WOODY-PLANT SUCCESSION IN THE URBAN FOREST: FILLING CRACKS AND CREVICES[1]

by Frank S. Santamour, Jr.

Abstract. The two most successful "pioneer" tree species in an abandoned urban brickyard were cottonwood *(Populus deltoides)* and ailanthus *(Ailanthus altissima)*. Woody plants of 16 genera were found in the area 10 years after abandonment and the presence or absence of species is discussed in relation to current planting practices.

What happens when a parcel of urban land is abandoned? Plants begin to invade the area and, if left unchecked, can convert the area into a forest. However, we seldom are permitted to observe the end result of plant invasion, since the period of non-use is usually short and another building or parking lot has soon replaced whatever structures has previously occupied the site.

Long before "ecology" became a much-used (and little-understood) word in our everyday lexicon, foresters and botanists were formulating theories as to why plants grow where they do. One of the more intriguing aspects of such research was the change in composition of plant communities on the same site with the passage of time. The universal process of formation development was termed "succession," and the final stage was a "climax" formation.

Clements (F.E. Clements. 1928. Plant succession and indicators. H.W. Wilson Co., New York, 453 p.) listed 6 stages in the development of a climax formation. The first was "nudation"; the destruction of existing vegetation. The second stage was "migration" of plants to the denuded site. Successful migration depended on seed production and mobility. The adjustment of these plants to their new location was called "ecesis," and this stage was followed by that of "competition" between plants. The plants of early migrations caused a change in the habitat, and this phase was called the "reaction" stage. The "stabilization" stage involved the replacement of colonizing plants with the least site demands by those with greater demands, leading to a "climax" formation. Obviously these stages do not constitute a straight-line progression, and successive migrations and competitions may be necessary to achieve stabilization.

With this brief introduction, it is of interest to study what has happened to a rather unique urban industrial site 10 years after abandonment, and what lessons on this site may provide for urban tree planters.

The Brickyard Site

At the time of the establishment of the U.S. National Arboretum in Washington, D.C. in 1927, there was considerable industrial activity adjacent to the Arboretum property along New York Avenue. Since 1909, the 30-acre site had been utilized for the manufacture of bricks and had passed through several ownerships and modes of brickmaking. A survey made in 1931 listed the presence of 9 "beehive" brick kilns built between 1927 and 1931. One additional kiln was constructed between 1931 and 1939, and 2 more kilns were built probably between 1939 and 1942. At present there are 12 kilns on the site. The brickyard operation ceased in January 1972 and the U.S. Department of Agriculture purchased the land for the U.S. National Arboretum in 1976.

The kilns are made of brick and are circular in shape, varying in inside diameter from 40 to 50 feet. The walls (25 to 41 inches in thickness) are about 8 feet high and surmounted by a circular or parobolic brick "crown." There is also a flattened area ("shoulder") around the crown which corresponds roughly to the wall thickness. When in use, most of the kiln crowns were apparantly covered with tar.

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In the 10 years since the abandonment of the brick factory, the intense heat generated by the brick making process has ceased and the kilns have been subject to natural weathering. The tar coverings have virtually disappeared and the mortar between the bricks has loosened. Cracks and crevices have trapped sufficient atmospheric dust and debris to harbor a kind of "soil" and plants have exploited these niches.

In 1982, we made a survey of the woody plants growing on or around these brick kilns (Fig. 1) to see whether such observations might provide any clues to the successes and failures of urban tree plantings. Surveys of plants on the "crowns" and "shoulders" of the kilns were made from an aerial bucket, since some of the kilns were judged unsafe to walk on. There was no attempt to measure size or determine the age of the various shrubs and trees or to determine the exact species in most cases. The data for numbers of plants recorded in each of the 3 kiln zones are given in Table 1.

Plant Migrants

It is likely that the first plant migrants were annual herbs and grasses, and this was the only type of vegetation that was found on the crown of one kiln, where the crown covering had been of concrete, rather than tar, and the weathering process had been retarded. The growth, death, and decomposition of these herbs serve to build up sufficient "soil" for the subsequent establishment of perennial woody plants.

Successful migration and establishment of woody plants depends on seed size and an efficient system of seed dissemination. Thus it is not surprising that the majority of the woody plant genera found on or near the kilns produce small

Figure 1. The "crown" of an abandoned brick kiln showing (from right); upper portion of ailanthus growing from base, and black locust and cottonwood growing on "shoulder" and "crown."

seeds that are disseminated by wind. *Populus, Salix, Platanus,* and *Betula* should be the most efficient of these, followed by *Acer, Ailanthus, Catalpa,* and *Ulmus.* The seed of *Robinia* are not particularly well adapted to wind dissemination, but the dry, seed-bearing pods can be carried considerable distances by wind.

Seeds of *Celtis, Crataegus, Juniperus, Morus,* and *Rhus* are probably disseminated by birds. Seed distribution of *Fagus* and *Quercus* could be by any combination of wind, water, gravity and animals.

Now that we have at least considered the mode of seed dissemination of all of the genera found on the kiln site, let us turn again to Table 1. There were, quite obviously, two highly successful species, and these have become dominant in quite different sites. The hot, dry crowns of the kilns are almost a pure stand of poplar, mainly *Populus deltoides* Bartram ex Marshall, the eastern cottonwood. The cool, moist areas around the bases of the kilns are largely occupied by the Chinese tree-of-heaven *(Ailanthus altissima* (Miller) Swingle*)*.

Table 1. Numbers of plants of various genera found growing on or at the base of abandoned brick kilns — 1982.

	KILN ZONE			
Genus	*Crown*	*Shoulder*	*Base*	*Total*
Acer	0	0	1	1
Ailanthus	4	7	206	217
Betula	3	0	0	3
Catalpa	1	1	6	8
Celtis	0	2	1	3
Crataegus	0	5	3	8
Fagus	0	0	1	1
Juniperus	0	1	1	2
Morus	0	0	11	11
Platanus	2	7	10	19
Populus				
deltoides	141	22	1	164
tremuloides	8	2	0	10
Quercus	0	0	1	1
Rhus	1	0	1	2
Robinia	1	22	4	27
Salix	6	11	0	17
Ulmus	0	0	23	23
Total	167	80	270	517

How is the eastern cottonwood, normally a denizen of flood plains or other well-watered sites, performing on the brick kilns? Not too well, but it is surviving. Most of the cottonwoods on the kiln crowns are dwarfed and contorted and only a few of the trees on the shoulder even approximate the upright vigorous growth expected from this species. However, the fact that some trees of cottonwood are found in all 3 zones indicates that this species possesses a wide range of adaptability. The same can be said of *Ailanthus* which, although it also occurs in all 3 zones, is doing best where moisture conditions are better. *Ailanthus* is well known as an urban "pioneer," but we seldom encounter cottonwood as an urban "weed tree." The answer may be the inability of cottonwood to compete with other species on sites which, although they may appear to be severe, can actually support species with higher site demands. The fact is that poplars *can be* successful urban trees and planted cottonwoods once lined Constitution Avenue in Washington, D.C.

Other bottomland trees that have taken hold in the more severe kiln locations are the willows *(Salix* spp.*)* and *Platanus,* probably derivatives of so-called "London" plane. Black locust *(Robinia pseudoacacia* L.*)* and *Catalpa* species have also exploited all 3 kiln zones, and these have also been previously noted as urban weeds. Among other common urban invaders, the elms (both American and Siberian) and mulberries *(Morus* spp.*)* were only found at the bases of the kilns.

As mentioned earlier, there was a paucity of species on the kilns from bird-disseminated seed. The case of *Celtis* deserves special mention. All three *Celtis* seedlings in the kiln area are *C. sinensis* Persoon, a Chinese species represented by only 3 planted trees on the Arboretum grounds a few hundred yards from the kilns.

Why was there not a greater representation of other bird-disseminated species that are growing in great numbers in close proximity to the brickyard site? Where are the Callery pears *(Pyrus calleryana* Decaisne*)*, flowering dogwoods *(Cornus florida* L. *)*, hollies *(Ilex* spp.*)* and cherries *(Prunus* spp.*)*, which include not only the Japanese flowering cherries but our ubiquitous native choke cherry *(P. virginiana* L.*)*. These are all major items in urban landscape planting.

Among the wind-disseminated species, where are the ashes *(Fraxinus* spp.*)*, the locally native and abundant tuliptrees *(Liriodendron tulipifera* L.*)* and sweetgums *(Liquidamber styraciflua* L.*)*, and the maples *(Acer* spp.*)*, presently represented by only 1 struggling seedling of boxelder *(Acer negrundo* L.*)*? Likewise, no seedlings of linden *(Tilia* spp.*)* crape myrtle *(Lagerstroemia indica* L.*)* or *Paulownia tomentosa* Thunberg (Steudel) were found on or around the kilns. The absence of another very popular urban tree (honeylocust *Gleditsia triacanthos* L.*)* can be explained by the current usage of seedless cultivars of that species.

If plant succession proceeds from species which are less site-demanding to those which are more site-demanding, it is obvious that we are not currently using many of these early migrant pioneers in planting the urban forest. Short life span, disease susceptibility, cultural problems, or lack of "esthetics" may be reasons to preclude the widespread use of many of these species. But urban trees have a tenuous survival at any rate, and increased planting of currently favored species will undoubtedly reveal pest and cultural problems similar to some of the pioneer species.

Urban tree planting in the United States is thus based largely on trees with high site demands. The planting of small trees in big holes, and some after care, will assure that these demands are met — for a short time. With increased tree growth and increased site demands — beyond those that the site can satisfy — our favored trees may only live as long as those less-favored pioneers.

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ABSTRACT

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Developing a root system soon after transplanting that will support plant growth is a problem. At least five separate and distinct growth events are involved: 1) initiation of new roots on roots that were severed when the plant was dug or when the roots were pruned, 2) initiation of new lateral roots on roots that have not been severed, 3) growth of roots that were not severed, 4) growth of newly initiated roots, 3) branching of newly initiated roots (initiation of lateral roots on newly initiated roots). These events do not occur at the same time, and they do not always occur in the same sequence, except that new roots must be initiated before they grow. The order of the events may vary with the season. If the season is such that unsevered roots are not growing, initiation of laterals on severed roots may occur first. If the season favors rapid root growth, the unsevered ones grow before the severed ones initiate laterals. Successful plant establishment does not depend on all five events, nor does it depend on the proper sequence of events. Successful establishment depends on enough of the events occuring to ensure a large root system.