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Journal Title: Bartonia; proceedings of the Philadelphia botanical club ...
Vol: 65
No:
Month/Year: /2011
Pages: 97-104

Article:
Author: ; Long-term Observations of Plant Succession on an Abandoned Cornfield in SouthernChester County, Pennsylvania, (1967-2000).

Bartonia No. 65: 97–104, 2011

Long-term Observations of Plant Succession on an Abandoned Cornfield in Southern Chester County, Pennsylvania, (1967-2000)

WILLIAM OVERLEASE AND EDITH OVERLEASE
1645 Sycamore Court
Bloomington, Indiana, 47401

ABSTRACT. Vegetational succession of an abandoned cornfield on the campus of West Chester University was studied for 34 years from 1967-2000. The succession followed three stages involving 1) dominance by herbaceous annuals, 2.) dominance by herbaceous perennials and 3) dominance by woody plants. Specific details for these three stages are provided.

INTRODUCTION

In the mid 1960s we began to collect data on early plant succession in disturbed urban sites and old fields, especially abandoned cornfields in Chester County, Pennsylvania. These data were summarized and presented in a series of papers given to the Pennsylvania Academy of Science (Overlease 1969, 1973, 1978). Most of these studies were short term, 1-3 years, with two over ten years. Since West Chester University had set aside an area on the campus for environmental studies (The Robert B. Gordon Natural Area for Environmental Studies), which included an abandoned cornfield, it seemed appropriate to conduct a long term study in this area. A site was established in 1967 and was monitored each year for 34 years. The following is a summary of these observations.

METHODS

A site was selected at the southwest corner of South New Street and Tigue Road in the Robert B. Gordon Natural Area for Environmental Studies, West Chester, Pennsylvania. The study area was 40 × 40 m. It was subdivided into 16 10 × 10 m subplots. Metal stakes were driven to mark the corners of the plots.

Recording of vegetation cover and species abundance was done at the end of the growing season, usually mid- to late-October or early November. For more accurate measurement of cover and general distribution of species, all plot corners were connected by twine. Data for each of the 16 subplots were compiled independently for possible future reference of individual species establishment, change, and abundance.

Mapping of plant cover was done on graph paper with each square representing one square meter. The sum of squares was used to calculate the total square meter cover by species.

Crown cover and plant cover were calculated by what cover was observed when looking down on the site from above. The upper cover was considered the recorded cover for an

area. A nine foot step ladder was used for better perspective during the early years. When multiple strata developed in later years, the understory cover was not mapped, though records of abundance and distribution were made.

Stem counts for tall goldenrod *(Solidago altissima)* and aster *(Aster pilosus)* were based on number of plants with mature, well-developed inflorescences. In some years, for example, 1980 and 1993, aborted inflorescences were very common due to the dry growing season, and very low stem counts were recorded these years.

The nomenclature of the plant species follows Overlease (1986).

RESULTS

Plant succession on the Tigue Road site can be divided into three major stages: 1.) dominance by herbaceous annuals; 2.) dominance by herbaceous perennials; 3.) dominance by woody plants.

DOMINANCE BY HERBACEOUS ANNUALS

For the first three years, over 50% of the study area was dominated by the herbaceous annuals foxtail grass *(Setaria faberii)* and common ragweed *(Ambrosia artemisiifolia)*. It was completely covered in year one with annuals, with 92% cover in year two, 73% year three, and 40% year four. In year five, there was a major decrease to 4.5% cover of the 1600 m^2 site. Though it normally would have covered less than 1% in year six, a disturbance occurred that resulted in 13% cover. Ground crews from the college cut a strip covering 210 m^2 along the west side of the site. They had decided to remove the tops of the goldenrod-aster cover so that lost balls from a nearby practice field could be more easily found. They were not aware of the study in progress on a weed-covered field. The foxtail was abundant but in a dwarfed condition under a goldenrod-aster cover. When the tops were removed in early summer, the area reverted to a well-developed foxtail cover. However, by the end of the next growing season, there was no evidence of the disturbance, with the entire local area covered by normal goldenrod-aster cover. Dwarf foxtail grass continued to be abundant under an herbaceous perennial plant cover for three years from year five through year seven. It was still locally frequent until year eight. From then on, only occasional individual plants were observed.

As shade developed over portions of the study area with increasing tree cover, native shade-tolerant, moisture-requiring annuals appeared. These included touch-me-not *(Impatiens capensis)* and great ragweed *(Ambrosia trifida)* in year 22, and richweed *(Pilea pumila)* in year 30. Though often locally frequent to common, these annuals never became abundant enough to map as plant cover. The exception was bur cucumber *(Sicyos angulatus)* which covered a local area of 57 m^2 in year 28 only. It had been locally common from year 26 on, but never abundant enough to be mapped.

The Tigue road site was not a typical site of early plant succession on abandoned cornfields in southern Chester County, Pennsylvania. After studying over 22 succession sites on cornfields in Chester County for up to 11 years of succession, I found a consistent pattern. Generally the first year, fields had abundant foxtail grass *(Setaria faberii)* with common ragweed *(Ambrosia artimiisifolia)* common to locally abundant. The second year, aster *(Aster pilosus)* was very abundant. From the third year to over 20 years, tall goldenrod *(Solidago altissima)* dominated the fields until shrub and tree cover shaded it out.

Table 1. Other herbaceous annuals found on the study site (1967-2000).

Annuals	
Conyza canadensis	LF, years 1-7; 2 in year 20; 2 in year 25; 1 in year 30
Chenopodium album	LF, years 1-6; 26 plants on 3 subplots in year 27
Galium aparine	VL years 8 to 18; LF from year 24 on
Capsella bursa-pastoris	VL, years 1 to10
Polygonum persicaria	VL, years 4 to 7
Polygonum pensylvanicum	VL, years 3 and 4
Impatiens capensis	VL years 13 and 14; LF from year 22 on
Veronica arvensis	LF from years 2 to 20; VL in year 30
Lamium purpureum	VL, years 8 to 10
Arabidopsis thaliana	VL, years 10 and 12; LF year 34
Erechtites hieraciifolia	One in year 3; LF in year 20 on
Pilea pumila	LF from year 30 on
Ambrosia trifida	VL, year 22 on
Thalaspi arvense	VL year 7; LF year 29; VL year 31
Annual-like biennials or perennials	
Lactuca scariola	Locally abundant years 4 and 5; LF from year 1 to 7
Lychnis alba	LC up to year 8; LF from then on
Lepidium campestre	LF to year 25; VL from then on
Barbarea vulgaris	LF throughout years 1 to 34
Oxalis stricta	LF throughout years 1 to 34
Erigeron annuus	Occasional to LF years 1 to 16; VL to year 27. Not found thereafter. LA on all 16 subplots in year 11.
Stellaria media	Present years 1 to 3; LA years 7 and 8; present years 9 and 10; LF years 31, 33, and 34.

VL: very local; 10 or fewer plants
LF : locally frequent, 10-20 plants
LC : locally common 100-500 plants
LA: locally abundant, 500 to 1000+ plants.

On the Tigue road site, foxtail dominated the study area for three consecutive years, along with common ragweed. It formed a thick thatch of litter at the end of each growing season. It continued to be abundant under goldenrod-aster perennial cover for three more years as dwarf understory plants.

This was unexpected. Back in the 1960s, Jack McCormick, ecologist for the field station of the Academy of Natural Sciences of Philadelphia at Waterloo Mills, showed me some of their study plots on early plant succession. He told me that they had statistical evidence that *Setaria faberii* would not grow on its own litter. The Tigue road site demonstrates that it is possible for foxtail to grow for several years on its own litter. The probable reason for the change to goldenrod-aster cover was a matter of the foxtail being suppressed by the taller dominant herbaceous perennials. When the shade (top of the overstory) was removed, the foxtail came back quite vigorously. This would probably continue as long as there was

an abundance of dwarf suppressed plants in the understory. Eventually they were shaded out and would no longer be available if the tops were then removed.

If the site were plowed, however, the foxtail, which has long-lived seeds, would be able to come back in abundance. I observed this in Chester County on a 20 year old abandoned cornfield with tall goldenrod cover. It was plowed and came back with a foxtail (*Setaria faberii*) cover the first year, though no corn had been planted on the site for 20 years.

DOMINANCE BY HERBACEOUS PERENNIALS

The tall goldenrod (*Solidago altissima*) and aster (*Aster pilosus*) dominance of the 1600 m^2 study site began slowly in year two with five stems of aster on three subplots and 24 stems of goldenrod, scattered in small groups on ten of the 16 subplots. By year three, it had increased to 320 aster stems on nine sub, and 696 goldenrod stems on 13 subplots. It was first mapped at this point, covering 10% of the 1600 m^2 area. Each succeeding year it rapidly increased in dominance with 21% cover in year four, 54% in year five, 72% year six, 97% year seven, and finally 100% in year eight. It continued to dominate with over 90% of the plant cover until year 14 when it first decreased to 84% cover. It continued to play an important role with nearly 50% to over 60% cover until year 24. Though goldenrod was the most abundant plant, aster was consistently common until year 16. From the year 19 on, it was only occasionally observed on the site.

By year 27, woody plants, both shrubs and trees, dominated 74% of the overstory plant cover and goldenrod was reduced to 24% cover. On the final year 34, it covered only 7.6% of the study area with woody plants covering 91% of the site.

The herbaceous perennial Canada thistle (*Cirsium arvense*) played a prominent role for several years of early plant succession. It was common throughout the site in year one, having survived as root sprouts. By year two, it covered 8% of the area, increasing to 17% in year three and to 31% in year four. It reached a peak of 35% of the total plant cover on 1600 m^2 in year five. It rapidly decreased to 15% cover in year six and to 2% in year seven. Scattered stems were common for two more years and then, after year nine, only occasional stems were observed. In year 30, it reappeared again, with 105 stems on five of the subplots in shaded and semi-shaded areas. It was continuously recorded with 100-200+ stems in these areas through the end of the study.

Wild carrot (*Daucus carota*), a biennial, was also important in the early years of succession. It shared dominance with common ragweed on 2% of the area in year two, and 2% cover with common ragweed and aster in year three. By year four, it shared 6% of the study site with a tall goldenrod-aster-wild carrot plant community. This specific community increased to 28% cover of the area in year five and into year six. It was not recorded as cover in year seven, but was again mapped with 15% cover in year eight. From then on, it was no longer recorded as cover. It became uncommon to rare on the site from year 19 on.

A small unusual plant community of evening primrose (*Oenothera biennis*), a biennial, and Canada thistle, made up 2% of the study area in year seven. It was recorded only once as a cover, though evening primrose was an occasional to frequent plant until year 20. It was absent or very rare after that.

In year 28, stiltgrass (*Microstegium vimineum*) was first recorded with 34 stems on two of the subplots. It covered 5 m^2 on three subplots in year 30 and rapidly increased to 60 m^2 cover on ten subplots by year 34. It is becoming very aggressive in shaded areas of the site.

Eighty-one species of herbaceous perennials were recorded on the 1600 m^2 study site during 34 years of observations. However, most species were not major contributors to the

mapped dominant plant cover. In addition, 21 species of intermediate herbaceous perennials (annual-biennial, annual-perennial, biennial-perennial, biennial) were listed. A total of 102 species of herbaceous perennials and intermediates were found on the site in 34 years.

Of the 102 species, just over half, or 53 species, were uncommon or rare or did not persist. However, 26 species, or 25%, persisted nearly throughout the 34 years (Table 2). Six species of early established herbaceous perennials persisted up to 25 years. Nine species of later-established perennials (from year six on) persisted up to the year 31. From year 18 on to year 34, nine species of later-arriving, shade-tolerant, herbaceous perennials became established. The arrival of some of the typical local woodland species such as Virginia knotweed *(Tovara virginiana)* and jack-in-the-pulpit *(Arisaema triphyllum)* in years 27 and 28 of the study was exceptionally noteworthy.

Table 2. Herbaceous perennials reported from the study site.

Early herbaceous perennials not persisting for 34 years of study	
Species	Years present
Physalis subglabrata	2–8
Convolvulus sepium	2–7
Verbascum thapsus	2–19 (biennial)
Agrimonia parviflora	2–25
Aster puniceus	3–11
Prunella vulgaris	5–18
Later herbaceous perennials not persisting for 34 years of study	
Species	Years present
Senecio aureus	6–21
Triodia flava	8–27
Pimpinellia saxifraga	8–28
Hypericum punctatum	8–28
Pycnanthemum flexuosum	8–29
Hieracium pratense	8–31
Achillea millefolium	9–28
Linaria vulgaris	11–20
Solidago juncea	11–26
Herbaceous perennials persisting through 34 years of study	
Species	Years present
Rumex crispus	1 on
Allium vineale	1 on
Taraxacum officinale	1 on
Solanum carolinense	1 on
Aster pilosus	1 on
Cirsium arvense	1 on
Silene alba	1 on
Barbarea vulgaris	1 on
Oxalis stricta	1 on
Soliago altissima	2 on
Asclepias syriaca	2 on
Cirsium discolor	2 on
Daucus carota	2 on

Herbaceous perennials persisting through 34 years of study (cont.)	
Species	Years present
Circaea quadrisculata	3 on
Solidago graminifolia	3 on
Potentilla canadensis	4 on
Aster novae-angliae	4 on
Polygonum scandens	4 on
Poa trivalis; P. pratensis	5 on
Carex spp. (leaves 3/8" wide)	5 on
Viola papilionacaea	5 on
Rumex acetosella	5 on
Solidago rugosa	6 on
Duchesnia indica	7 on
Galium aparine	8 on
Apocynum cannabinum	11 on

Late arriving herbaceous perennials persisting to year 34	
Species	Years present
Agrostis hyemalis	18 on
Conium maculatum	21 on
Hackelia virginiana	23 on
Cinna arundinacea	26 on
Muhlenbergia schreberi	27 on
Tovara virginiana	27 on
Arctium minus	28 on (biennial-perennial)
Microstegium vimineum	28 on
Arisaema triphyllum	28 on

DOMINANCE BY WOODY PLANTS

SHRUBS

The first shrubs to appear on the study site were blackberry (*Rubus allegheniensis*, year four, one stem), and Japanese honeysuckle (*Lonicera japonica*, year four, one stem). By year five, multiflora rose (*Rosa multiflora*, year five, one stem), poison ivy (*Toxicodendron radicans*, year five, one stem), and wild grape (*Vitis aestivalis*, year five, one stem) appeared. Three stems of oriental bittersweet (*Celastrus orbiculatus*) were also found in year five, one on each of three subplots. New arrivals in year six included black raspberry (*Rubus occidentalis*), wineberry (*Rubus phoenicolasius*), and greenbriar (*Smilax rotundifolia*). All arrived with one stem except for black raspberry which had two stems on one subplot.

Blackberry became generally common, with over 100 stems on 15 of the 16 subplots by year eight. Multiflora rose was slower to become established and did not reach a total of 100 stems on 11 subplots until year 20. However, it began to develop clusters of stems from the roots from year seven on. By year 20, 11 clusters of multiple stems were recorded. It soon spread rapidly, forming dense thickets. In year 34 there were 68 stem clusters with 475 stems on the 1600 m^2 site.

Black raspberry was found totaling 100 stems on ten subplots in year 14. It continued at about that level through the study. In contrast, blackberry rapidly increased with a total of over 1000 stems in year 16 on all 16 of the subplots. It continued at near that level through the end of the study.

Japanese honeysuckle spread rapidly from one stem in year four to locally frequent in nine subplots in year eight. On year 13, it was mapped covering 115 m^2, or 7% of the study area. It very soon increased to 30% of the cover on year 15 and reached a peak cover

at 47% in year 19. It continued at over 36% cover until the 24th year when severe winter kill reduced it to 5% cover. Though it recovered to 17% the following year, it gradually decreased to 1% in year 30 and to zero cover by year 31. Although not recorded as a specific cover in the later years, it continued as a prominent species of a newly designated mixed shrub community from year 24 on.

Oriental bittersweet increased rapidly with a total of over 100 stems in all of the 16 subplots by year 13. It continued to be locally abundant throughout the study.

As was noted above, by year 24, the common shrubs and twining shrubs had become such thickets that they were mapped as a mixed shrub cover. It covered 16% of the site year 24 and increased to 26% by year 28. It continued to be mapped near that level for the rest of the study.

Poison ivy didn't become locally frequent until year 20 when it was found in ten subplots. It was a locally frequent shrub, though not abundant, throughout the study.

Amur honeysuckle *(Lonicera maackii)* became established in year 19 with two stems in one subplot. It remained as one large bush until year 24 and then began to gradually increase as shade developed. By year 28, it had increased to 18 stems in seven subplots. It was mapped with a cover of 29 m^2 in year 29. By the year 34, it covered 51 m^2 with 108 stems in 13 subplots.

Autumn olive *(Eleaegnus umbellata)* first appeared in year 24 with one stem. It had increased to eight stems by year 29, covering 3 m^2 in two subplots. By year 34 it had increased to 13 stems covering 25 m^2 in four subplots.

Other species of shrubs recorded, though not common, included silky dogwood *(Cornus amomum)*, greenbriar *(Smilax glauca)*, fox grape, *(Vitis labrusca)*, black haw *(Viburnum prunifolium)*, and Virginia creeper *(Parthenocissus quinquefolia)*. In year 33, privet (*Ligustrum* sp.) and spice bush *(Lindera benzoin)*, a forest shrub, were first recorded.

It is important to note that all species of shrubs appear to have seeded onto the study site as none were found until the fourth year of succession. The small numbers of the first arrivals of shrub species appears significant though rapid buildup of numbers was evident for some species.

TREES

No tree seedlings or sprouts were found on the study site until the third year when one seeding black cherry *(Prunus serotina)* was found. Though present with scattered stems, black cherry never became a prominent tree on the site. By year 29, nine stems covering 10 m^2 on seven subplots were present. In year 34, it had increased to 15 stems covering 21 m^2 on nine subplots.

Another common tree of early plant succession, tulip tree *(Liriodendron tulipifera)*, was rarely found. One seedling was observed in year five and again in year seven. They did not persist.

Red maple *(Acer rubrum)* first appeared in year six and persisted throughout the study with one to five stems. In year 34 it consisted of two stems on two subplots covering 15m^2.

Bird cherry *(Prunus avium)* was also an early arrival with one seedling in year seven and again in year eight. Neither seedling persisted.

Box elder *(Acer negundo)* also was first observed in year seven with three seedlings. By year 29, eight stems were found covering 9 m^2 in four subplots. In year 34, thirteen stems covered 29 m^2 in six subplots.

The most dominant tree, black locust *(Robinia pseudo-acacia)* first appeared with five root sprouts spreading from nearby roadside trees on two subplots in year 7. By the year

13, it had increased to 23 root sprouts in four subplots with a crown cover of 2% of the study site. In year 20 there were 50 root sprouts found in ten subplots covering 14% of the site. In recent years, the crown cover had increased dramatically. It covered 46% of the 1600 m^2 study area in 13 subplots in year 34. Six trees had trunks with diameters at breast height (d.b.h.) of over 10". Eighteen trees had d.b.h's over 5". The first dead black locust sprouts and sapling trees were noted year 22. From three to six dead saplings were recorded each year until the end of the study.

Three new species of trees appeared for the first time in year eight: white ash *(Fraxinus americana)*, crabapple *(Malus domestica)*, and flowering dogwood *(Cornus florida)*. One seedling white ash was found in three subplots. By year 20, there were 17 stems in six subplots. The first crown cover of white ash was recorded in year 29 with 11 m^2 cover. It has also increased dramatically in crown cover in recent years. In year 34, it covered 80 m^2 with 32 stems in 11 subplots. One tree had a d.b.h. of 6" in year 34 and four trees had 4" d.b.h's.

One seedling crabapple was found in year eight. It slowly increased to five stems in three subplots by year 20. The first crown cover was recorded in year 29 with 5 m^2 cover. By year 34, 31 stems were found in 14 subplots with 45 m^2 of crown cover.

Flowering dogwood continued to persist with only two to three stems from year eight on. It was recorded with 14 m^2 of crown cover in year 29 though nearly covered with a tangle of wild grape and Japanese honeysuckle. It continued at nearly 14 m^2 cover until the end of the study.

Black walnut did not appear until year 13, with one seedling. In year 22, six seedlings were noted in five subplots. By year 28, it had increased to 33 seedlings in 13 subplots. The first crown cover was recorded in year 29 with 52 m^2. In year 34, 40 seedlings and saplings were found in all 16 subplots with 92 m^2 of crown cover. One black walnut was 8" (d.b.h.) and one 4" (d.b.h.).

Other species of trees found as seedlings on the 1600 m^2 study site but not persisting included Chinese elm *(Ulmus pumila)*, three times; red mulberry *(Morus rubra)*, twice; Norway maple *(Acer platanoides)*, once; honey locust *(Gleditsia triacanthos)*, once; and Chinese chestnut *(Castanea mollissima)*, four times. One sapling of red cedar *(Juniperus virginiana)* persisted from years 17 to 24 when it was girdled and killed by rodents. It had reached a height of nine feet.

Literature Cited

Overlease, W. R. 1969. Early succession on abandoned cornfields in southern Chester County, Pennsylvania. *Proceedings of the Pennsylvania Academy of Science* 43:101-105.

Overlease, W. R. 1973. Observations on early plant succession in southern Chester County, Pennsylvania. *Proceedings of the Pennsylvania Academy of Science* 47: 111-113.

Overlease, W. R. 1978. Theory and fact in patterns of species change in plant succession in southern Chester County, Pennsylvania. Unpublished manuscript.

Overlease, W. R. 1986. Checklist of the flora of Chester County, Pennsylvania. *Bartonia*, 52: 60-77.