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Horticulture 2883: Directed Study in Horticulture
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Looking at Bark: Winter Tree Assessment and Mapping Temple University Main Campus, Philadelphia, PA

To many, winter landscapes in temperate regions seem nothing more than barely tolerated, bare, brown vistas of plainness and to try to identify plants in such an environment would seem impossible. But to those of sharp eye and heightened patience, winter panoramas are full of delicate assemblies of twig, bud and bark, compositions that, although present throughout the seasons, only now display themselves more conspicuously, a promise for tomorrow, subtle in their restraint. Winter colors are polar opposites of spring, summer and fall hues. Spring can be described as fresh, rising sap green brilliance, the ascending sun burnishing new growth of leaves, twigs and flowers, the most easily viewed determinants of a plant's name and designation. Summer's color grows intense and vivid, as low herbaceous borders blaze yellows, reds and oranges mimicking the sun's heat. Now fruits mature and are served up for scattering and enjoyment by all earth's creatures. Fall paints similarly bright colors only higher, tinting the tree leaves. The brighter colors soon dissipate as winter's grays and browns shroud the landscape while plants rest until spring. To take the time to look closely within these mellowed shades is to compare textures and contrasting patterns, entering a more finely tuned level of discernment and perception. So began the scheme to identify and map all interior trees on Temple University's main campus in Philadelphia, PA. during the winter of 2009.

Differentiating between and identifying dormant plants in the winter is very complex, even intimidating, but using keys, tools that assist identification of an unknown plant by narrowing the number of species possibly matching characteristics of a particular plant, it can be done, varieties within species notwithstanding. A mature tree specimen is better able to be identified than a young sapling, as the appearances of juvenile structures vary widely from those at maturity. Features such as leaves, flowers, fruit, bark, plant habit and locale are organized into key categories, two options at each stage, until only one choice is left. Persistent leaves and fruit, whether on the tree or on the ground, are the only ones that can be organized into keys for winter identification, barring those that are consumed or dispersed. Color in the landscape, more subtle than during the growing season, is yet a discriminatory dynamic.

Temple University in Philadelphia, Pennsylvania, was founded in 1884 by educator and minister Russell Hermann Conwell, who served as it first president. "Initially offering evening classes for ministers-in-training, Temple received a college charter in 1888, authorized to grant degrees in 1891, and became a university in 1907" (http://www.britannica.com). Ambler College, a satellite campus of Temple University located in Ambler, Pennsylvania, began to develop inventories of the trees in its historical arboretum in 2005 at the behest of Eva Monheim, certified arborist and instructor for Woody Plants, assisted both by students and alumnus JT Taylor, who has launched a World Wide Web database. This project for spring 2009 addresses the needs of Temple University urban foresters for tree inventories and adds tree data from Temple University's urban main campus to a wider network of tree records. An essential tool of good management, a tree inventory is the gathering of accurate information on the health and diversity of the neighborhood forest, whether in a suburban or urban location, and utilized to show the development of inventories and their importance within institutions and for communities, leading to a comprehensive community forestry management plan that looks to the future. There are practical benefits that urban centers receive from trees, on which monetary values can be placed. Trees increase in value over the years, an idea of which most citizens are unaware. An urban forest management plan is an effective tool, an action plan, used to record quantity, quality and health of a community's trees and to observe and recognize trends. Typical questions that can be answered with this information are: How many trees are there? What is the balance among genera and species? Is there a preponderance of exotic trees, or do natives support healthy local insect and wildlife communities? How old are they and in what condition are they today? Tree populations in urban environments are constantly growing and changing in places fraught with increased danger. The risks must be managed. Changes in building structures, roads, subsurface work and utility line work all impact the urban forest on an ongoing basis, creating poor or impossible conditions for some trees as well as potential sites for new plantings. Built in hazards associated with confined and compacted root spaces, increased subsurface heat from steam pipes (Eck, Pers. Com.) as well as increased atmospheric heat generated by city conditions, presence of noxious fumes and a high chance for mechanical injury all take their toll on tree health. To manage the community forest effectively one must know its condition. Considered a "living," working document, the urban forest management plan should be updated annually and adjustments made appropriately for the following year. According to the American Public Works Association, the entire document itself should be reviewed on a five or ten year basis to determine if management and urban forest conditions have changed significantly (http://www.apwa.net). For example, if large portions of the urban forest are mature and declining simultaneously, the college or city budget will feel a deep impact when the time comes to remove and replace a great number at the same time. This impact will be doubly felt by citizens now left with large gaps in the canopies that both shade their summer streets and absorb water and pollution. How much better it is to be proactive, to balance young vigorous trees against the mature specimens. Maintaining consistent work schedules and looking to the future for long term budgeting means that street crews can train and prune a mix of younger and older trees. A cryptic system of codes has been devised to note pertinent information gained during the visual assessment in the small space of the print out, creating an easily read record of each tree's condition (Fig. 1). This kind of forward thinking will not only enhance the long term health of the trees but will also minimize liability by preventing hazardous situations. It is key to review the record annually and keep it updated.

ROOT	
R-1	SGR (Circling roots)
R-2	Roots absent from one side
R-3	Severed roots
R-4	Mushrooms (root rot)
R-5	Shallow root system
R-6	Soil cracking close to trunk
R-7	Root plate separating from surrounding soil
R-8	Lack of root flare (no root flare at soil line)
TRUNK	
T-1	Fungus conks on trunk
T-2	Large branches previously removed
T-3	Open trunk and branch hollows
T-4	Decayed trunk
T-5	Cracks and cavities in branches and trunk
T-6	Abnormal taper or bulges in trunk
T-7	Mechanical damage (vandals, mower, truck, etc.)
OTHER	

O-1	Dead branches (any>2 inch diameter)
O-2	Included bark in branch union
O-3	Branches blocking a view
O-4	Branches hanging too low over the road (<16')
O-5	Leaning
O-6	Unbalanced canopy
O-7	Overhead wires
N/E/O	Native/Exotic/Other

Table 1. Codes used to indicate status of individual trees in the urban forest.

Tree identification using bark as the principal determinant (after bud and branch patterns), was the focused intent of this dendrological excursion and is discussed pertinent to trees found on the Main Campus of Temple University, Philadelphia, Pennsylvania. Key features such as plant habit and siting are obvious initial considerations and were used preliminarily. Other distinguishing botanical markers such as spines and thorns are also important components of the identification process. The campus was divided into zones based on the 2005 review done by the Synterra group and further divided as necessary to keep the information focused and accurate (Fig. 1).

The following discussion consists of two sections. The results of the survey will be discussed along with a description of the formation of bark beginning with primary meristems and culminating in explanatory classifications of the main visual categories of bark with illustrative photographical support. Anecdotal responses from this writer, students and passersby along with a summary of obstacles encountered and lessons learned along the way follow.

Results were gathered and assessed on more than one level. The following graphs depict the balance of tree families, genus and species found on Temple's main campus, as well as the ratio of native to exotic choices. Santamour, of the U.S. Agricultural

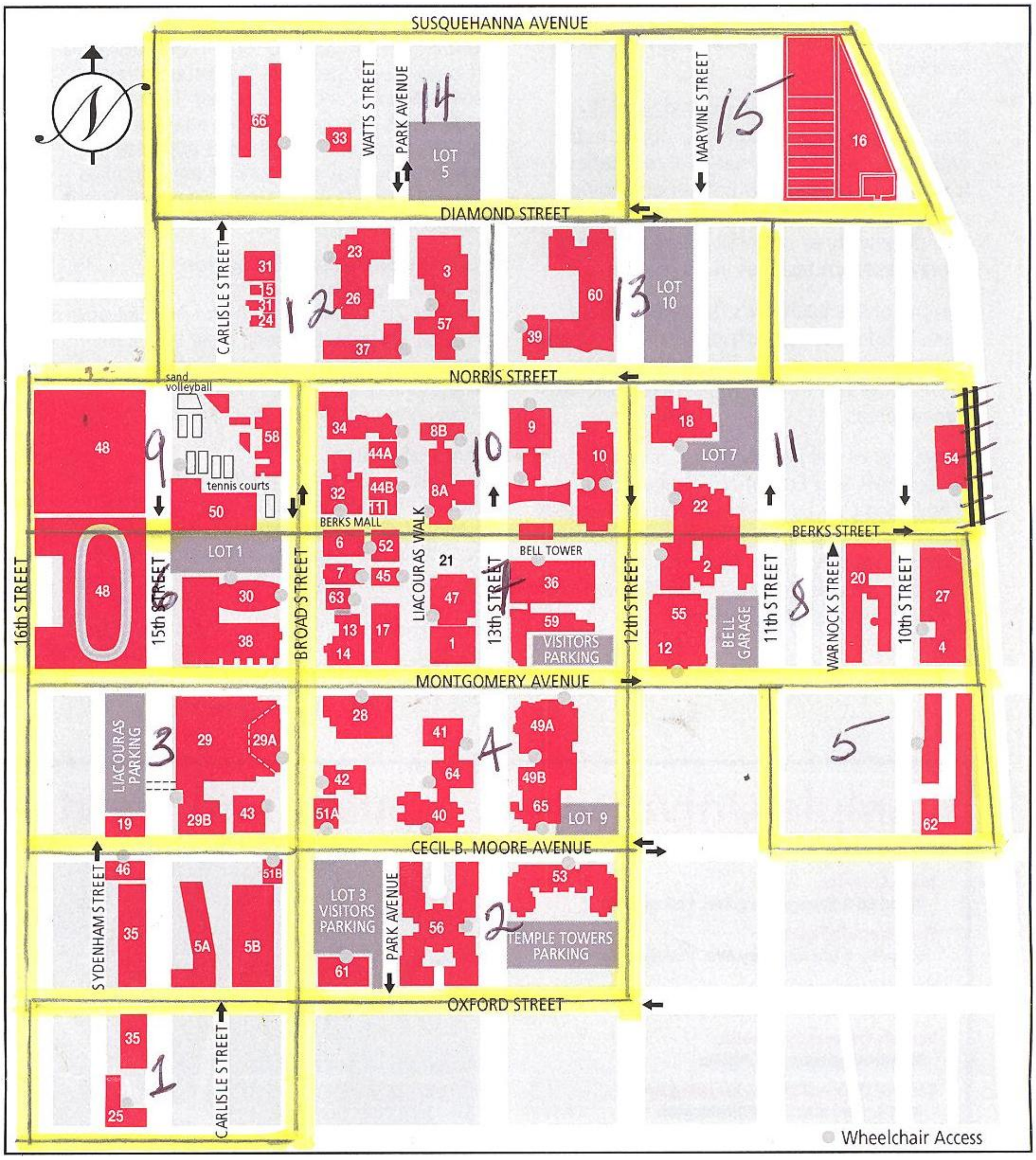
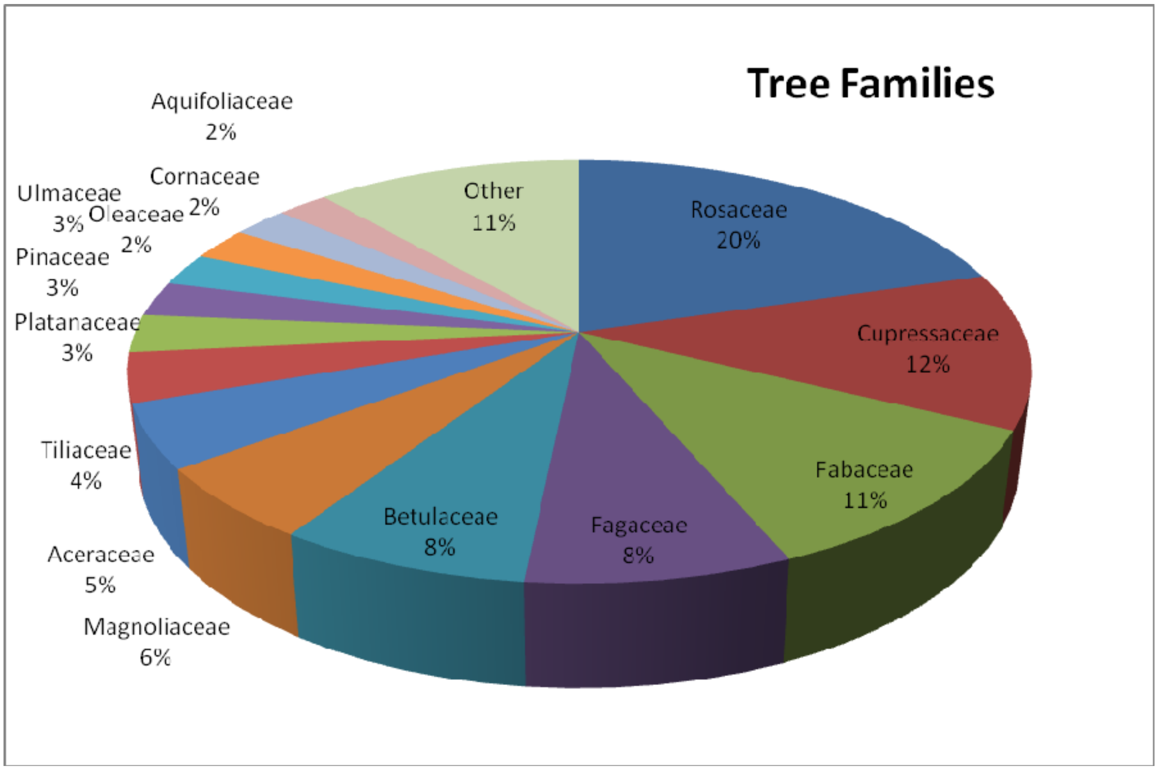


Figure 1. Zone divisions on Temple University Main Campus

Research Service advocates the “10-20-30 formula”, that is for tree selections in urban centers, as follows:

1. No more than 30% of any family
2. No more than 20% of any tree genus
3. No more than 10% of any single tree species

Using this commonsensical formula the dangers of large scale devastation by pests and diseases seen in years past and that even threaten today can limit problems to a manageable extent. Also, “strips or blocks of uniformity (species, cultivars, or clones with proven adaptability) should be placed throughout the city to spatial as well as biological diversity.” (Santamour). As Figure 2 demonstrates, the largest family represented on Temple University’s Main Campus is the rose family (*Rosaceae*),

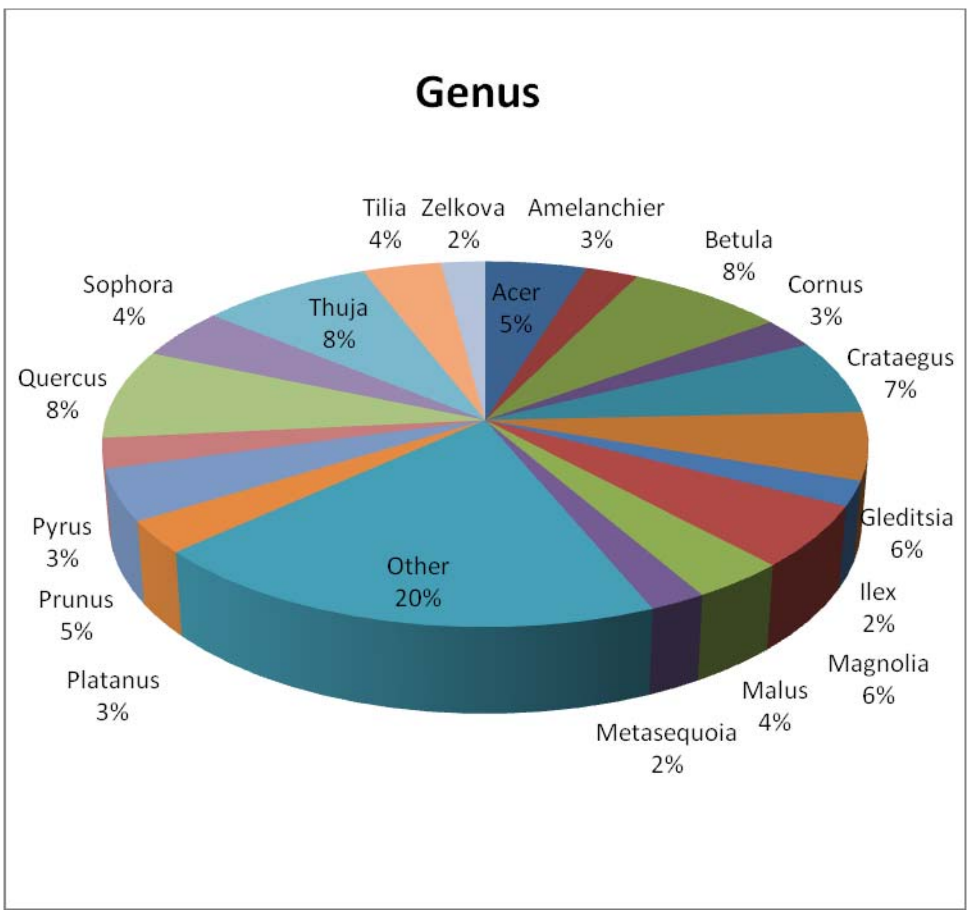


▲Fig. 2. Range of tree families on Temple University Main Campus
(Grateful acknowledgement to Ben Mosko, Ambler College, Tech. Center)

20 per cent of the whole, a number that reflects the significant number of hawthorns,common serviceberry, and crabapples planted, although this is well below thirty per cent. There are a great many hawthorns that were planted many years ago and while a resilient tree that has long been thought a good selection for city, are not in the most robust of health but continue to survive. They have definite disadvantages in the twenty first century, thorns making ideal snags for plastic bags and litter of many sorts,

all of which is difficult to remove. According to Glenn Eck, the homeless population roots through trash bags in the evening hours along the streets, unwanted items being tossed at random, giving the wind ideal playthings (Pers. Comm.) Eck makes little to no effort to enhance their living conditions and plans to remove them as they deteriorate. Please see Appendix B for a full listing.

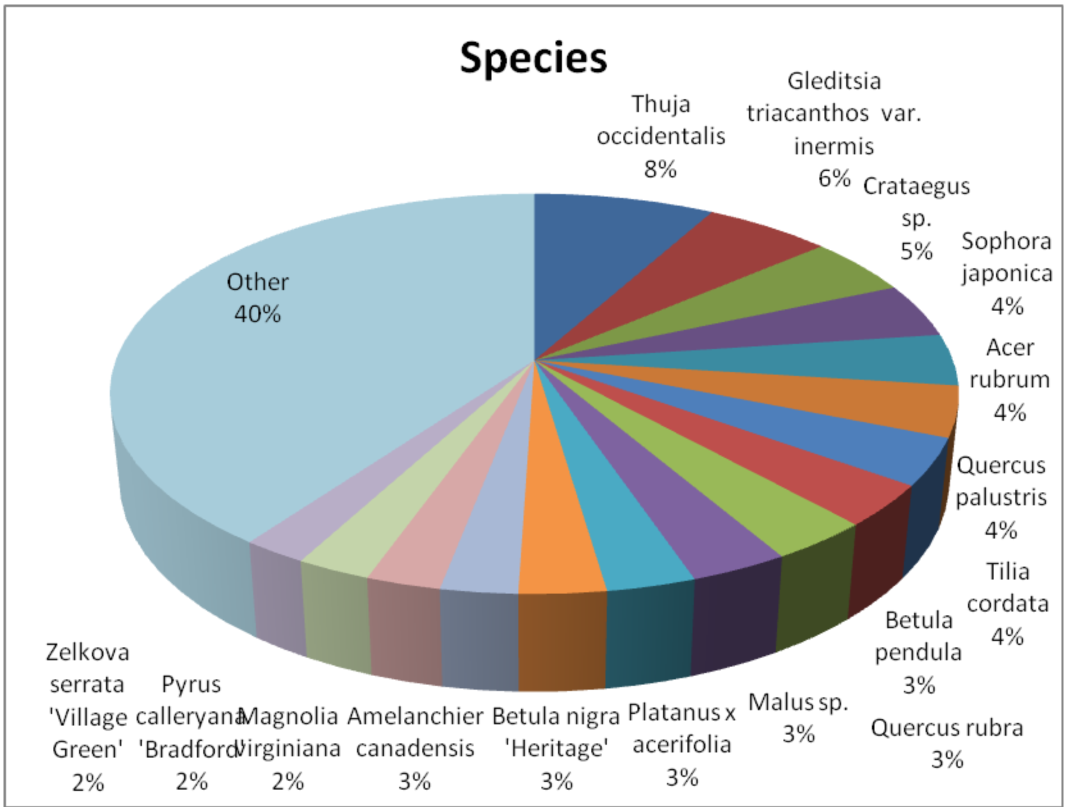
According to Santamour, no genus should be represented in numbers greater than 20 per cent and there is no genus on this campus that even comes close to 20 per cent (Fig. 3). The "Other" category is composed mainly of *Crataegus* sp. and crabapples that are



▲Fig. 3. Range of tree genera on Temple University Main Campus
(Grateful acknowledgement to Ben Mosko, Ambler College, Tech. Center)

are difficult to identify specifically. Please see Appendix C for a full listing.

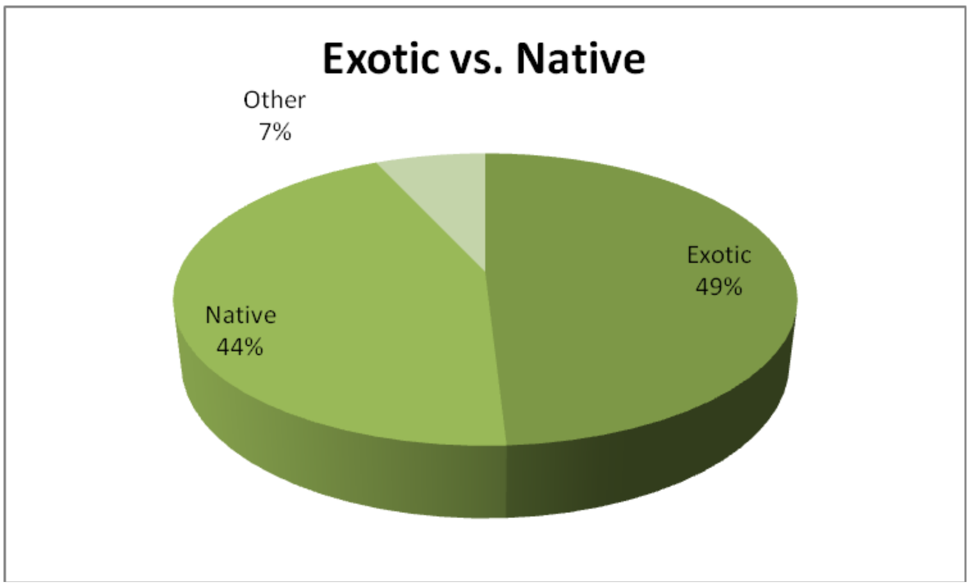
The last of Santamour's categories regards species selection which should reflect no more than 10 per cent of the whole (Fig. 4). The 40 per cent slice seen in the pie chart, again reflects the many Crataegus sp., as well as a few plants that only the genus was known



▲Fig.4. Range of tree species on Temple University Main Campus
(Grateful acknowledgement to Ben Mosko, Ambler College, Tech. Center)

verifiably. The 103 Thuja occidentalis planted as a screen in the Edberg-Olsen football practice field represents the largest slice. Categories with less than 2 per cent are classed in "Other". Please see Appendix D for a full listing.

Much has been learned in recent years about the value of planting native plants in a landscape for ecological reasons but unfortunately not before many of the large old trees were set in place (Fig. 5), even though they are non-invasive and tolerant of city conditions. They, however, don’t support native microbiota and local wildlife. Over fifty per cent of Temple’s tree population is not native to the eatern deciduous forest. Eck, Assistant Superintendant of Grounds at Temple University’s main campus, is making a concerted effort to increase the ratio of native to exotic trees on campus. He has an ideal opportunity at hand just now, with the Tyler School of Art having just been completed



▲Fg. 5. Range of native vs. exotic tree species on Temple University Main Campus (Grateful acknowledgement to Ben Mosko, Ambler College, Tech. Center)

there is need to landscape the large interior courtyard. There is also planting going on this Spring on Berk’s Street and in the courtyard at Beury Hall (Eck, Pers. Com.).

Morphology

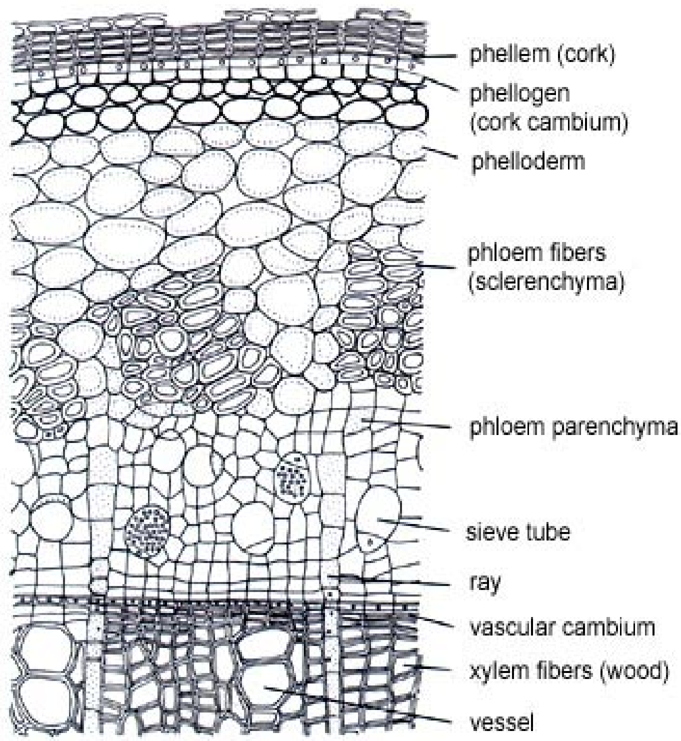
Tree bark tissue is considered to be all tissue exterior to the vascular cambium (Raven, Evert and Eichhorn, 1999) and covers the trunk of a living tree, serving principally as mechanical support for working plant organs that allow physiological growth and development. Bark provides shielding of internal structures from invasion by insects and disease, from desiccation by environmental factors such as temperature and wind, as well as insulating capabilities (Raven, Evert and Eichhorn, 1999). Bark is not yet in the picture when unicellular gametes merge to become a zygote but is well on its way when the resulting seed is shed from the mature ovary (fruit). By now the relatively undifferentiated cells in the embryo have developed and arranged themselves separately as protoderm, ground meristem and procambium, all *primary* meristems The embryonic root, or radical, anchors itself in the soil below and the plumule (shoot meristematic tissue) rises from the base of the cotyledon into the atmosphere in an "orderly sequence of leaves, nodes, and internodes" (Raven, Evert and Eichhorn, 1999), to find the raw materials of sunlight, air and water for definitive growth. Primary growth involves elongation of the apical meristems at both root and shoot, resulting in the extension of the plant body (Raven, Evert and Eichhorn, 1999) and gives rise to primary tissues such as the epidermis, the protective covering of stems and roots. Secondary or radial growth, in which plant tissues thicken, stems from activity of *lateral* meristems. The vascular cambium (lateral meristem), "forms a cylindrical sheath about the xylem of stems and roots and their branches" (Evert p 323), and forms phellogen, meristematic cork cambium, phellem or cork, and phelloderm (Feg. 6), the three components of periderm which usually arises from the sub-epidermal Cortex" www.botany.hawaii.edu.

Where vascular cambium producs cells to the inside and outside, phellogen, the middle layer, divides only towards the outside. The resulting phellem cells have suberin and or lignin deposited, creating a waterproof layer that also is a barrier to insects and disease (Fig.6).

> "Successive periclinal divisions by the Cork Cambium (Phellogen) produces files of cork cells (Phellem) towards the

outside of the organ. The overlying Epidermis is dead because the outer cork cells have died. They have separated the Epidermis from other living cells in the organ" and eventually are crushed and sloughed off. http://www.botany.hawaii.edu/)

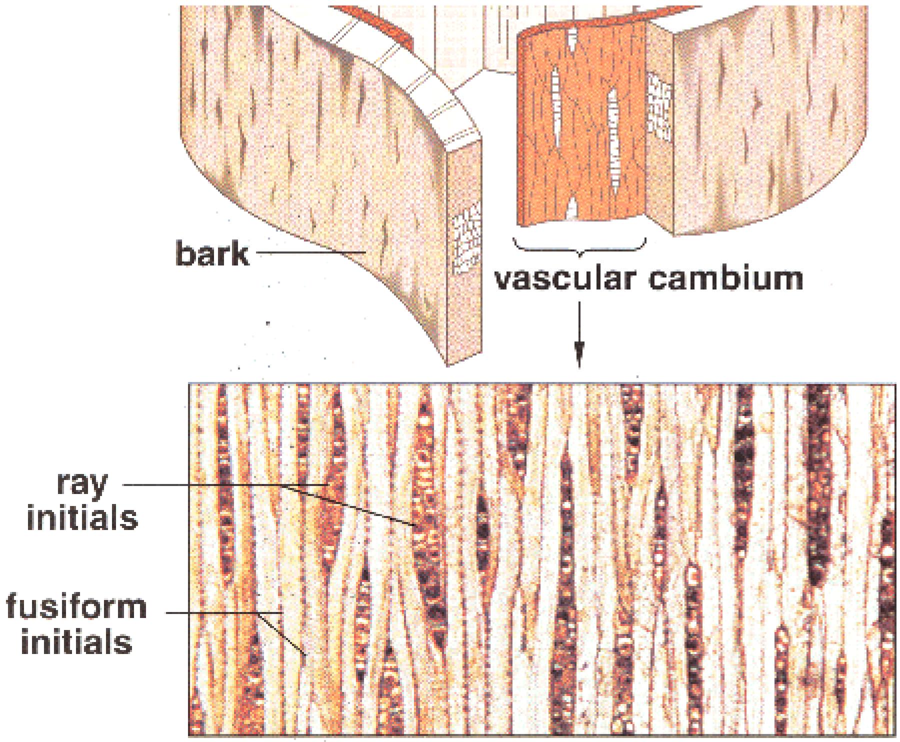
"As the periderm develops, it separates, by means of a non-living layer of cork cells, variable amounts of primary and secondary tissues of the axis from the subjacent living tissues. The tissue layers thus separated die, bringing about a distinction between the nonliving outer bark (rhytidome), and living inner bark". (Evert p 427)



▲ Fig. 6. Schematic of periderm layers
http://www.apsnet.org

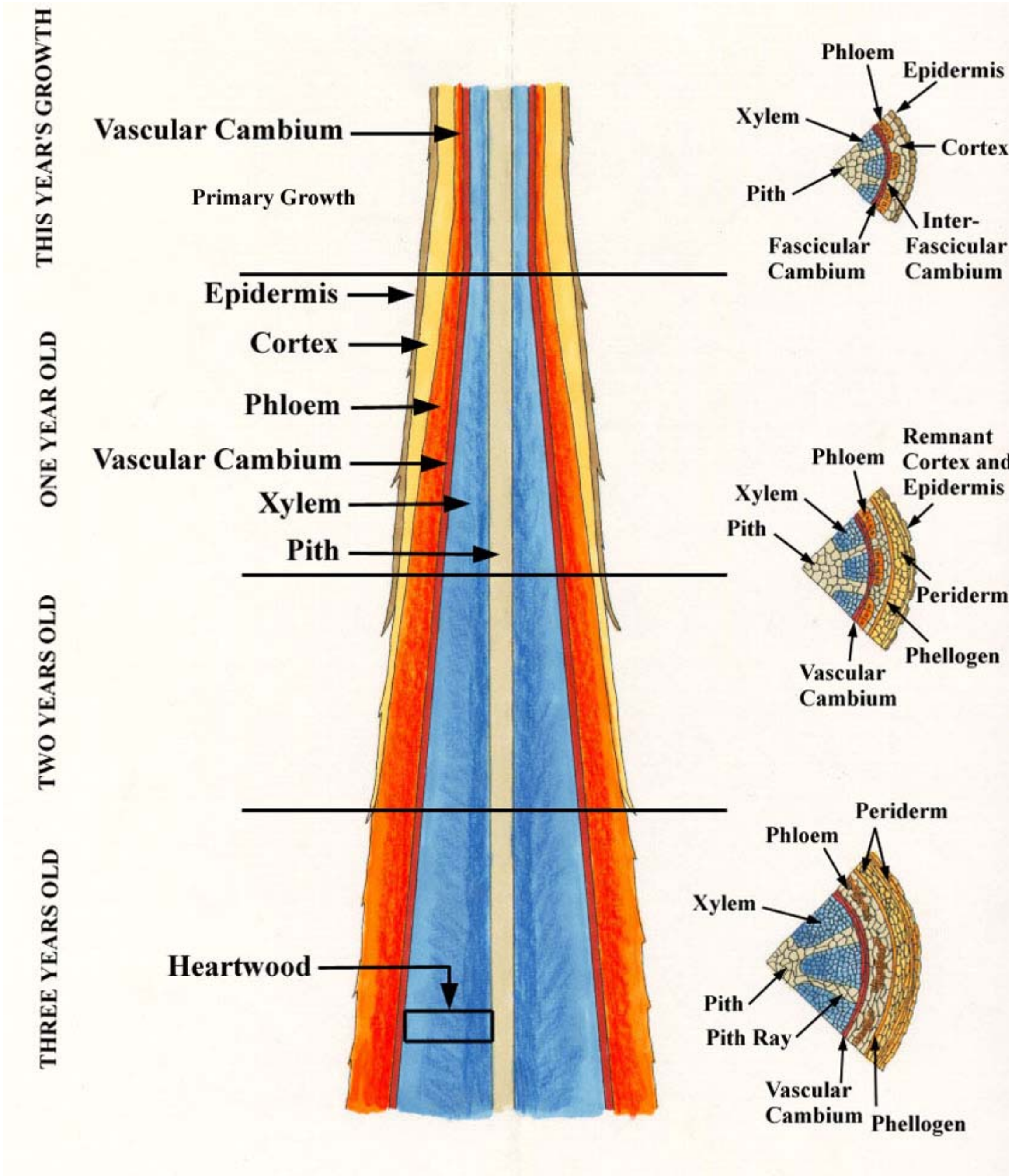
Cambial initials have two shapes morphologically, fusiform initials and ray initials, each with very different destinies (Fig.7). Fusiform initials are elongated, tall and straight, several times longer than wide, forming the cells of the longitudinal axes of the plant such as treachery element fibers, sieve elements, and axial parenchyma (Evert 2006). Ray initials are "slightly elongated to isodiametric" ("iso meaning the same and "diametric" describing dimension, that is, approximately cube shaped, and give rise to the elements of the radial system of the xylem and the phloem (Evert 2006).

Phellem is typically the thickest of the three dominant tissues of the outer bark even when it is reduced by sloughing. It mainly consists of densely packed parenchymatous cells with walls that become suberized or lignified (or both) before the cells die and become air-filled. Phellem is sometimes referred to as "cork," but since its cells are not always suberized, this term is best reserved for the phellem of cork oak" (http://www.ecology.info/article). Figure 8 shows the sequence of growth of tissue formation seen over time.



▲Fig.7. Fusiform initials and ray initials arise from the vascular cambium
http://www.cas.muohio.edu

According to Vaucher (2003) it would take at least a "million photographs" to fully document the full variety of textures and surface qualities found in tree bark. The description of a any given bark's appearance typically applies to mature specimens, and provides only broad visual markers. By its polymorphic nature and slight variants in DNA within species, the bark of woody plants will alter its thickness and transform its



▲Fig.8 Sequence of tissues arising from the vascular cambium as maturity advances.
(http://www2.puc.edu/Faculty/Gilbert_Muth/art0062.jpg)

characteristics at every stage of growth over the tree's lifetime. One must be cognizant that these are dead cells that slough regularly as the plant expands its girth. Add to that the engineering capabilities of the environment, vagaries of temperature and water regimes, siting, latitude, presence or absence of catastrophic events such as fire, disease and effects of microflora, there is immense possibility for slight differences, even between two trees of identical genus and specie. Differentiating *Betula* from *Quercus* (birch from oak), is simple enough, birch having smooth peeling bark and oak with rough vertical fissures. However, ciphering between *Sophora japonica*, *Tilia cordata* and *Ginkgo biloba*, (pagodatree, littleleaf linden and maidenhair, respectively), each with hard interlacing ridges of bark, the effort becomes much more problematic.

Bark formation is anything but haphazard, determined by evolutionary needs and the ecology of the trees' surroundings. Therefore, there exist as many types of bark as there are biomes with distinct ecosystems within them. Many trees retain well-defined morphological characteristics that today retell their ancient history. In arid regions bark may need to be photosynthetic as it may be too risky to employ moisture rich leaves for many months of the year (Sandved, Prance and Prance). White bark such as that of silver birch reflects the sun's heat, enabling pioneer trees to colonize open fields. In western North America giant redwoods and sequoia grow very thick, insulating, corky bark, up to two feet thick, a defense in fire prone areas. According to Sandved, Prance and Prance, there is a tree species called suffruteces (subshrubs), living on tropical grasslands in Brazil where fire is a routine part of the ecology, having "underground trunks and branches that spread over a large area and put up only small branches above the ground". Fire burns the leafy shoots yet the earth insulates the trunks and branches. A protection that plants employ to protect themselves from predators are prickles, thorns and spines. Not the same, they are named according to the particular tissues from which they arise. A prickle is a modified extension of the cortex and epidermis (Ex. roses, *Zanthoxylem*). It can be easily removed as it is attached only superficially. A spine is a modified leaf that occurs at the location of lateral buds in pairs (Ex. black locust). A thorn is a modified branch or stem. In cross-section, thorns show concentric circles of pith, wood and bark and occur singly (Ex. honeylocust, hawthorn) (Dr. Whiting, class notes).

To classify the diversity of bark photographically, this paper will follow a modified version of Vaucher's categories in *Tree Bark: A Color Guide* (2003). Where examples exist on Temple's main campus, an example will be highlighted. Where the photographic origin is not cited, the source is Henderson State University's Dendrology course materials (http://www.hsu.edu/default.aspx?id=6956). The examples that follow only begin to showcase the enormous range, color and textures of bark. One would need a much expanded format to address this topic properly.

Fig 9. **Thin, smooth**, often wrinkled
Ex. ***Albezia julibrissin,*** mimosa
Anderson Hall south side

Fig. 10. **Ridges/Vertical fissures** or ribs: sometimes cracked
Ex. ***Quercus phellos***
Tomlinson Theater

Fig. 11. **Ridges interlacing**, **deep**, thick, hard,diamond shaped
Ex. ***Fraxinus americanus***
Bell Parking garage N. side
Also: ***Juglans cinerea***
Tech Center N. side
(ridges more shallow)
http://www.forestry.umn.edu/extension

Fig. 12. **Ridges interlacing, shallow**
Ex. ***Tilia cordata***
Barton Hall
(Also: ***Sophora japonica***
Paley Library (ridges thicker)
Ginkgo biloba
Sullivan Hall (ridges thicker, flatter))
http://www.forestry.umn.edu/extension

Fig. 13. **Corky** with raised rhytidomes: thick, hard
Ex. *Quercus suber* native to Mediterranean climates
http://www.forestryimages.org

Fig. 14. **Spongy/fibrous: soft,** longitudinal ridges weather on top; often very thick
Ex. *Sequoia sempervirens*
http://oregonstate.edu

Fig. 15. **<u>Scaly:</u> large**, elongated asymmetrical
Ex. ***Pinus thunbergii***
Beury Hall
http://oregonstate.edu

Fig. 16. **<u>Peeling</u>/ thin/smooth**: separating into thin strips, rolling, flaking
Ex. ***Betula nigra* 'Heritage'**
Heritage river birch (Tech. Center)

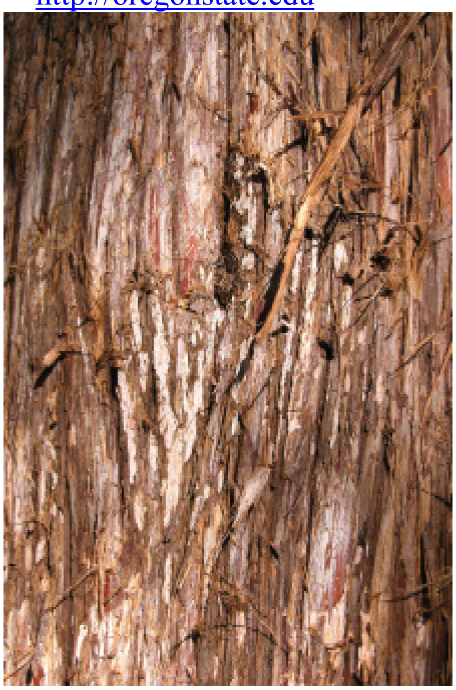


Fig 17. **<u>Fibrous,</u>** narrow, flexible, peeling strips
Ex. ***Juniperus virginiana,***
eastern red cedar
Ritter Hall west

Fig. 18. **<u>Patchy</u>**: smooth, flaking asymmetrically, lighter bark beneath
Ex. ***Platanus x acerifolia,***
Tech Center
Stephen J. Baskauf
Vanderbilt University
www.cas.vanderbilt.edu

Fig. 19. **<u>Lenticels:</u> scattered, thin**
Ex. ***Hamamelis virginiana***
Berk's Mall

Fig. 20. **<u>Lenticels:</u> forming horizontal lines**
Ex. ***Betula lenta***
Johnson & Hardwick Hall

Fig. 21. **<u>Prickly:</u>** thick, conical
Ex. ***Zanthoxylem americanum***
Hercules' club or toothache tree
Tech Center N.

Fig. 22. **<u>Thorny:</u>** slender, thin, often branched
Ex. ***Gleditsia triacanthos***
Paley Library NE corner

The dissimilarities between juvenile and mature forms of tree bark became more and more apparent as time went on, noticeably on *Quercus palustris,* but fascinatingly so on *Acer rubrum,* of which there were many of varied stages. When red maples are very

Fig. 23. A***cer rubrum*** (adolescent)
Broad St.

Fig. 24. ***Acer rubrum*** (mature)
(z.about.com/d/forestry)

young, their bark is smooth consisting of just the thin epidermis mentioned earlier. The bark is silvery gray, smooth at first, with a nice sheen, not especially evident in these photographs (Figures 23 and 24.). dark patches surround branch origins, prompting this writer to initially think of and excurrent version of *Betula pendula.* Gradually, with age, the bark darkens, begins to split and breaks up into large scaly plates.

It was a very informative process to focus on the part of the physical world that is the most prominent, takes up the greatest percentage of landscape space yet is clearly unseen by most during the winter months. There are a great many trees on Temple's main campus and without leaf cover one is struck primarily by varying architectural shapes of tree trunk and branch backlit by limestone and brick. Yet one had only to look up to see thousands of small, persistent globular fruits highlighted in the weak winter sun, glowing like iridescent amber throughout the canopies of the Japanese scholartrees. Students bundled up against the cold, were busy catching a smoke or rushing between classes. They did not see. Some did, but only when their way was obstructed by a person with a measuring tape and clipboard. Others were curious, such as student groups who take the time to stand throughout the campus to raise awareness or collect funds for various exemplary causes, such as those connected to Greenpeace and PennEnvironment, (green groups), were most interested and had the most questions but all showed a lack of awareness of trees in cities and why an inventory was important. One weekend, a single student's interest generated many queries and a lengthy discussion. Younger students, elementary through high school also walk through the campus on their way to and from their own classes. A seven year old child was surprised and interested to know that trees had names. Hereafter he knows who "Mr. River Birch" is and will identify him by his peeling bark. A teenager declared that "trees are dead", and that "all these years I've been in school, ain't no teacher ever told me that trees are alive" He, being quite certain that he was right, I sent him on his way to ask his teacher this question.

Focusing with such intent for months at time on a narrow subject such as bark changes how one sees it. There is so much less distraction in winter and weekends, with the campus free of hustle and bustle, provided many quiet hours for measuring and reflection. The varied appearance of the bark of trees as it exists in the real world is as individual and unique as human fingerprints (Vaucher). None will be the same as no two will experience the exact same physical and biological events over their lifetime. Enough general similarities exist, however, that a practiced eye can, with knowledge of geography and habit, discern the differences without benefit of leaves. The experience offered other experiences and lessons that only became apparent by daily viewing.

This winter sojourn, for this writer, became close to poetic on some days. It was as if the buildings fell away and what was left was a museum of tall assemblies, some in formation and some not, but with all manner of form and ornamentation. There were the wispy, hanging tendrils of *Betula* blowing in the winter wind. There were stout twigs and branches belonging to the waiting buds of bipinnately compound leaves of *Gymnocladus* and *Juglans,* along with impossibly thin and delicate buds and twigs of *Styrax.* This writer's personal response can be summed up by a chance event described in the following short piece.

Tree Opus

"Cinque...dieci...venti...
trenta...trentasei...quarantatre"
(Five...ten...twenty ...
thirty...thirty-six...forty-three)

"The Marriage of Figaro"
Wolfgang Amadeus Mozart 1785

> Figaro, measuring-stick in hand, is measuring the space in his new home. In contrast to Mozart's opera, I am measuring trees in the Founder's garden at Temple University's main campus for an independent arboriculture project. By happenstance, a class of modern dance students is moving within the circular garden space, turning in slow, improvisational movements. Mozart's music echoes in my mind as I identify, and measure and assess the trees, the bust of Russell Conwell, Temple's founder looking solemnly on. The dancers are lifting, carrying, flourishing and tossing long poles that still retain the natural curves of the branches they once were. The poles seem to be as much part of this tableau as the elegant but dormant trees. The dancers explore the energy of this space, some jogging slowly, pushing the pole as it bumps along the stone surface, others lifting and transferring, pole to pole, a purple scarf undulating gently in the breeze. This is a round sunken garden, completely surrounded by silver birches, delicate, graceful, pendulous branches enclosing and sheltering the space and those moving

> within it. Time slows with the motions of the dancers and now my rhythms seem to coincide with theirs. I feel that I have fallen out of time as my movements reflect theirs. My yellow tape measure lifts high and swings in a gentle arc around the trunk of a tree, the numbers glinting in the dappled sunlight. I hug the tree momentarily to note the measurement and jot it down. On to the next tree. I dance and weave my way slowly around the perimeter of the circular courtyard keeping time with and inspired by the performance in the center. The breeze lifts the fine weeping branches of the birches, their suspended catkins already swelling with the warmer temperatures. Everything around me is on edge, waiting, ready to burst into flower and leaf. Here is the resurgence of spring, the reaffirmation of life in real time.

Bark is a side of nature so close to everyone, yet whose beauty and diversity is overlooked by the casual passerby. At last, attitudes are changing toward the environment. As the world warms and average citizens become more aware of plants and their vital role in living on earth, city dwellers will learn through instruction and education to look beyond the flowers, the colorful sexual parts of plants, to see the rich diversity of bark and understand its valuable role in the life of trees. There were certainly no brown vistas of plainness found by this writer at the main campus of Temple University. As the resultant lists are reviewed, each tree's form and bark is seen in the mind's eye. Even as spring turns to summer, the bark of trees still beckons.

ADDENDUM

Lessons were learned as well, regarding urban university campus locations for visual tree assessments and regarding distinct winter time requirements. A short list follows delineating needs for which to be prepared:

1. Locked gates and fences requisite for any city campus.
2. Climbs into raised planters and foundations
3. Steep banks
4. Thick, often thorny, basal shrubbery and plantings
5. Winter wind contested hold on papers and tape measure. On several occasions, remaining upright was the biggest challenge

6. Precipitation in many forms, principally rain

Two main drawbacks became apparent during this project, one due to the winter season and the other due to design choices on Temple's campus. Assessing trees in winter dormancy precludes assessment of the crown of a tree as well as any clear conclusion as to the health and longevity of each specimen. Secondly, ivy is used extensively throughout the campus and while it makes sense as a ground cover and a deterrent to trash buildup, it covers the root flares and basal structures of trees, making it impossible to assess them. While it is apparent that great effort is taken to keep the ivy off the trees themselves, in some places the ground cover is well over 12 inches deep, creating ideal cover for rodents and other wildlife.

The way was thoroughly prepared, barring weather. I owe a debt of gratitude to several people on Temple University's Main Campus, without whom this project could not have been completed. Glenn Eck was 100 per cent available and supportive, even when this writer challenged identities of many trees. I thank him for his patience. On the weekends, Joe Clemens was easily on hand to answer questions and to pry padlocks open. I also appreciate Scott Washburn, Facilities Coordinator, who assisted with CAD maps and advice as well as Ben Mosko of Ambler College Tech. Center for help with Excel spreadsheets and analyses.

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<u>APPENDICES</u>

<u>APPENDIX A</u>: MAIN CAMPUS TreeBook 2009 See separate spread sheet.

<u>APPENDIX B</u>

<u>FAMILY MIX</u>: Temple University Main Campus 2009
BY PERCENTAGE

Family	Number	Percentage
Rosaceae	259	20.35%
Cupressaceae	152	11.94%
Fabaceae	144	11.31%
Fagaceae	102	8.01%
Betulaceae	97	7.62%
Magnoliaceae	71	5.58%
Aceraceae	62	4.87%
Tiliaceae	48	3.77%
Platanaceae	37	2.91%
Pinaceae	34	2.67%
Oleaceae	32	2.51%
Ulmaceae	32	2.51%
Cornaceae	30	2.36%
Aquifoliaceae	28	2.20%
Taxodiaceae	22	1.73%
Ginkgoaceae	21	1.65%
Celastraceae	19	1.49%
Hamamelidaceae	19	1.49%
Anacardiaceae	17	1.34%
Sapindaceae	17	1.34%
Styracaceae	9	0.71%
Lythraceae	6	0.47%
Cercidiphyllaceae	5	0.39%
Rhamnaceae	3	0.24%
Ericaceae	2	0.16%
Caprifoliaceae	1	0.08%
Juglandaceae	1	0.08%
Moraceae	1	0.08%
Rutaceae	1	0.08%
Theaceae	1	0.08%

ALPHABETICALLY

Family	Number	Percentage
Aceraceae	62	4.87%
Anacardiaceae	17	1.34%
Aquifoliaceae	28	2.20%
Betulaceae	97	7.62%
Caprifoliaceae	1	0.08%
Celastraceae	19	1.49%
Cercidiphyllaceae	5	0.39%
Cornaceae	30	2.36%
Cupressaceae	152	11.94%
Ericaceae	2	0.16%
Fabaceae	144	11.31%
Fagaceae	102	8.01%
Ginkgoaceae	21	1.65%
Hamamelidaceae	19	1.49%
Juglandaceae	1	0.08%
Lythraceae	6	0.47%
Magnoliaceae	71	5.58%
Moraceae	1	0.08%
Oleaceae	32	2.51%
Pinaceae	34	2.67%
Platanaceae	37	2.91%
Rhamnaceae	3	0.24%
Rosaceae	259	20.35%
Rutaceae	1	0.08%
Sapindaceae	17	1.34%
Styracaceae	9	0.71%
Taxodiaceae	22	1.73%
Theaceae	1	0.08%
Tiliaceae	48	3.77%
Ulmaceae	32	2.51%

APPENDIX C
GENUS MIX: Temple University Main Campus 2009

BY PERCENTAGE

Thuja	105	8.2%
Quercus	101	7.9%
Betula	97	7.6%
Crataegus	84	6.6%
Gleditsia	76	6.0%
Magnolia	71	5.6%
Acer	62	4.9%
Prunus	58	4.6%
Sophora	57	4.5%
Tilia	48	3.8%
Malus	45	3.5%
Platanus	37	2.9%
Cornus	34	2.7%
Pyrus	34	2.7%
Amelanchier	32	2.5%
Ilex	28	2.2%
Metasequoia	27	2.1%
Zelkova	27	2.1%
Pinus	23	1.8%
Cryptomeria	22	1.7%
Ginkgo	21	1.6%
Chamaecyparis	19	1.5%
Euonymus	19	1.5%
Syringa	18	1.4%
Cotinus	17	1.3%
Koelreuteria	16	1.3%
Liquidambar	12	0.9%
Fraxinus	9	0.7%
Styrax	9	0.7%
Tsuga	8	0.6%
Cercis	6	0.5%
Lagerstroemia	6	0.5%
Cercidiphyllum	5	0.4%
Hamamelis	5	0.4%
Ulmus	5	0.4%
Cedrus	4	0.3%
Chionanthus	4	0.3%
Gymnocladus	3	0.2%
Rhamnus	3	0.2%
Corylopsis	2	0.2%
Fagus	2	0.2%

Oxydendron	2	0.2%
Aesculus	1	0.1%
Albizia	1	0.1%
Cladastris	1	0.1%
Juglans	1	0.1%
Juniperus	1	0.1%
Morus	1	0.1%
Pyracantha	1	0.1%
Stewartia	1	0.1%
Viburnum	1	0.1%
Zanthoxylum	1	0.1%

GENUS MIX: Temple University Main Campus 2009

ALPHABETICALLY

Genus	Number	Percentage
Acer	62	4.9%
Aesculus	1	0.1%
Albizia	1	0.1%
Amelanchier	32	2.5%
Betula	97	7.6%
Cedrus	4	0.3%
Cercidiphyllum	5	0.4%
Cercis	6	0.5%
Chamaecyparis	19	1.5%
Chionanthus	4	0.3%
Cladastris	1	0.1%
Cornus	34	2.7%
Corylopsis	2	0.2%
Cotinus	17	1.3%
Crataegus	84	6.6%
Cryptomeria	22	1.7%
Euonymus	19	1.5%
Fagus	2	0.2%
Fraxinus	9	0.7%
Ginkgo	21	1.6%
Gleditsia	76	6.0%
Gymnocladus	3	0.2%
Hamamelis	5	0.4%
Ilex	28	2.2%
Juglans	1	0.1%
Juniperus	1	0.1%
Koelreuteria	16	1.3%

Lagerstroemia	6	0.5%
Liquidambar	12	0.9%
Magnolia	71	5.6%
Malus	45	3.5%
Metasequoia	27	2.1%
Morus	1	0.1%
Oxydendron	2	0.2%
Pinus	23	1.8%
Platanus	37	2.9%
Prunus	58	4.6%
Pyracantha	1	0.1%
Pyrus	34	2.7%
Quercus	101	7.9%
Rhamnus	3	0.2%
Sophora	57	4.5%
Styrax	9	0.7%

APPENDIX D:

GENUS AND SPECIES MIX: Temple University Main Campus 2009
BY PERCENTAGE

Species	Number	Percentage
Thuja occidentalis	103	8.091%
Gleditsia triacanthos var. inermis	72	5.656%
Crataegus sp.	60	4.713%
Sophora japonica	56	4.399%
Acer rubrum	53	4.163%
Quercus palustris	52	4.085%
Tilia cordata	48	3.771%
Betula pendula	43	3.378%
Quercus rubra	42	3.299%
Malus sp.	41	3.221%
Platanus x acerifolia	37	2.907%
Betula nigra 'Heritage'	36	2.828%
Amelanchier canadensis	32	2.514%
Magnolia virginiana	31	2.435%
Pyrus calleryana 'Bradford'	31	2.435%
Zelkova serrata 'Village Green'	27	2.121%
Crataegus laevigata	24	1.885%
Prunus serrulata 'Kwanzan'	23	1.807%
Ginkgo biloba	21	1.650%

Pinus thunbergii	20	1.571%
Metasequoia glyptostroboides	19	1.493%
Cornus kousa	18	1.414%
Syringa reticulata 'Ivory Silk'	18	1.414%
Cotinus coggygria 'Royal Purple'	17	1.335%
Euonymus alata 'Compacta'	17	1.335%
Cornus florida	16	1.257%
Cryptomeria japonica	16	1.257%
Koelreuteria paniculata	16	1.257%
Betula pendula 'Laciniata'	15	1.178%
Chamaecyparis obtusa 'Aurea'	15	1.178%
Magnolia x soulangiana	14	1.100%
Prunus x yeodensis 'Yoshino'	13	1.021%
Liquidambar styraciflua	12	0.943%
Magnolia stellata	10	0.786%
Prunus x incamp 'Okame'	10	0.786%
Styrax japonicus	9	0.707%
Metasequoia glyptostroboides	8	0.628%
Tsuga diversifolia	8	0.628%
Ilex x 'Nellie R. Stevens'	7	0.550%
Cercis canadensis	6	0.471%
Cryptomeria japonica 'Yoshino'	6	0.471%
Lagerstroemia indica	6	0.471%
Magnolia grandiflora	6	0.471%
Fraxinus pennsylvanica	5	0.393%
Hamamelis virginiana	5	0.393%
Magnolia acunimata	5	0.393%
Quercus phellos	5	0.393%
Acer ganella	4	0.314%
Cedrus atlantica 'Glauca'	4	0.314%
Fraxinus americana	4	0.314%
Gleditsia triacanthos	4	0.314%
Ilex opaca	4	0.314%
Ilex x 'Nellie R Stevens	4	0.314%
Ilex x Nellie R.Stevens	4	0.314%
Prunus cerasifera	4	0.314%
Acer griseum	3	0.236%
Betula lenta	3	0.236%
Cercidiphyllum japonicum	3	0.236%
Chamaecyparis obtusa	3	0.236%
Gymnocladus dioicus	3	0.236%

Ilex cornuta	3	0.236%
Ilex x meserveae	3	0.236%
Magnolia macrophylla	3	0.236%
Malus sargentii	3	0.236%
Pinus thunbergii 'Thunderhead'	3	0.236%
Prunus subhirtella	3	0.236%
Prunus subhirtella 'Pendula'	3	0.236%
Pyrus calleryana 'Redspire'	3	0.236%
Rhamnus cathartica	3	0.236%
Ulmus parvifolia	3	0.236%
Cercidiphyllum japonicum 'Pendula'	2	0.157%
Chionanthus retusus	2	0.157%
Chionanthus virginicus	2	0.157%
Corylopsis chinensis	2	0.157%
Euonymus alata 'Compacta'	2	0.157%
Fagus sylvatica 'Fastigiata'	2	0.157%
Ilex x Nellie R. Stevens	2	0.157%
Magnolia kobus	2	0.157%
Oxydendron arboreum	2	0.157%
Thuja occidentalis 'Aurea'	2	0.157%
Acer palmatum var. dissectum	1	0.079%
Acer saccharum	1	0.079%
Aesculus hippocastaneum	1	0.079%
Albizia julibrissen	1	0.079%
Chamaecyparis pisifera 'Filifera Aurea'	1	0.079%
Cladastris kentukea	1	0.079%
Ilex opaca cv.	1	0.079%
Juglans cinerea	1	0.079%
Juniperus virginiana	1	0.079%
Malus x 'Snowdrift'	1	0.079%
Morus sp.	1	0.079%
Prunus sargentii	1	0.079%
Prunus subhirtella 'Pendula'	1	0.079%
Pyracantha coccinea	1	0.079%
Quercus coccinea	1	0.079%
Quercus macrocarpa	1	0.079%
Sophora japonica 'Laciniata'	1	0.079%
Stewartia pseudocamillia	1	0.079%
Ulmus sp.	1	0.079%
Ulmus x hollandica	1	0.079%
Viburnum sp.	1	0.079%

Zanthoxylum americana	1	0.079%

ALPHABETICALLY

Species	Number	Percentage
Acer ginnala	4	0.314%
Acer griseum	3	0.236%
Acer palmatum var. dissectum	1	0.079%
Acer rubrum	53	4.163%
Acer saccharum	1	0.079%
Aesculus hippocastaneum	1	0.079%
Albizia julibrissen	1	0.079%
Amelanchier canadensis	32	2.514%
Betula lenta	3	0.236%
Betula nigra 'Heritage'	36	2.828%
Betula pendula 'Laciniata'	15	1.178%
Betula pendula	43	3.378%
Cedrus atlantica 'Glauca'	4	0.314%
Cercidiphyllum japonicum 'Pendula'	2	0.157%
Cercidiphyllum japonicum	3	0.236%
Cercis canadensis	6	0.471%
Chamaecyparis obtusa 'Aurea'	15	1.178%
Chamaecyparis obtusa	3	0.236%
Chamaecyparis pisifera 'Filifera Aurea'	1	0.079%
Chionanthus retusus	2	0.157%
Chionanthus virginicus	2	0.157%
Cladastris kentukea	1	0.079%
Cornus florida	16	1.257%
Cornus kousa	18	1.414%
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Cryptomeria japonica	16	1.257%
Euonymus alata 'Compacta'	17	1.335%
Euonymus alata 'Compacta'	2	0.157%
Fagus sylvatica 'Fastigiata'	2	0.157%
Fraxinus americana	4	0.314%
Fraxinus pennsylvanica	5	0.393%
Ginkgo biloba	21	1.650%
Gleditsia triacanthos var. inermis	72	5.656%

Gleditsia triacanthos	4	0.314%
Gymnocladus dioicus	3	0.236%
Hamamelis virginiana	5	0.393%
Ilex cornuta	3	0.236%
Ilex opaca cv.	1	0.079%
Ilex opaca	4	0.314%
Ilex x meserveae	3	0.236%
Ilex x 'Nellie R Stevens	4	0.314%
Ilex x Nellie R. Stevens	2	0.157%
Ilex x 'Nellie R. Stevens'	7	0.550%
Ilex x Nellie R.Stevens	4	0.314%
Juglans cinerea	1	0.079%
Juniperus virginiana	1	0.079%
Koelreuteria paniculata	16	1.257%
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Magnolia acunimata	5	0.393%
Magnolia grandiflora	6	0.471%
Magnolia kobus	2	0.157%
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Pinus thunbergii	20	1.571%
Platanus x acerifolia	37	2.907%
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Prunus serrulata 'Kwanzan'	23	1.807%
Prunus subhirtella 'Pendula'	1	0.079%
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Quercus macrocarpa	1	0.079%
Quercus palustris	52	4.085%
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Stewartia pseudocamillia	1	0.079%
Styrax japonicus	9	0.707%
Syringa reticulata 'Ivory Silk'	18	1.414%
Thuja occidentalis 'Aurea'	2	0.157%
Thuja occidentalis	103	8.091%
Tilia cordata	48	3.771%
Tsuga diversifolia	8	0.628%
Ulmus parvifolia	3	0.236%
Ulmus sp.	1	0.079%
Ulmus x hollandica	1	0.079%
Viburnum sp.	1	0.079%
Zanthoxylum americana	1	0.079%
Zelkova serrata 'Village Green'	27	2.121%