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### BOTANY OF THE LUCEILLE HAGARMAN READING SCULPTURE GARDEN

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When most persons think of the places where learning happens at a college or university, they probably think of indoor spaces such as lecture halls or laboratories. Thus, it is not surprising that more consideration is typically given to the design of academic building space than is given to the design of outdoor space on campuses. The botanical plantings and hardscaping surrounding newly constructed or renovated academic buildings may even be left to outside architects and contractors, with little to no consult with educators or students at these institutions. The reality, however, is that outdoor space comprises the great majority of acreage on most campuses. At Millersville University, for example, the landscape comprises 57% of the campus's 250 acres, whereas academic buildings (i.e., classrooms, laboratories and faculty offices) comprise just 27% (Fig 1). Therefore, transforming a university's outdoor assets into

learning landscapes, through their purposeful design to complement classroom curricula, has the potential to greatly enhance learning and its applications on a campus. The recent renovation of the Millersville University library, completed in Summer 2013, created the opportunity for members of the campus community, staff, faculty and students, to design an impactful outdoor space for learning — The Luceille Hagarman Reading Sculpture Garden (Fig 2). This article describes the botanical aspects of this garden.

#### THE GARDEN FLORA

A garden is a place where people and plants interact. The Reading Sculpture Garden was conceptualized to facilitate these interactions in ways that promote learning about the diversity, conservation and evolution of Pennsylvania's native flora. This type of learning greatly benefits a university that hosts the only formal botany curriculum in the Pennsylvania State System of Higher Education and which has a student body where 1-in-10 students are biology majors.

**Diversity & Nativity in the Garden.** Initial plantings in the Garden included 82 species, of which 25 were trees, 9 were shrubs, and 48 were perennial herbs (Appendix 1). The primary criterion for species selection was that of nativity to Pennsylvania. Thus, far majority of these 82

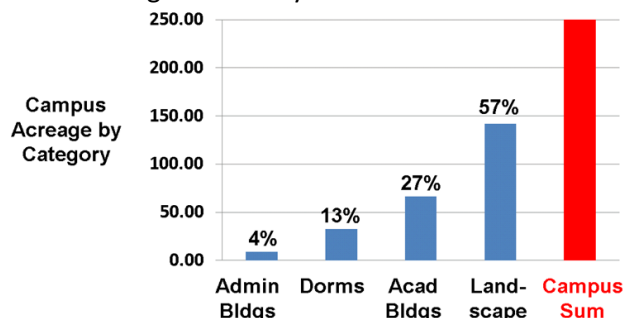


Fig 1. The landscape comprises the majority (57%) of Millersville University's 250 acres

species are native to Pennsylvania. A secondary criterion was a plant's capacity to exhibit flowers, fruits or otherwise interesting features during the school year, September through April, when most students and visitors would be around to appreciate them.

Native plants were chosen because they are the building blocks of sustainable ecosystems (Burghardt et al. 2009). They have coevolved alongside Pennsylvania's native fauna and provide the ecosystem services that are necessary for life. Native plants, however, are in decline because of habitat destruction, habitat degradation and the spread of nonnative plants in the wild—all of which are related to human activity (Hooper et al. 2005). Native gardens help reverse this decline and create landscapes where both native flora and welcome native fauna such

as bees and butterflies can thrive. Gardening with native plants also eliminates the potential for spreading non-native and invasive plants into the wild where they can out-compete and displace native plants. Thus, native plant gardens can be tools for the promotion of education about native biodiversity and its conservation. The Biology Department at Millersville has a long history of promoting the use of native plants in the landscape for these very reasons. For more than 25 years, Biology has helped to organize and sponsor the annual *Native Plants in the Landscape Conference* at Millersville. This conference annually attracts over 300 participants to Millersville from Pennsylvania and surrounding states to learn about the biology and use of native plants in the landscape.



**Fig 2.** The Luceille Hagarman Reading Sculpture Garden as seen from Google maps, accessed Feb 28, 2016 (photograph likely taken in the summer of 2014). The easternmost end of the branching and winding path in the Garden lies at 39.99862 degrees N latitude and 76.35527 W longitude (WGS 84 decimal degrees). [See this in color on the Web.]

Native plants of particular interest in the Garden include our state tree, Eastern Hemlock (*Tsuga canadensis*), and our state flower, Mountain laurel (*Kalmia latifolia*). Two species of Dayflower, the White-mouth dayflower (*Commelina erecta*) and the Virginia dayflower (*Commelina virginica*), which were extirpated in the state decades ago, are now thriving in the Garden. Other curious plants that have found homes in the garden include a prehistoric-looking Horsetail (*Equisetum hyemale*) and an American larch (*Larix laricina*), which is one of just a few species of conifers that are deciduous.

A few significant non-native plants were also tucked into the garden in order to enhance the Garden's educational value. Bald cypress (*Taxodium distichum*), for example, is native only as far north as Delaware and Maryland, yet it was planted here to expose students and Garden visitors to yet another rare example of a deciduous conifer. Ideally, our Bald cypress would also develop the curious cypress "knees" for which swamp-dwelling trees of the species are famous. Perhaps the low, moist depression in which our tree is planted will prove moist enough to elicit the growth of knees in our tree. The Franklin tree (*Franklinia alatamaha*), a member of the Tea Family, is a beautiful small tree or large shrub that was discovered in 1765 along the Altamaha River in Georgia (then a British colony) by two prominent Pennsylvanian plant explorers, John Bartram and his son William. It was later named by William in honor of his father's close friend and Philadelphian, Benjamin Franklin. Extinct in the wild since the early 1800s, all remaining plants of this beautiful species are found only in cultivation and trace their origin to seed collected by the Bartrams and disseminated out of Philadelphia. Last but not least, the Ginkgo tree (*Ginkgo biloba*), native to China, was added to the garden because of its evolutionary significance as the only extant species of Ginkgo remaining on the planet. Ginkgo also is an anomaly in the plant world in that fossil evidence indicates that it has remained relatively unchanged for over 180 million years (Beek 2000).

**Evolutionary History in the Garden.** A view from the fifth floor of the library quickly reveals that the garden's winding, dichotomously branching path (Fig 2) is a stylized depiction of plant phylogeny along which representatives of Pennsylvania's major plant groups are planted (Fig 3). Thus, a broad phylogenetic sampling of species was an important objective that guided the selection of plants for the Garden.

Proceeding along the Garden path (Fig 3) from east to west, the first two side branches of the path lead to Lycopods, Ferns & Allies – groups of plants dispersing by spores rather than seeds. The ancestors of these free-sporing plants arose between 350-400 million years ago (Ma). Today, such plants comprise just 5.8% (115 species) of the Commonwealth's native flora (Hartley 2015; Rhoads & Block 2007), yet their ancestors would have been the dominant plants during the Devonian geologic period. Their prevalence extended into the Mississippian and Pennsylvanian periods, as the primary components of the carboniferous swamps where their fossil remains would become the basis for Pennsylvania's rich coal deposits. Further west along the main spine of the Garden brings one to the Gymnosperms, whose arrival 300 Ma marks the origin of seeds. Gymnosperms are represented in the Garden by Ginkgo and conifers along a large, southerly arcing branch (Fig 3). Although comprising little more than 1.0% (15 species) of the native Pennsylvanian flora today, ancestors of these coniferous (cone-bearing) plants and other gymnosperms would have succeeded the seedless Lycopods, Ferns & Allies to become the dominant plants in Pennsylvania in parallel with the rise of reptiles during the Triassic and Jurassic periods. Further west and north of the Gymnosperm branch lie the Angiosperms, whose ancestors first appeared approximately 150 Ma with the origin of flowers and fruits. Although they are relatively recent additions to the Pennsylvanian flora, Angiosperms today comprise the far majority of our flora's species (93.3%, or 1845 species) distributed across a number of important subgroups, of which the Magnoliids, Monocots,





**Fig 3.** Illustration of the Garden master design, which called for the growing of plants native to Pennsylvania along branches of the walk that depict their phylogenetic relationships. [See this in color on the Web.]

Rosids and Asterids figure prominently in the Garden flora.

### HISTORICAL OVERVIEW

The Reading Sculpture Garden is the product of a five-year collaborative effort between students, staff and faculty of the departments of Library, Art & Design, Biology, Housekeeping & Grounds, Capital Construction, Contracting &

Design, and the Office of the Vice President for Finance & Administration. A design for the Garden was commissioned by the Library Renovation Committee, Chaired by Dr. Marilyn Parrish, in January 2010, and the design that followed is largely the consensus of design proposals submitted by undergraduate students of Fall 2010's Plant Systematics (a biology course taught by Dr. Christopher Hardy) and Sculpture (an art course taught by Prof. Line Bruntse).



The spring of 2014 saw the installation of the porous pavement walks that are the “trunk” and “arms” of the phylogenetic tree (Fig 4). The shape of planting beds came to life with the help of some fluorescent marking paint, and then the arduous task of sod removal began, aided by Jeffrey Gipe and other staff of the Housekeeping & Grounds Department. The post-construction soil was extremely compacted, rocky, and deficient in organic nutrients, so compost and fertilizer were added before planting. Planting and mulching began in June of 2014 and continued throughout the summer, with watering being a weekly effort.

Stan Kollar and staff from nearby Kollar Nursery, along with help from Dr. Hardy and the first two Robertson Endowed Library Garden Botany Interns, Nathan Hartley (the 2013 intern; MU '14) and Sherrie Moyer (the 2014 intern; MU '16), gave the garden a fresh look when they added 32 new species of trees and shrubs in

August of 2014 (Fig 5). Organic compost, fertilizer, and a lot of water got the plants off to a solid start despite the unforgiving soil conditions.

The following spring, Kollar Nurseries returned to create sweeping beds of herbaceous perennials. These lush flowering perennials helped pull together the woody elements of the beds for a more unified feel.

Ongoing work includes creating a website that will house information about the Garden and its plants in the way of “plant fact pages” that outline key features of each plant in the Garden. Labels with the names of plants are also to be developed for installation in the garden. There also is work to be done to amend the environmental conditions of the Ferns and Lycopods beds to increase the likelihood that such plants can be successfully sustained in the Garden in the long-term. These issues will be addressed as resources are available.



**Fig 4.** The Garden walk on June 3, 2014, a couple of months after the walk's installation and on the day that ground was broken on the first mulch bed on the Ferns & Allies branch. Photo taken looking north-northwest towards Dutcher Hall from the eighth floor of the Library. [See this in color on the Web.]





**Fig 5.** Woody plants being added to the Asterids section of the Garden on August 24, 2014. Pictured here are Sherrie Moyer (Botany Intern 2014), Dr. Hardy, and part of the crew from Kollar Nursery. [See this in color on the Web.]

## LIFE IN THE GARDEN

Not even a year after planting, the perennials were literally abuzz with action. The transformation from rocky, compacted earth to garden beds full of nectar and botanical cover was quickly noticed by the native insect community. Even though European honey bees are the more familiar pollinators to most, wild native bees provide pollination to a larger number of crops and native plants (Winfree et al. 2008; Rollin et al. 2013). The Garden increases the capacity of our campus to keep our native pollinators housed and fed.

Students walking through the garden took time to capture pictures of bees and butterflies filling up at the buffet of flowering Asterids (Figs 6, 7) and spiderworts from the Monocots (Fig 8). Dr. Hardy's Plant Systematics students also spent time hovering over the garden, learning about



**Fig 6.** An Eastern bumble bee (*Bombus impatiens*) preparing to “dive” into the flower of a Turtlehead (*Chelone glabra*). Photo taken in September 2015.



phylogenetic relationships and about the native flora of Pennsylvania. Students in the Fall 2014 and 2015 Plant Systematics courses were able to use the Garden after-hours as a place to study, and multiple laboratory quizzes were administered either in the Garden or with plant material collected from the Garden.



**Fig 7.** Blue-winged wasps (*Scolia dubia*) on Mountain mint (*Pycnanthemum* sp.)

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**Fig 8.** A hoverfly (*Sphaerophoria* cf. *philanthus*) on the flower of Ohio spiderwort (*Tradescantia ohioensis*).

thank the many additional people who contributed to the establishment of the Garden through its design or installation phases. In addition to those named in the article, persons include Seth Taylor, Lenny Aurand, Jim Brandau and other Grounds staff, Greg Petrino, Bill Hart, Thomas Waltz, Roger Bruszewski, Chip German, Greg Szczrybak, Members of the Library Renovation Committee, Jay Parrish, Andy Welaish, Josh Fleming, Al Unrath, Nazli, Zuzu and Zaavi Hardy, and the Office of the President at Millersville University.

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**Appendix 1** (continued on the next page). Species of the Luceille Hagarman Reading Sculpture Garden, 2015. Codes: \* denote a preexisting species from prior to Garden construction, <sup>E</sup> denotes a species not native to Pennsylvania and present either because it was already there or because it was selected for educational purposes, and <sup>†</sup> denotes a species that did not survive in the Garden by the time of publication of this article.

<b>Species</b>	<b>Common Name</b>	<b>Growth Habit</b>
<b>Lycopods</b>		
<i>Huperzia lucidula</i>	Shining firmoss	Evergreen perennial herb
<i>Lycopodium obscurum</i>	Ground-pine	Evergreen perennial herb
<b>Ferns &amp; Allies</b>		
<i>Adiantum pedatum</i> <sup>†</sup>	Northern maidenhair fern	Perennial herb
<i>Asplenium platyneuron</i> <sup>†</sup>	Ebony spleenwort	Perennial herb
<i>Dennstaedtia punctilobula</i>	Hay-scented fern	Perennial herb
<i>Equisetum hyemale</i>	Scouring rush horsetail	Perennial herb
<i>Onoclea sensibilis</i>	Sensitive fern	Perennial herb
<b>Magnoliid Angiosperms</b>		
<i>Asarum canadense</i>	Wild ginger	Perennial herb
<i>Calycanthus floridus</i>	Carolina-allspice	Deciduous shrub
<i>Lindera benzoin</i>	Spicebush	Deciduous shrub
<i>Liriodendron tulipifera</i>	Tuliptree	Deciduous tree
<i>Magnolia virginiana</i>	Sweetbay magnolia	Deciduous tree
<b>Monocot Angiosperms</b>		
<i>Allium cernuum</i>	Nodding onion	Perennial herb
<i>Andropogon gerardii</i>	Big bluestem	Perennial herb
<i>Arisaema triphyllum</i>	Jack-in-the-pulpit	Perennial herb
<i>Bouteloua curtipendula</i>	Side-oats gamma grass	Perennial herb
<i>Carex pensylvanica</i>	Pennsylvania sedge	Perennial herb
<i>Commelina erecta</i>	Whitemouth dayflower	Perennial herb
<i>Commelina virginica</i>	Virginia dayflower	Perennial herb
<i>Eragrostis spectabilis</i>	Purple lovegrass	Perennial herb
<i>Goodyera pubescens</i> <sup>†</sup>	Downy rattlesnake plantain	Perennial herb
<i>Iris versicolor</i>	Blue flag iris	Perennial herb
<i>Lilium superbum</i> <sup>†</sup>	Turk's cap lily	Perennial herb
<i>Panicum virgatum</i>	Switchgrass	Perennial herb
<i>Sisyrinchium angustifolium</i> 'Suwannee'	Blue-eyed grass	Perennial herb
<i>Spiranthes odorata</i> <sup>†</sup>	Fragrant ladies' tresses	Perennial herb
<i>Sporobolus heterolepis</i>	Prairie dropseed	Perennial herb
<i>Tradescantia ohiensis</i>	Ohio spiderwort	Perennial herb
<i>Trillium erectum</i>	Purple trillium	Perennial herb
<i>Trillium grandiflorum</i>	Large-flowered trillium	Perennial herb
<b>Gymnosperms</b>		
<i>Abies balsamea</i>	Balsam fir	Coniferous evergreen tree
<i>Chamaecyparis thyoides</i>	Atlantic cedar	Coniferous evergreen tree
<i>Ginkgo biloba</i> <sup>E</sup>	Maidenhair tree	Coniferous deciduous tree
<i>Juniperus virginiana</i>	Eastern red cedar	Coniferous evergreen tree
<i>Larix laricina</i>	American larch	Coniferous deciduous tree
<i>Picea glauca</i> <sup>E</sup>	White spruce	Coniferous evergreen tree
<i>Picea pungens</i> <sup>*E</sup>	Colorado blue spruce	Coniferous evergreen tree

<i>Picea rubens</i> <sup>†</sup>	Red spruce	Coniferous evergreen tree
<i>Pinus cembra</i> <sup>*E</sup>	Swiss stone pine	Coniferous evergreen tree
<i>Pinus strobus</i>	White pine	Coniferous evergreen tree
<i>Taxodium distichum</i> <sup>E</sup>	Bald cypress	Coniferous deciduous tree
<i>Thuja occidentalis</i>	Arbor-vitae	Coniferous evergreen tree
<i>Tsuga canadensis</i>	Eastern hemlock	Coniferous evergreen tree
<b>Rosid Angiosperms</b>		
<i>Acer pensylvanicum</i>	Moosewood	Deciduous tree
<i>Acer sacharrum</i>	Sugar maple	Deciduous tree
<i>Baptisia australis</i>	False indigo	Perennial herb
<i>Betula nigra</i>	River birch	Deciduous tree
<i>Carya tomentosa</i>	Mockernut hickory	Deciduous tree
<i>Cercis canadensis</i>	Redbud	Deciduous tree
<i>Gleditsia triacanthos</i> <sup>*</sup>	Honey locust	Deciduous tree
<i>Hamamelis vernalis</i> <sup>E</sup>	Witch-hazel	Deciduous shrub
<i>Hamamelis virginiana</i>	Witch-hazel	Deciduous shrub
<i>Hypericum prolificum</i>	Shrubby St. John's wort	Deciduous shrub
<i>Juglans nigra</i>	Black walnut	Deciduous tree
<i>Quercus phellos</i> <sup>*</sup>	Willow oak	Deciduous tree
<b>Asterid Angiosperms</b>		
<i>Chelone glabra</i>	Turtlehead	Perennial herb
<i>Conoclinium coelestinum</i>	Blue mistflower	Perennial herb
<i>Echinacea purpurea</i>	Purple coneflower	Perennial herb
<i>Eutrochium fistulosum</i>	Joe-Pye weed "Little Joe"	Perennial herb
<i>Franklinia alatamaha</i> <sup>E</sup>	Franklinia	Deciduous tree
<i>Ilex opaca</i>	American holly	Evergreen tree
<i>Ilex verticillata</i>	Winterberry	Deciduous shrub
<i>Kalmia latifolia</i>	Mountain laurel	Evergreen shrub
<i>Liatris spicata</i>	Blazing star	Perennial herb
<i>Lobelia cardinalis</i>	Cardinal flower	Perennial herb
<i>Monarda fistulosa</i>	Bergamont	Perennial herb
<i>Monarda didyma</i>	Bee-balm	Perennial herb
<i>Pycnanthemum incanum</i>	Hoary mountain mint	Perennial herb
<i>Pycnanthemum flexuosum</i>	Flexuous mountain mint	Perennial herb
<i>Pycnanthemum muticum</i>	Short-toothed mtn mint	Perennial herb
<i>Pycnanthemum verticillatum</i>	Whorled mountain mint	Perennial herb
<i>Rhododendron maximum</i>	Great laurel	Evergreen shrub
<i>Rudbeckia hirta</i>	Black-eyed Susan	Perennial herb
<i>Rudbeckia triloba</i>	Three-lobed coneflower	Perennial herb
<i>Salvia lyrata</i>	Lyre-leaved sage	Perennial herb
<i>Solidago caesia</i>	Bluestem goldenrod	Perennial herb
<i>Solidago odora</i>	Fragrant goldenrod	Perennial herb
<i>Solidago rugosa</i>	Wrinkle-leaf goldenrod	Perennial herb
<i>Symphyotrichum novae-angliae</i>	New England aster	Perennial herb
<i>Symphyotrichum novi-belgii</i>	New York aster	Perennial herb
<i>Vaccinium corymbosum</i>	Highbush blueberry	Deciduous shrub
<i>Zizia aurea</i>	Golden Alexander	Perennial herb



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