some other form. The character of the rainfall, whether light, heavy or frequent is a determining factor in the appearance of plants. With a heavy downpour most of the water which has fallen runs off the surface and does very little good. On the other hand, gentle rains which come frequently soften the ground, and thus furnish some water to the lower strata, or at least preserve the supply which is already there. The writer believes that there is a delicate balance of some kind established between fungi and the climatic and edaphic conditions of any neighborhood. It is only when the climatic and edaphic conditions are suitable that the fungus species again appears.* The conditions, therefore, which control the character of the vegetal covering of a mesophytic forest are most complex and intricate.

HEMLOCK FORMATION. — This formation occurs on the sloping hillsides and precipitous banks of streams and is developed notably on Wissahickon and Crum creeks. It is found generally along the Wissahickon creek and at the ox-bow of Crum creek below the Springfield water works on the north and west banks of the stream at this point. The forest of hemlocks consists in a few places of a pure growth without the admixture of any other tree species, but usually associated with the hemlock, *Tsuga Canadensis* (L.) Carr. the botanist finds the beech, *Fagus Americana* and red maple, *Acer rubrum*. These trees are tolerant of the dense shade of the hemlocks. Where the forest floor has not been dis-

* Cf. Whitney, M. & Cameron, F. K. The chemistry of the soil as related to crop production. U. S. Dep. Agr. Bureau Soils Bull. 22: 47-55. 1903.

turbed, sapling hemlocks, beeches and red maples are present ready to replace the dominant trees when they have succumbed to the wind. On the floor of the forest in places *Lycopodium lucidulum* Michx. forms an association (*Lycopodium* association). The laurel, *Kalmia latifolia* L., occurs in the drier soils and forms a thicket (*Kalmia* association). *Mitchella repens* L. carpets the ground (*Mitchella* association) and *Viola rotundifolia* Michx. is a characteristic plant with which grows *Peranium pubescens* (Willd.) MacM., *Ciuna latifolia* (Trev.) Griseb., *Hieracium paniculatum* L., and in late summer *Aster divaricatus* L. In many places, the hemlock, *Tsuga Canadensis*, forms an element in the mixed-deciduous-forest formation. When such is the case, it is found in isolated patches usually of a few trees near the water-courses on steep hillsides. It forms then an association (*Tsuga* association) and with *Lycopodium lucidulum* are found three other species, viz., *Lycopodium annotinum* L., *L. clavatum* L., and *L. obscurum* L. (*L. dendroideum* Michx.), which grow near the hemlocks. Two alternative hypotheses may be adduced for this. Either an original hemlock forest has been replaced by a deciduous one, or occasional hemlock trees have been under certain edaphic conditions developed amidst the component species of the deciduous forest.

SERPENTINE-BARREN TREELESS FORMATION.—The details concerning this formation will not be given here, as an account has been given elsewhere of the character of the vegetation of the serpentine barrens.* The herbs found upon the broken-down serpentine rock are *Phlox subulata* L. (*Phlox* association), *Trifolium aureum* L. (*T. agrarium* L.), *Pteridium aquilinum* (L.) Karst. (*Pteris aquilina* L.), *Verbascum Blattaria* L., *Panicum latifolium* L., *Potentilla Canadensis* L., *Cerastium oblongifolium* Torr. (*Cerastium* association), *Senecio Balsamitae* Muhl. (*Senecio aureus Balsamitae* Torr. & Gray), *Castilleja coccinea* (L.) Spreng., *Arenaria stricta* Michx., *Talinum teretifolium* Pursh, *Ixophorus glaucus* (L.) Nash (*Setaria glauca* Beauv.), *Aster ericoides depauperatus* Porter, *Polygonum tenue* Michx., *Lespedeza Virginica* (L.) Britton, *Andropogon scoparius* Michx., *Solidaga puberula* Nutt., *Eupatorium aromaticum* L., *Panicum dichotomum* L., *Koellia flexuosa* (Walt.) MacM.

* Harshberger, J. W. The flora of the serpentine barrens of southeast Pennsylvania. Science, II. 18: 339-343. 11 S 1903.

(*Pycnanthemum linifolium* Pursh) and in wet places *Cyperus inflexus* Muhl. and *Fimbristylis laxa* Vahl.

MEADOW-PASTURE-FIELD-PLANT FORMATION.* — From early historic accounts of the region, the original forest was interspersed with open glades and natural meadows where for some edaphic reason the trees did not grow. These areas (such as we have left in the "Indian clearing" near Lima, Delaware County, and in the Playwicky clearing in Bucks County) were settled upon first, and with the exception of the areas above mentioned we have no natural openings that have not been altered by the hand of man. The botanist, therefore, has no data upon which to base a statement of the plant covering of such open, treeless areas.

Several kinds of fields may be distinguished. A classification of the plants according to the character of the inclosed areas might be made, but it would be too minute for a general phyto-geographic survey, such as this paper is intended to be. The uncultivated fields of southeastern Pennsylvania may be classified as follows :

1. Fields formed by clearing of the original timber.
2. Wet fields that may be called meadows, usually level and situated in low ground.
3. Barren fields characterized by the shallowness or poor character of the soil.
4. Dry fields that are fertile, but lack abundant water, the rain draining off after it falls. These fields are situated usually on hill-sides.
5. Fields with rich soil that have been fallow, and that are used as pastures.
6. Abandoned fields in which weeds have been allowed to grow rampant and in which trees are beginning to appear.

Fields of the first class, formed by the clearing away of the original timber, are usually at once cultivated by plowing and sowing between the stumps ; occasionally, however, they are left uncultivated and they become veritable weed patches. Most of the herbaceous weeds, mentioned as growing in cultivated areas, appear and occupy the ground. Some of the original woodland

* For a list of plants peculiar to this formation on Darby Creek, the writer is under obligations to Miss Lydia P. Borden, of Manoa, Delaware County, Pa.

species, such as *Podophyllum peltatum* L., etc., remain as a characteristic plant growth. If permitted to relapse again to natural conditions, fields of the first class become fields of the sixth class in three or four years time.

Meadow-land (2) may be defined as that which has been reclaimed from a too wet condition by ditch or tile drainage. Compared with other field-areas meadows are relatively better supplied with ground water. Meadow-land merges into a swamp on the one hand or a cultivated field on the other. Plants growing in meadow-land are, therefore, not subjected to the vicissitudes of cultivation, but they are trodden down and browsed upon by cattle turned into such areas. Associations of species are not always clearly marked in meadows and no attempt is made to group the plants together naturally. A list of meadow plants is given by way of calling attention to the plants of the region which grow in such localities.

Anthoxanthum odoratum L., *Dactylis glomerata* L., *Lolium perenne* L., *Andropogon Virginicus* L., *Phleum pratense* L., *Alopecurus geniculatus* L., *Agrostis alba* L., *Poa annua* L., *P. compressa* L., *P. pratensis* L., *P. trivialis* L., *Cyperus strigosus* L., *Carex* (various species), *Juncus* (several species), *Scirpus* (several species), *Trifolium pratense* L., *T. repens* L., *T. agrarium* L., *T. procumbens* L., *T. hybridum* L., *Melilotus alba* Desv., *Muscari botryoides* (L.) Mill., *Daucus Carota* L., *Hedeoma pulegioides* Pers., *Hypericum perforatum* L., *Polygonum Pennsylvanicum* L., *P. scandens* L. (*P. dumetorum scandens* Gray), *Eupatorium perfoliatum* L., *E. ageratooides* L., *E. purpureum* L., *Prunella vulgaris* L., *Chrysanthemum Leucanthemum* L., *Achillea Millefolium* L., *Lappula Virginiana* (L.) Greene (*Echinosperrnum Virginicum* Lehm.), *Strophostyles angulosa* Ell., *Glechoma hederacea* L. (*Nepeta Glechoma* Benth.), *Nepeta Cataria* L., *Potentilla Canadensis* L., *Salvia lyrata* L., *Specularia perfoliata* (L.) A. DC., *Ranunculus bulbosus* L., *R. abortivus* L., *R. septentrionalis* Poir., *Bursa Bursa-pastoris* (L.) Britton (*Capsella Bursa-pastoris* Moench), *Barbarca Barbarea* (L.) MacM. (*B. vulgaris* R. Br.), *Taraxacum Taraxacum* (L.) Karst. (*T. officinale* Weber), *Alsine media* L.

Growing in the wetter portions of the meadows near the streams that frequently run through such areas, the botanist finds

Spathyema foetida, *Heracleum lanatum*, *Rudbeckia laciniata*, *Impatiens biflora*, *I. aurea*, *Lobelia siphilitica*, *L. cardinalis*, *Bidens laevis*, *B. bipinnata*, *B. frondosa*, *Cicuta maculata*, *Thalictrum polygamum*, *Lilium superbum*, *Monarda fistulosa*, *Sium cicutaefolium*, *Lobelia Nuttallii*, *Mimulus ringens*, *Myosotis palustris*, *Iris versicolor*, *Stellaria longifolia*, *Mentha spicata*, *Lysimachia quadrifolia*, *Veratrum viride* and *Scutellaria integrifolia*.

Many of these plants have remained after the removal of the timber and some of them have advanced into the meadows from the adjacent forest. This is especially true of the species enumerated below. They are woodland species that have adapted themselves to growing in the open. *Erythronium Americanum* Ker., *Valerianella chenopodiifolia* (Pursh) DC., *Cardamine bulbosa* (Schreb.) B. S. P., *Polemonium reptans* Michx., *Senecio aureus* L., *Ornithogalum umbellatum* L., *Tradescantia Virginiana* L., *Geranium maculatum* L., *Podophyllum peltatum* L., *Steironema ciliatum* (L.) Raf., *Lilium superbum* L., *Monarda fistulosa* L., *Bicuculla cucullaria* (L.) Millsp., *Arisaema triphyllum* (L.) Torr., *Phytolacca decandra* L., *Salomonina commutata* (R. & S.) Britton, *Clematis Virginiana* L. along the fences, *Vagnera racemosa* (L.) Morong, *Hydrophyllum Virginicum* L., *Salvia lyrata* L., *Origanum vulgare* L., *Thaspium trifoliatum aureum* (Nutt.) Britton, *Viola* (several species), *Uvularia perfoliata* L., *Cimicifuga racemosa* (L.) Nutt., *Mentha* (several species), *Commelina nudiflora* L., *Scutellaria integrifolia* L.

The pasture-fields of categories 3, 4, 5 supply a number of plants which are not found in the meadow-land proper. Most of the aforementioned grasses are encountered and also a large number of woodland species, that have been introduced since the timber was removed, as well as the majority of the introduced weeds mentioned above.

The plants listed below usually grow in drier soil than the meadows afford.

Helianthus giganteus L., *Rudbeckia hirta* L., *Vernonia Novboracensis* Willd., *Solidago serotina* Ait., *S. nemoralis* Ait., *S. rugosa* Mill., *S. caesia* L., *Aster ericoides* L., *A. puniceus* L., *Ambrosia artemisiacifolia* L., *Bidens discoides* (T. & G.) Britton (*Coreopsis discoidea* Torr. & Gray), *Heliopsis helianthoides* (L.) B. S. P. (*Heliopsis laevis* Pers.), *Arctium Lappa* L., *Asclepias Syriaca* L. (*A.*

Cornuti Decaisne), *A. purpurascens* L., *Apocynum androsaemifolium* L., *Clinopodium vulgare*, *Hypericum perforatum* L., *Dianthus prolifera* L., *Onagra biennis* (L.) Scop. (*Oenothera biennis* L.), *Chenopodium album* L., *Cunila origanoides* (L.) Britton (*C. Mariana* L.) *Potentilla Canadensis* L., *Houstonia caerulea* L., *Linaria Linaria* (L.) Karst. (*L. vulgaris* Mill.), *Specularia perfoliata* (L.) A. DC.

The soil of fields, which may be designated as sandy loam, supports a number of additional species.

Parsonsia petiolata (L.) Rusby (*Cuphea viscosissima* Jacq.), *Veronica officinalis* L., *V. serpyllifolia* L., *Antennaria plantaginifolia* Hook, *Potentilla Canadensis* L., *Fragaria Virginica* Mill., *Lepidium Virginicum* L., *Rumex acetosella* L., *Rubus Canadensis* L., *Sisyrinchium anceps* Cav., *Penstemon pubescens* Solander, *Plantago lanceolata* L., *P. Virginica* L., *P. major* L., *Trichostema dichotomum* L., *Lobelia inflata* L., *Verbascum Thapsus* L., *V. Blattaria* L., *Abutilon Abutilon* (L.) Rusby (*A. Avicennae* Gaertn.), *Lycopus Virginicus* L., *L. sessilifolius* Gray, *Anaphalis margaritacea* Benth. & Hook., *Nabalus altissima* (L.) Hook. (*Prenanthes altissima* L.), *N. albus* (L.) Hook. (*Prenanthes alba* L.), *Galinsoga parviflora* Cav., *Euphorbia corollata* L., *Leonurus Cardiaca* L., *Convolvulus Sepium* L., *Leptilon Canadense* (L.) Britton (*Erigeron Canadensis* L.), *Agrimonia Eupatoria* L., *Potentilla Norvegica* L., *Matricaria inodora* L., *Trifolium pratense* L., *T. repens* L., *T. agrarium* L., *T. procumbens* L., *Oxalis stricta* L. (*O. corniculata stricta* Sav.), *Malva rotundifolia* L., *Rhus radicans* L. (along fences and stone heaps), *Saponaria officinalis* L., *Lysimachia nummularia* L., *Andropogon scoparius* Michx., *A. Virginicus* L., *Paspalum setaceum* Michx., *Syntherisma sanguinalis* (L.) Nash. (*Panicum sanguinale* L.), *Panicum nitidum* Lam., *P. capillare* L., *Ixophorus glaucus* (L.) Nash (*Setaria glauca* Beauv.), *I. viridis* (L.) Nash (*S. viridis* Beauv.), *Anthoxanthum odoratum* L., *Phleum pratense* L., *Alopecurus gemiculatus* L., *Agrostis alba* L., *Holcus lanatus* L., *Avena fatua* L., *Capriola Dactylon* (L.) Kuntze (*Cynodon Dactylon* Pers.), *Elysinæ Indica* (L.) Gaertn., *Sieglingia sesleroides* (Michx.) Scribn. (*Triodia cuprea* J. F. Jacq.), *Dactylis glomerata* L., *Poa annua* L., *P. pratensis* L., *P. trivialis* L., *P. compressa* L., *Festuca ovina* L., *Agropyron repens* (L.) Beauv., *Panicum rostratum* Muhl. (*P. anceps* Michx.).

Fields (6) that are abandoned after a long period of cultivation and in which weeds have been permitted to grow rampant and in which trees begin to appear, show some interesting changes in the flora which are not mentioned in connection with fields of the first category. In such fields, trees appear not from the stump, but as chance seedlings, that grow from seeds carried by the winds or animals. The predominant weeds noticed on an old dam site along Crum creek were *Eupatorium purpureum* L., *Aster* (several species), *Solidago* (several species), *Rubus* (several species), *Chelone glabra* L., *Ambrosia trifida* L., *Rudbeckia laciniata* L., etc. These were surrounded by small trees of the following species: *Betula lenta* L., *Liriodendron Tulipifera* L., *Acer rubrum* L., *Ulmus Americana* L. and *Fraxinus Americana* L. All of these trees have winged fruits and without doubt the trees grew from seeds wafted to the open dam site by the wind.

ROADSIDE-PLANT FORMATION.—The flora of a roadside is peculiar. Along the highways we find a miscellaneous assortment of plants, mostly weeds, with an admixture of native plants that are able to compete with foreign introductions and that have adapted themselves to growing under the more trying conditions of the open, shadeless, dust-laden environment. The weeds of the roadsides in southeastern Pennsylvania have been derived from two main sources, viz., Europe, and eastern North America. The European weeds seem to get the upper hand in the struggle for existence for several reasons: (1) Because they have been longer associated with man and his methods of cultivation; (2) because they have adapted themselves during a thousand years, since Europe was a forest wilderness, to living in the open, in fields along roadsides, and in garden patches; (3) because in migrating to a new country they have been removed from their competitors by whom they were held in subjection through the struggle for existence; (4) because in eastern North America they come into competition with native species mostly derived from the forests and that have not had sufficient time to adapt themselves to the changed conditions produced by the destruction of the forests, the cultivation of the soil and growth in open places subjected to the full force of the sunlight.

Western American weeds, seem to have an advantage, because

derived from an open prairie country, where, with frequent fires and the roaming of herds of buffaloes and antelopes, they have been subjected to environmental conditions very similar to those which are met with in the more highly cultivated districts of our eastern states.

Plants derived from the native flora can hardly be looked upon as weeds ("plants out of place"). Only a few of our troublesome weeds are native. The native plants have usually persisted in the soil when a road has been constructed, and in many places they are found in greatest abundance along the highways in rich arable land, because they have been left in undisturbed possession of the stretches of land on either side of the roadway, while the same species have been exterminated in the cultivated fields. In other cases native plants have migrated from the woods and natural meadows to the roadside and have implanted themselves there, especially in those districts of our country cut off from the railroad and other lines of cross-country travel. The plants in the following list are arranged according to their source :

Europe. — *Linaria Linaria* (L.) Karst., *Daucus Carota* L., *Phleum pratense* L., *Hypericum perforatum* L., *Rumex crispus* L., *R. obtusifolius* L., *R. Acetosella* L., *Verbascum Thapsus* L., *V. Blattaria* L., *Plantago lanceolata* L., *Allium vineale* L., *Trifolium pratense* L., *T. arvense* L., *Chrysanthemum Leucanthemum* L., *Arctium lappa* L., *Xanthium glabratum* (DC.) Britton (*X. strumarium* L.), *Anthemis Cotula* DC., *A. arvensis* L., *Taraxacum Taraxacum* (L.) Karst., *Cerastium vulgatum* L., *Lactuca scariola* L., *Asparagus officinalis* L., *Saponaria officinalis* L., *Melilotus alba* L., *Mollugo verticillata* L., *Carduus lanceolatus* L., *C. arvensis* (L.) Robs. (*Cnicus arvensis* Hoffm.), *Datura Stramonium* L., *D. Tatula* L., *Syntherisma sanguinalis* (L.) Nash (*Panicum sanguinale* L.), *Chactochloa glauca* (L.) Scribn. (*Setaria glauca* Beauv.), *Eleusine Indica* (L.) Gaertn., *Polygonum Persicaria* L., *Chenopodium album* L., *C. anthelminticum* L. (*C. ambrosioides anthelminticum* Gray), *Atriplex hastata* L., *Amaranthus spinosus* L., *Portulacca oleracea* L., *Cerastium viscosum* L., *Euphorbia Cyparissias* L., *Convolvulus arvensis* L., *Cichorium Intybus* L.

Eastern North America. — *Erigeron annuus* (L.) Pers., *Achillea Millefolium* L., *Plantago Rugelii* Decaisne, *Barbarea Barbarea* (L.)

MacM., *Trifolium repens* L., *Lepidium Virginicum* L., *Equisetum arvense* L., *Ambrosia trifida* L., *Rhus glabra* L., *Phytolacca decandra* L., *Nabalus altissimus* (L.) Hook., *Asclepias Syriaca* L., *Oxalis stricta* L., *Onagra biennis* (L.) Scop., *Ambrosia artemisiaefolia* L., *Rhus radicans* L., *Bidens bipinnata* L., *B. connata* Muhl., *Verbena hastata* L., *Solanum Carolinense* L., *Panicum capillare* L., *Agropyron repens* (L.) Beauv. *Polygonum aviculare* L., *P. Pennsylvanicum* L., *Amaranthus graccizans* L. (*A. albus* L.), *Convolvulus Scpium* L., *Commelina Virginica* L.

Western North America. — *Helianthus annuus* L., *Rudbeckia hirta* L.

India. — *Abutilon Abutilon* (L.) Rusby.

RUDERAL-PLANT FORMATION. — It is a difficult matter to distinguish clearly between the roadside plant formation and the ruderal plant formation, because near our large cities the conditions influencing vegetation are nearly similar along the much frequented highways and the neglected waste areas, or rubbish heaps. Ruderal areas are distinguished rather by the absence of certain plants found by the roadside and by the numerical frequency of the species, than by a difference in the component plants. The ruderal plant formation may be said to consist of those plants which will grow on rubbish heaps, or on made ground formed by ashes and other dry material representing the waste of a large city, or town. Such dumping places are found usually near the outskirts, and the material, as it settles down, is first covered with a rank growth of weeds and other coarse plants. Later such areas are divided into building lots. All of our large cities afford examples of such waste heaps and fields. The association of species depends largely on chance. It is determined by the way in which seeds, roots and other plant material are heaped together in the waste. Near Philadelphia the following plants are most abundant in the ruderal formation:

Plantago Rugelii, *Linaria Linaria*, *Daucus Carota*, *Rumex crispus*, *R. obtusifolius*, *Verbascum Thapsus*, *Arctium Lappa*, *Xanthium glabratum*, *Lactuca scariola*, *Melilotus alba*, *Carduus lanceolatus*, *Datura Stramonium*, *Datura Tatula*, *Syntherisma sanguinalis*, *Chaetochloa glauca*, *Atriplex hastata*, *Chenopodium album*, *C. anthelminticum*, *Amaranthus spinosus*, *Cichorium Intybus*, *Melilotus officinalis*,

Trifolium hybridum, *Lepidium Virginicum*, *Ambrosia artemisiaefolia*, *Bidens connata*, *Panicum capillare*, *Amaranthus graecizans*, *Solidago* (several species), *Aster* (several species), *Populus alba*, *Helianthus annuus*, *Citrullus vulgaris*, *Onagra biennis*.

The list of weeds that grow in waste places near Philadelphia and other large manufacturing towns of our region is not exhausted with the above enumeration. Only the commonest plants have been mentioned. In general, it may be said that the plants of the ruderal formation are coarse, tall, much-branched weeds of an ill smell and producing an abundance of easily distributed fruits and seeds. These weeds owe their presence in such abundance to the perfect means of distribution which they possess, as hooks, wings, tufts of hair, or other contrivances.

BALLAST-PLANT FORMATION. — Ballast-ground may be defined as a place where the material used to steady ships at sea, such as sand, gravel, stone, rubble and the like, is unloaded from vessels and piled up in heaps along the water's edge. The material composing ballast has been gathered from a great number of sources in a great many parts of the world, South America, Australia, Europe and India, from whence the ships have cleared. The result is that roots, stems, fruits and seeds of a heterogeneous assemblage of plants are mixed up in the ballast stuff, and when this lies exposed for some time the roots begin to grow and the seeds to germinate, until the ballast heap is covered by plants native to diverse parts of the globe. Some of these plants will appear but once. Others will remain and become adventitious.

B. CULTIVATED.

Southeastern Pennsylvania is preëminently an agricultural country. It is a country of well-kept, carefully cultivated farms. Now, however, many of the finest farms have been converted into suburban demesnes, where, dictated by the wealth and culture of the owners, large sums have been expended upon buildings and landscape improvements. For convenience and because the classification is a natural one the cultivated plant formation may be divided into the following areas :

1. Cereal-rootcrop-clover area.
2. Orchard area.

3. Vegetable-garden area, (a) Kitchen-gardens, (b) Truck-gardens.
4. Nursery area.
5. House- and garden-plant area.
6. Botanic-garden area.

These must be dismissed because an accurate and detailed description is not possible here. They are mentioned because the natural vegetation of the region has been modified and influenced by the establishment of farms, gardens and suburban parks. If a phyto-geographic chart of the region was to be constructed, such as Robert Smith has done for Scotland, all of these areas would have to be surveyed and located upon the map. In closing, the writer believes that enough has been given in this sketch to serve as an introduction to the plant geography of a region of considerable botanical interest, historic and otherwise.

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