Liriodendron tulipifera – Tulip Tree

Cahokia Mounds – Illinois

THE MAGNOLIACEAE – MAGNOLIAS, TULIP-TREE, CUCUMBER-TREE

By Susan McDougall

In 2011, my husband and I toured and photographed arboretums across the continental United States as part of a book project. One of the Arboretums we visited was the National Arboretum in Washington, D.C. Easily accessed by automobile, or well-groomed paths, the arboretum is home to several specialty plantings, including a State Tree field with representatives from all 50 states, as well as an outstanding historic azalea collection and a native plant garden. Herbaceous species — common in the East but unknown to us — a fine bonsai display, and an interesting alternative energy group of plants added to the interest of the arboretum. We spent an engaging, warm day in our national garden.

Late in the day as we walked back towards the arboretum entrance, we decided to make a quick visit to the Gift Shop and take a final photograph or two of the plants that bordered the parking lot. There we saw an attractive magnolia, and as I set up the camera, David checked the label. The tree was named 'Susan,' a cross between two other selections, with parentage native to Asia. Susan' was developed at the National Arboretum and is a large shrub or small tree, making it ideal for a southern landscape.

I thought this was a rather nice finish to the day – a tree named the same as me, after all – and consented to a photo of the two of us. As it turned out, naming a magnolia a conventional female name was not uncommon at all.

Just to mention a few, 'Susan' is part of the Little Girl series from the National Arboretum, with other names such as 'Ann', 'Betty', 'Jane', and 'Judy'. It sounds like my high school home room roll call.

But the list goes on. 'Ann' makes her way into several names including 'Ann Jenkins,' 'Anne Pickard,' and 'Anne Rose.' Moving on ahead in the alphabet, there is 'Cathryn,' 'Cleopatra,' 'Elvira,' 'Janet,' and 'Pearl.' Not for the women only, prosaic men's names such as 'Peter,' 'Paul,' 'John,' and 'Joe' are in good company with descriptive names, ancient names, Disney names, and country names; all have been applied to various cultivars and selections of magnolias. It is somewhat reminiscent of naming Thoroughbred horses. Not as exotic, perhaps, but definitively creative. Developers and finders have been busy for a long time; a list 148 pages of magnolia names is availble, with entries dating to nearly two hundred years ago. People have been busy altering and observing the magnolias for a very long time.

And for good reason. Magnolias are amongst the most spectacular of flowering trees.

INTRODUCING THE MAGNOLIAS: LARGE FLOWERS AND SUPER-SIZED LEAVES

With colors ranging from bright white to sunshine yellow to the deep crimson of many cultivars, magnolia flowers are most often borne singly near the tips of branches, where the largest can easily obscure the unfolding leaves of a newly awakening springtime tree. Most magnolia trees are deciduous, and in winter the subdued colors of their gray branches and their open form resemble those of many forest and garden companion trees, within or outside of the family. But when spring comes, and the bright leaves unfurl while flowers open, few trees can match the spectacular show of the magnolias. Size alone makes the display unique: magnolia flowers can measure up to 16 inches across, the largest of any flowering tree species. Wide petals fold back to reveal an interior structure of many stamens and pistils.

Although most easily recognized by large size and form, magnolia flowers do vary, from the two-inch Tulip-tree flowers (*Liriodendron tulipifera*), to the aptly-named Bigleaf Magnolia (*Magnolia macrophylla*) which bears flowers up to 16 inches in diameter. This size is nearly matched by the Southern magnolia (*M. grandiflora*) with its 12-inch flowers; this species along with its many cultivars are widely grown outside their native range. Even the smaller greenish flowers of species such as the Umbrella Magnolia (*M. tripetala*) open widely, giving the appearance of a much larger blossom.

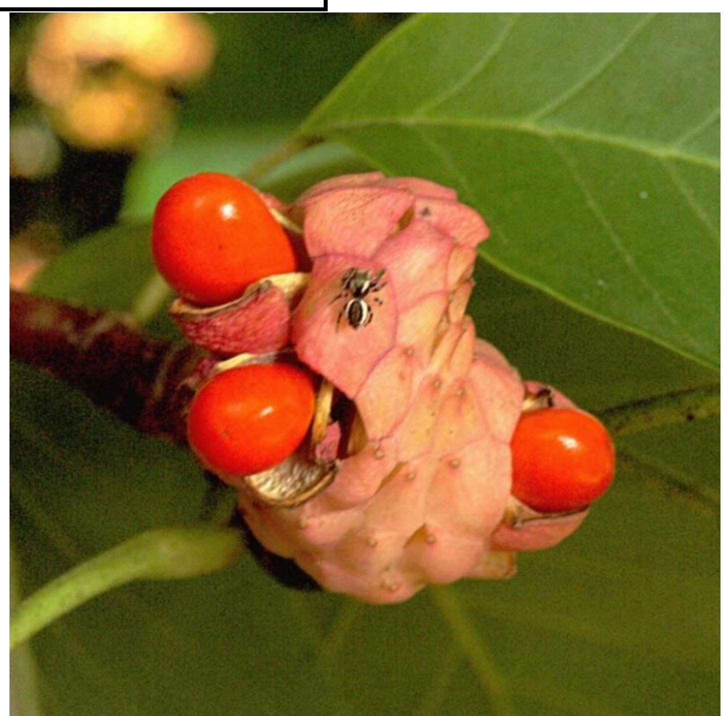
Tulip-tree (*Liriodendron tulipifera*)

The broad magnolia flowers are composed of both petals and sepals, but for most species the two are nearly the same size. Collectively they are called tepals; these showy parts often spread into a flattened shape, accented by the large flower center.

Many Magnoliaceae flowers are scented, although not all are appealing, as the blossoms evolved to attract insects rather than humans. The evergreen Southern Magnolia flowers are sweetly scented, while the malodorous Umbrella Magnolia (M. *tripetala*) lacks appeal. Some magnolia flowers have little scent. Hybrids are often selected for both fragrance and flower color, appealing combinations for a garden setting.

The aptly-named Bigleaf Magnolia (*Magnolia macrophylla*)

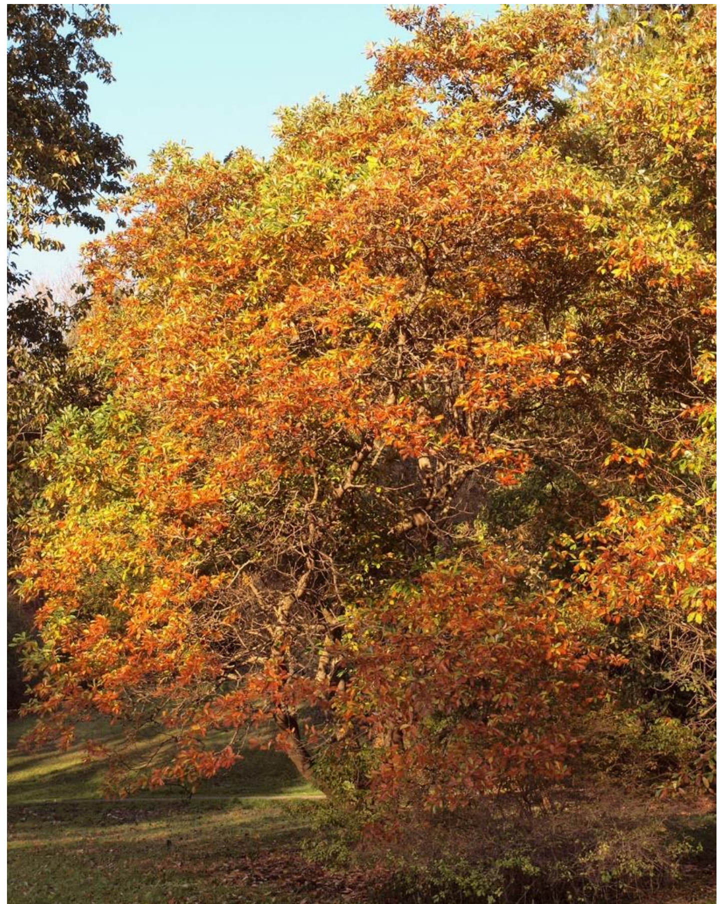
Magnoliaceae leaves often match or exceed the showy flowers in size. Bigleaf Magnolia sometimes bears leaves nearly three feet in length; leaf size alone tends to limit horticultural use of this uncommon, slow-growing species. With leaves that may reach a foot in length, the Cucumber-tree is often planted as a shade or ornamental tree and is both disease resistant and tolerant of colder conditions — it is the most northerly of the magnolias. The Cucumber-tree bears small flowers near the top of the tree that last only a short time, although the tree itself is long-lived. The common name refers to the lumpy, cucumber-like fruit. In the *Magnolia* genus, the developing fruit carries its seeds on the outside, each hung by a slender thread. *Liriodendron* trees bear a samara-like structure that encloses the small seeds.



Cucumber-tree (*Magnolia acuminata*) fruit

Unlike the Cucumber-tree, many magnolias bear their flowers low enough on the tree to be viewed without a ladder, most often near the tips of the branches. The flowers close at night and mature in a way that hinders self-pollination, thus promoting out-crossing, a mechanism that enhances a genetic fluidity upon which natural selection can act.

Most magnolias are deciduous, with only two North American species bearing leaves year-round. One is the widely planted Southern Magnolia, which although native to the subtropical habitat of the southern coasts is tolerant of much colder climates. The other is the less well-known Sweetbay (*M. virginiana*), a coastal tree with white, fragrant flowers. Sweetbay is also grown outside its native range, where cooler conditions may result in leaf drop during the autumn season.



Sweetbay (*Magnolia virginiana*) in autumn color

Roses and Magnolias: A Comparison

Although Magnoliaceae flowers are the largest of native trees — a feature that contributes to the horticultural attraction of the family — in temperate regions other trees are more widely grown for color, form, and fruit. The Rose Family (Rosaceae) is well-represented on the continent with a variety of native species and cultivars, as well as many exotics from more distant places. Known for their profusion of springtime blossoms, flowering cherries, prunes, and crabapples enjoy wide appeal; often planted alongside streets, in parks, and gardens, they offer a stunning and welcome contrast to fading winter grays. The flowers cover the trees so effectively that unfurling leaves are often hidden, with their bright colors adding warmth and welcome to the lengthening days of spring.

Rather than individual flowers, in the Rose Family it is the opening of thousands of small blossoms that creates the effect of a single large display. These flowers are typically borne in clusters and can vary in color from bright white to deep magenta. Most native Rosaceae species bear pale flowers; as with the magnolias, the darker pinks are typically the outcome of selecting and propagating trees that produce flowers of a desired color.

Although the individual flowers of Rosaceae trees are on the small side, in mass they appear much larger and have the added appeal of a three-dimensional effect. As the flowers begin to fade and the bright green of new leaves can be seen, spent petals prolong the season as they fall to the ground, covering sidewalks and lawns with a final burst of color.

Covering the trees more completely with their blossoms than the more sparsely distributed magnolias, by comparison Rosaceae tree flowers are nearly tiny, as the photos below demonstrate.

IF MAGNOLIA AND PRUNE FLOWERS WERE THE SAME SIZE:

***Magnolia grandiflora* 'Exoniensis'**

Bitter Cherry (*Prunus emarginata)*

The flowers of Bitter Cherry (*Prunus emarginata)*, a native tree of western North America, are about .5 inches wide. They are borne in clusters, however, making them more visible to possible pollinators, and adding to the impression of a mass of bright color. Although larger by comparison, it would take several clusters to fill the cup-shaped form of the magnolia flower.

True size of the Bitter Cherry by comparison

A cluster of Bitter Cherry flowers

Why produce such a large flower when a small one will fit the purpose? Or conversely, why expend energy on thousands of small flowers when a gigantic blossom works?

That the production and maintenance of large flowers as a successful strategy is evident in the antiquity of the Magnoliaceae. Family members have provided accents to continental plant communities for a much longer time than Rosaceae family members, such as the Bitter Cherry.

The Classification and Evolution of the Magnoliaceae

A member of the Magnoliales Order, which includes five other plant families with one of them —the Annonaceae or "custard apple" — consisting of over 2,000 species, the Magnolia Family is composed of two subfamilies, the Magnolioideae and the Liriodendroidae, the latter with only a single recognized genus, the tulip-trees (*Liriodendron*). In the past, botanists have included several genera in the Magnolioideae, although the classification lacked agreement. Recently most of this numerous splitting has been reduced to one genus. With approximately 210-225 species, true magnolias are primarily temperate zone plants, ranging from North and South America to Asia, which is home to approximately two-thirds of the species. The *Liriodendron* genus has two species. In North America, a single species of *Liriodendron* and 8 species of *Magnolia* are native, all with natural ranges east of the Rocky Mountains.

Magnoliaceae species are angiosperms, flowering plants that in terms of species' number (around 300,000) dominate the world today. Angiosperms produce fruits that enclose the seeds; their predecessors, the gymnosperms, lack a surrounding tissue for their seeds (gymnosperm means "naked seed"). Although angiosperms diverged from gymnosperms about 200 million years ago, unambiguous fossils date to about 130 mya. And although research into the origins of early angiosperm families is ongoing, it is generally agreed that the Magnoliaceae is one of the most ancient plant families. Since their structures decay rapidly, plant fossils are sparse, and thus determining a timeline is difficult, but plant structure, in particular the flower, place the magnolias amongst the earliest of flowering plants. With their similar petals and sepals (the two showy parts of the flower) the structure of magnolia flowers is one indication of age. Another feature is the cone-like center of the flower; here the carpels (the female structure) are surrounded by spirally arranged stamens (the male part), a configuration noted in other ancient families. When mature, the seed-bearing carpels are borne in a woody structure resembling a cone. All these features point to a lineage in the distant past, in which similar cone-like fossils have been found in ancient geological deposits.

But why would a flower, which requires considerable energy to produce, arise in the first place and why do such large flowers decorate the magnolias today? One might expect the earlier families to have very tiny flowers, evolved as they were from a coniferous ancestor. And indeed, not all early flowers were the size of today's magnolia blossoms.

The more ancient conifers (the gymnosperms) lacked the flowers of the later angiosperms. Flower production would require more energy than simpler functional structures, and evolution of this organ must have had an advantage. Perhaps some agent was around to make use of this invention.

As it turns out, there *was* involvement, from quite a different kingdom. The flowers that humans appreciate for color and form evolved under a selective pressure unrelated to this appeal. Blossoms are showy, but they also include sweet and nutritious attractors for mobile pollinators — small, voracious creatures, earthbound at first, but eventually taking to the air. Evolution of these insects was an ongoing process, often in conjunction with plants (in the case of insects seeking food), although probably not in perfect synchronicity. The rise of the angiosperms with their appealing, nutritious flowers was undoubtedly a long, sinuous road, with fits and starts. Always the purpose was continuation, and the new flower proved itself to be an excellent development.

It certainly did not happen quickly, as the ancestral gymnosperms had been around for around 175 million years, give or take, before the earliest angiosperms made an appearance in the fossil record. Gymnosperms were preceded by seed-bearing species that introduced sexual reproduction rather than cloning, the latter being a more limited approach for both plants and animals. Gymnosperms relied in large part on physical forces, such as wind and water, for seed dispersal. In time, animals would offer another method for dispersal, and seeds would increase in size, but at the beginning, seeds were small, and physical forces at times inconsistent.

Missing from the gymnosperm version of sexual reproduction were the insects that would play such an important role in the co-evolution of a whole new idea in plants — the flower. This organ was not developed for human appreciation, whose own story lay far in the future, but rather on pollinating insects that would respond to color, form, and food.

Primitive flying insects were present during the time of the earliest angiosperms, although bees were absent. Their evolution would proceed in response to the continuing development of the flower upon which they could specialize. Today bees are present on every continent except Antarctica, and are represented in seven families, with over 16,000 species.

The earliest flowers, such as those of the Magnoliaceae, were pollinated by beetles, ancient insects with representatives dating back about 325 million years. Today modern beetle species number around 450,000, over half of all insect species. This large number may in part reflect the long heritage of beetles, but it also may indicate an adaptability that included co-evolution with angiosperm flowers, including the early magnolias.

Beetles are so-called "dumb" pollinators, meaning that they lack the specialized abilities of later insects, such as the bees. With mouthparts intended for chewing, they tend to eat flowers when collecting pollen. And many are heavy enough to inflict damage on the fragile parts of a blossom. Thus, from the point of view of an evolving flower, it was best to be hefty enough to withstand both beetle weight and predation. By evolving larger flowers, the magnolias could sustain minimal damage while continuing to attract beetles as pollinators.

HOW DID MAGNOLIA FLOWERS GET SO LARGE?

Angiosperm flowers are modified leaves, a highly successful evolutionary development that has resulted in stunning diversity of form and color. There are four whorls of altered leaves, each modified into a flower organ – sepals, petals, stamens, and pistils. Although it is not particularly difficult to conceive of a petal as a colorful leaf, the modification of leaves into reproductive parts is a harder to visualize, as is the size of the earliest flower. Did they evolve in response to the availability of pollinators, or were other factors of greater importance, such as radical changes in the physical environment? Was the process rapid or was the slow?

The earliest flowering plants probably evolved in aquatic conditions, and some researchers believe that this kind of habitat may have been important to expediting angiosperm evolution.

The precursors of modern beetles, known as" Protocoleoptera," are abundant in the fossil record, often found as impressions or petrified in amber. These were small insects; "modern" beetles are much more recent, originating about the time the dinosaurs disappeared, about 65 million years ago. As the plants evolved, exploiting a changing environment, research indicates that beetles likewise changed in response. The most important alteration was the acquisition of an enzyme that enabled beetles to digest the walls of plant cells. These herbivorous beetles today account for approximately half of all beetle species.

Early in their evolution, angiosperm flowers were probably small and resembled today's magnolia blossoms. Other characteristics of these beetle-pollinated flowers include pale color (typically white but sometimes pink or purplish), raised carpels with the base of the stamens on a smooth column, a lack of nectaries but abundant pollen, and an open configuration.

Today, the largest magnolia flowers (although not the smaller ones) support the weight of heavy beetles, but such flowers are uncommon in the plant world, and most beetles are small.

Many of the smaller magnolia flowers are pollinated by bees and flies; the Tulip-tree is one such North American species.

A large beetle

Besides the Magnoliaceae, beetles are important pollinators of other plant families. Beginning with the cycads, beetles have found nourishment while at the same time benefitting their hosts, including the Aster Family – also ancient. Beetle pollination is referred to as cantharophily, and flowers dependent on beetles are labeled cantharophilous. Although beetles pollinate many angiosperm families, few are dependent upon them.

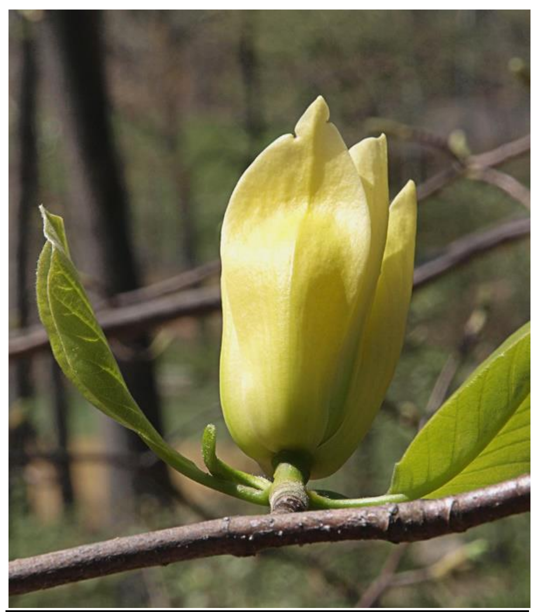
More recently evolved complex flowers, as well as the "primitive" magnolias, are attractors for bees, with the pollen being carried on the bee abdomen to another tree where cross-fertilization can occur. Honeybees, however, are not native to North America but were introduced by European immigrants. These bees have naturalized across the continent and for some magnolias are important pollinators. This is true for the Southern Magnolia as well as species with smaller flowers, such as the Cucumber-tree. In at least one study of the Southern Magnolia, beetle visits correlated with the developmental state of the flower, while bees visited consistently throughout the flowering period and carried more pollen than any other insect.

While bees forage on the flower surface, beetles enter the large Southern Magnolia buds where they find food and shelter under the closed tepals. They feed on both pollen and a sugary substance, carrying pollen grains when they depart. Scarab beetles, one of several beetle groups, are a common pollinator, as is the introduced Japanese beetle. Thus, while species such as the Southern Magnolia represent in form and function an old lineage, they exhibit an adaptive flexibility to introduced insects, one that that may have contributed to their persistence in a world of constant change.

Southern Magnolia *(Magnolia grandiflora*)

Nearly all North American magnolia species are native to the Southeastern United States; however, for the most part they are absent from Florida. A couple are quite rare, and one — the Cucumber-tree — grows as far north as Ontario, Canada. Many are coastal, although a few, such as Fraser Magnolia (*M. fraseri*), range above 300 meters to the highest elevations of the Appalachian Mountains. Others, such as Umbrella Magnolia (*M. tripetala*) are present in mountain habitats at elevations of over 1,000 meters, but also reach the Atlantic and Gulf coasts.

Magnolias achieve their best growth rates in rich, moist soils where they often associate with other native hardwood trees. Some show a preference for upland habitats, where the ground is sufficiently moist, and at least one – the Sweetbay – grows in swampy ground, often near the coast. This magnolia is evergreen in the warmer parts of its range, but only one — the Southern Magnolia — is fully evergreen.



Cucumber-tree (*Magnolia tripetala*)

Outside their native habitat, magnolias and their many cultivars are widely grown across the continent, sometimes in regions where they are marginal, but in other settings thriving as horticultural specimens. The Southern Magnolia may be the most widely grown, and although it is native to the warm climate of the southern coast, it can grow in cooler settings, such as the Pacific Northwest.

Many of the magnolia cultivars are derived from Asian species, and at least two of these exotic imports, along with their many cultivars, are widely enough established to be included in field guides.

One *Liriodendron* species – the Tulip-tree – is native to North America, while the only other member of the genus is found in China. The North American Tulip-tree ranges from central Florida as far north as New York and can attain large stature far outside its native range.

MAGNOLIA WOOD

Magnolia family members are not considered "economically significant," which may be fortunate for both individual trees and species. At least two are valued for precision work: sold under the name "yellow poplar," the Cucumber-tree and the Tulip-tree produce lightweight and fine-grained wood. Although the wood of most magnolia species lacks application to tools, building, and other uses, the trees are horticulturally significant, as the thousands of cultivars attest.

EATING THE MAGNOLIAS

The bark and flowers of some magnolia species are traditional considered as medicinally beneficial. In China the cultural importance of magnolias comes from a long history of use, and a few species are used in modern "alternative" medicine. Studies validating the use of magnolia parts for a wide range of ailments are incomplete, although suggestive.

Magnolia* x *soulangeana

Some magnolias have edible flowers, although the taste may not be for everyone. Most blossoms have a ginger-cardamom taste that will vary in intensity depending on factors such as time of year, age of the tree, and flower color, among others. White and pale pink flowers are generally milder in taste. The flower petals of Southern Magnolia can be pickled and consumed, although the flavor is reportedly strong. Magnolia flowers also are eaten dried; in one test which included 14 species and cultivars, consumers judged the flowers as ranging from a pronounced strong taste to bitter. The flowers of a popular magnolia cultivar, *Magnolia* x *soulangeana*, are also sometimes pickled; the flavor is ginger-like and useful as a spice. Such mixed reaction to the taste of the blossoms probably implies that magnolia flower foraging is not likely to become a wildly popular endeavor.

Leaves are sometimes used as a substitute for bay leaves, but as with other parts of the magnolia, leaf harvesting is not a commercial enterprise.

Other members of the animal kingdom, such as ground-dwelling birds and small mammals, find magnolia seeds palatable, but the seeds possess little appeal to humans: like the bark they are bitter.

MEDICINE

Magnolia parts, particularly the bark and roots, have a long history of medicinal use. The family is well-represented in Asia, and the use of several species for a wide range of human ailments dates back for thousands of years. Written Chinese accounts of application of magnolias date to 200 AD, and the trees have been the source of medicines for at least 2500 years. In North America, many aboriginal tribes utilized parts of the trees for a variety of afflictions. These include groups from the Northeastern United States and Canada, to the Southeast, home to the widely distributed Southern Magnolia, among others. Treated maladies ranged from rheumatism to toothaches, and, as with other traditional medicines, the use of magnolias has been the subject of recent scientific study, with many of the uses to which magnolias were traditionally applied being scrutinized. Primarily with in-vitro experiments rather than clinical studies, a range of organic molecules present in several magnolia species have been isolated and tested. Many of these studies have been undertaken on Chinese magnolia species.

Magnolia virginiana **(Sweetbay)**

The interest is not in Asia alone, as the presence of organic compounds found only in the Magnoliaceae Family has spurred research elsewhere as well.

Some Southeastern tribes harvested magnolia roots and stem bark, and branches as well for a tonic that was employed in the treatment of rheumatism, fevers, and tuberculosis. These parts were also made into a decoction used to induce sweating. Sweetbay leaves made into a tea were used for the treatment of colds; perhaps the astringency of magnolia parts influenced the application to both life-threatening and seasonal maladies.

In the North, the bark of the Cucumber-tree was harvested for alleviating toothaches and as a relief for stomachache. Early American researchers accepted the efficacy of magnolia in the treatment of various human ailments, and when procedures became available, undertook the analysis of magnolia chemistry. In the late 20th century, more study determined the presence of compounds that are known to be beneficial, particularly as anti-bacterial agents. Most encouraging was the presence of chemicals known to inhibit tumor cell growth, such as found in Sweet Bay; whether such inhibitors are efficacious against human disease is not fully investigated. Chemicals, including liriodenine, which is also found in other plant families, have been identified as anti-inflammatory and cytotoxic (toxic to cells).

As one of the most studied North American magnolias, Southern Magnolia was used by several tribes in the treatment of a variety of illnesses, including fever, diarrhea, rheumatism, arthritis, high blood pressure, heart disturbances, abdominal discomfort, muscle spasm, infertility, and epilepsy. Two isolated compounds from this species exhibited anti-cancer properties as well as activity against specific viruses, in particular polio and herpes.

In Asia, extracts from *Magnolia officinalis* (Houpo Magnolia) and *Magnolia obovata* (Japanese Cucumber-tree) have been intensively studied. Such international interest in the potential of magnolias as a source of new drugs have resulted in the identification of no fewer than 250 compounds representing several classes of organic molecules.

Found in approximately 15% of plants, including ancient groups as well as the Magnoliaceae and other angiosperms, are aporphine alkaloids. At least one is known to be an anti-inflammatory; others exhibit cytotoxic properties. A few studies have shown efficacy against certain cancers, such as colon and cervical. Isolation of such compounds and investigation of their general (rather than specific actions in magnolia species) anti-cancer properties form the basis of most scientific inquiries.

Sesquiterpenes are another organic group found in the magnolia family; these are extensively studied complex chemicals present in many plants. Evolutionary selection would undoubtedly have favored species with an arsenal of sesquiterpenes in its tissues, for these compounds are effective against insects and fungi. Sesquiterpenes are members of the terpene class of molecules; terpenes are perhaps best known as being present in cannabis, but they are also abundant in magnolias such as Sweetbay and are most common in conifers. With strong odors, terpenes can contribute to the lack of the appeal of a plant, discouraging herbivores while at the same time attracting parasitic species.

Several sesquiterpene compounds have been isolated from North American and Asian magnolia species. Sweetbay provides the foundation of many studies in which extractions are studied for their efficacy against various human ailments, often confirming traditional use while sometimes exhibiting a seasonal effectiveness. For example, leaves may prove more effective during the growing season.

Of the many organic molecules present in the various parts of a magnolia tree, lignans — a group of polyphenol compounds — show perhaps the greatest promise as a “natural” source of drugs for fighting many diseases. As with the sesquiterpenes, lignans are "secondary metabolites," meaning they are not directly involved with growth. In theory, plants can survive without them, but their usefulness and perhaps their necessity to evolutionary success have secured a presence in at least 70 plant families.

Lignan concentration in magnolias is generally low. Higher concentration occurs in many grains, including flax. Thus, much effort has been put into the study of flaxseed and sesame seeds as well. Amongst the trees, Norway spruce, a conifer, exhibits higher lignan concentrations than most. However, lignans are present in magnolia species, and given the traditional medicinal use, research into two lignans in particular — magnolol and honokiol — has been extensive. Much of this investigation has been conducted by Chinese scientists, in part because of a directive by the government to determine the possible use of lignans as drugs.

The basic chemical formula for a lignan is simplicity itself. They are "biphenyl," meaning there are two identical organic groups linked together; the formula is $2(C_6H_5)$. Present primarily in dicot families, with a few known in the non-woody monocots, many lignans are small molecules, although research seems to turn up new more complex lignans on a regular basis. The interest centers around their applicability as drugs, with such studies motivated partly in response to the traditional uses of magnolias.

The subject of extensive investigation, particularly using extractions of *Magnolia officinalis* and *M. grandiflora*, magnolol is present in the root and stem bark. This is a small biphenyl with the formula $C_{18}H_{18}O_2$.

Lignans and lignins

The spelling is so similar that these molecules have at times been functionally mistaken for one another. Research has determined that their evolution was driven by different factors. Lignins are primarily structural while lignans evolved as defensive agents. The chemical starting point for the two is the same; beginning in the "shikimic acid pathway," with reactions producing a molecule that can be further synthesized into lignan or lignin. Although related, their function is quite different. An insoluble fiber, lignin (with an "i") is the stuff of wood; their primary function is to aid in the transport of water and strengthen cell walls. Without lignin, vascular plants would have difficulty standing upright.

Lignins and lignans account for about 20 percent of the weight of angiosperms. Lignin is considered second only to cellulose as the most common "biopolymer" on Earth: these are large molecules composed of many repeating organic units – DNA itself is a biopolymer. Considering the important role that lignin plays in plant physiology, it is not surprising that the vascular plants and lignin evolved concomitantly, about 450 million years ago. Plant movement into terrestrial habitats was in part made possible by lignification.

However, research into the possibility of lignin in more primitive plants such as seaweed has complicated the lignin story. Marine algae diverged from vascular plants a billion years ago. The presence of a lignin-like compound in the flexible joint of a coralline alga may represent a convergent evolution of an organism able to withstand stress from waves and currents, and

Honokiol has the same formula but a different configuration. Laboratory investigations of magnolol extracted from bark have presented an opportunity to investigate traditional use in Asia and North America. Such studies have shown that magnolol is anti-inflammatory, anti-microbial, a hormone regulator, and effective against pain. Its efficacy against afflictions such as depression, spasms, and stroke are also the subject of specific studies. These qualities alone may explain in part the benefits of the traditional medical use of the bark.

But scientific inquiry has gone beyond the exploration of magnolol as a medicinal herb. In the laboratory setting both magnolol and honokiol have exhibited great promise in the treatment of several cancers. Magnolol has demonstrated the amazing capability of modulating various genes involved with cancer cells. This ancient compound demonstrates an effectiveness against bladder cancer (with over 165,000 deaths annually), brain cancer, breast cancer, ovarian, prostate, and leukemia, among others.

Most studies have been in-vitro; clinical trials are lacking, although some “in-vivo” experimentation has been performed on mice and rabbits. While numerous studies confirm the benefits of traditional use of several species, the studies themselves are limited in application to development of useful, plant-based medicines. Such applications rely on commitment of monetary resources, often in short supply, interest, and the availability of qualified researchers. So, although clinical studies of magnolia compounds are yet to be undertaken to any extent, traditional use remains as part of human medical practices. And a quick survey of the Internet turns up magnolol in a plethora of pills and potions. While the claims are both numerous and occasionally incredulous, the facts are more elusive.

How does magnolol, a chemical evolved to fight insect and herbivore feeding, combat deadly cancer? One set of organic compounds implicated in cancer development are transcription

a vascularized plant able to survive varying terrestrial physical forces.

The chemical composition of lignins varies between plant families, but in general they tend to be complex molecules with a molecular weight so large that understanding their structure has been challenging. Lignins can also vary within a particular species; bark and conducting vessels may incorporate different lignins.

*By contrast to the heavy lignin molecules, many lignans are small with less complex chemical structures. With only 18 carbon atoms, magnolol is among the simplest. Thus, while lignin compounds have molecular weights averaging in the thousands or tens-of-thousands grams/mol, the **lignans** are typically less than a thousand.*

Whether small or large, what began as an evolutionary defense against insect predation has become one of the hopeful signs applying plant compounds against a wide range of human afflictions, including cancer. It is estimated that about 9.5 million people died of cancer in 2018, about 1 of every 6 deaths. The human toll is incalculable, and the cost to society great. New attention to the insect-fighting lignans, present in many plant families but primarily a subject of research because of the traditional use of magnolia tree species as medicines, adds hope to the seemingly never-ending fight against cancer. Learning the mechanism by which these old compounds work is important and necessary in a laboratory setting, testing the results outside the walls of academia never more prescient.

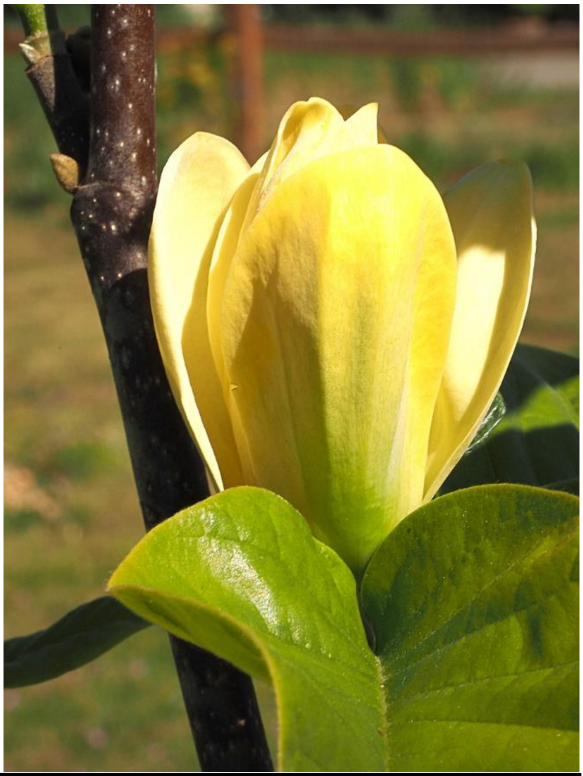
factors (TF). These are proteins that convert human DNA into RNA, which in turn controls the expression of many genes. Through TF directions, cell division, growth and death are directed. About 1600 transcription factors are found in human DNA; a small handful are associated with cancer; in other words, the wrong directions can influence the growth of cancer cells. Lignans such as magnolol do not directly control these molecules, but they do suppress a protein that is part of the cancer activation mechanism.

Lignans can also directly cause the death of cancer cells (apoptosis). Thus, lignans are the subject of research for the possibility of new cancer-fighting drugs, an effort driven in part by the long history of magnolia use.

FLOWERS, LEAVES – TREES

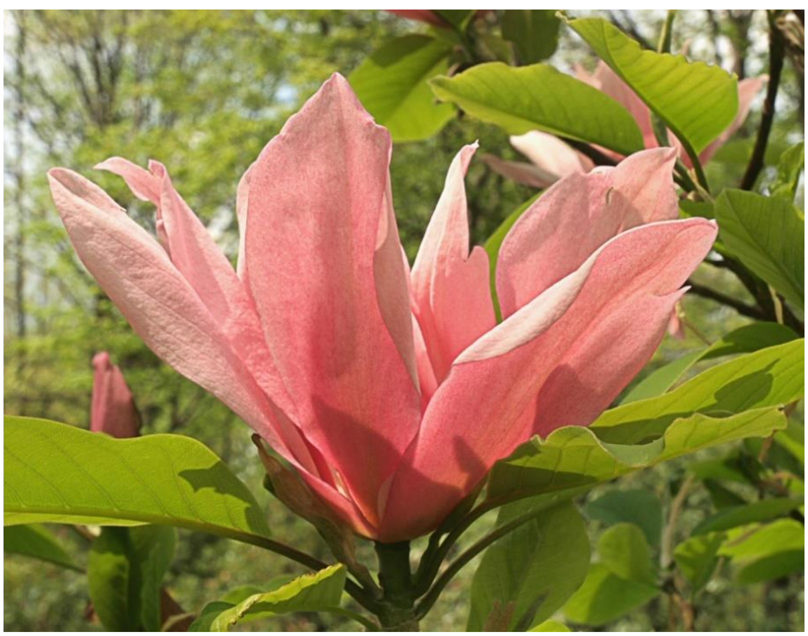
While scientific research seeks to uncover the secrets of the chemicals contained within the Magnoliaceae, this ancient family continues to add beauty for its own sake to private gardens and public places alike. Stunning flowers, curious seeds, and colorful leaves all add to the appeal of a magnolia. Many of the most beautiful flowers, such as those shown in the photos below, are selections made popular by color, form, and vigor. The native American species also bear striking flowers, and the trees themselves are rugged and beautiful. Sometimes rare, like the Fraser Magnolia, others are symbolic of specific geographic regions, such as the evergreen Southern Magnolia. Some are widely distributed — the stately Tulip-tree ranges through the East — one even inhabits the cooler lands north of the 45th parallel. Most prefer warmth, not unlike the habitats where this most ancient family first came into existence. Magnolias are indeed unique in the world of trees.

'Jane Platt' *magnolia* – a cultivar of *Magnolia stellata*, native to Japan



Magnolia 'Yellow Bird'

'Raspberry Ice' ***magnolia***



Magnolia 'Blushing Bell'

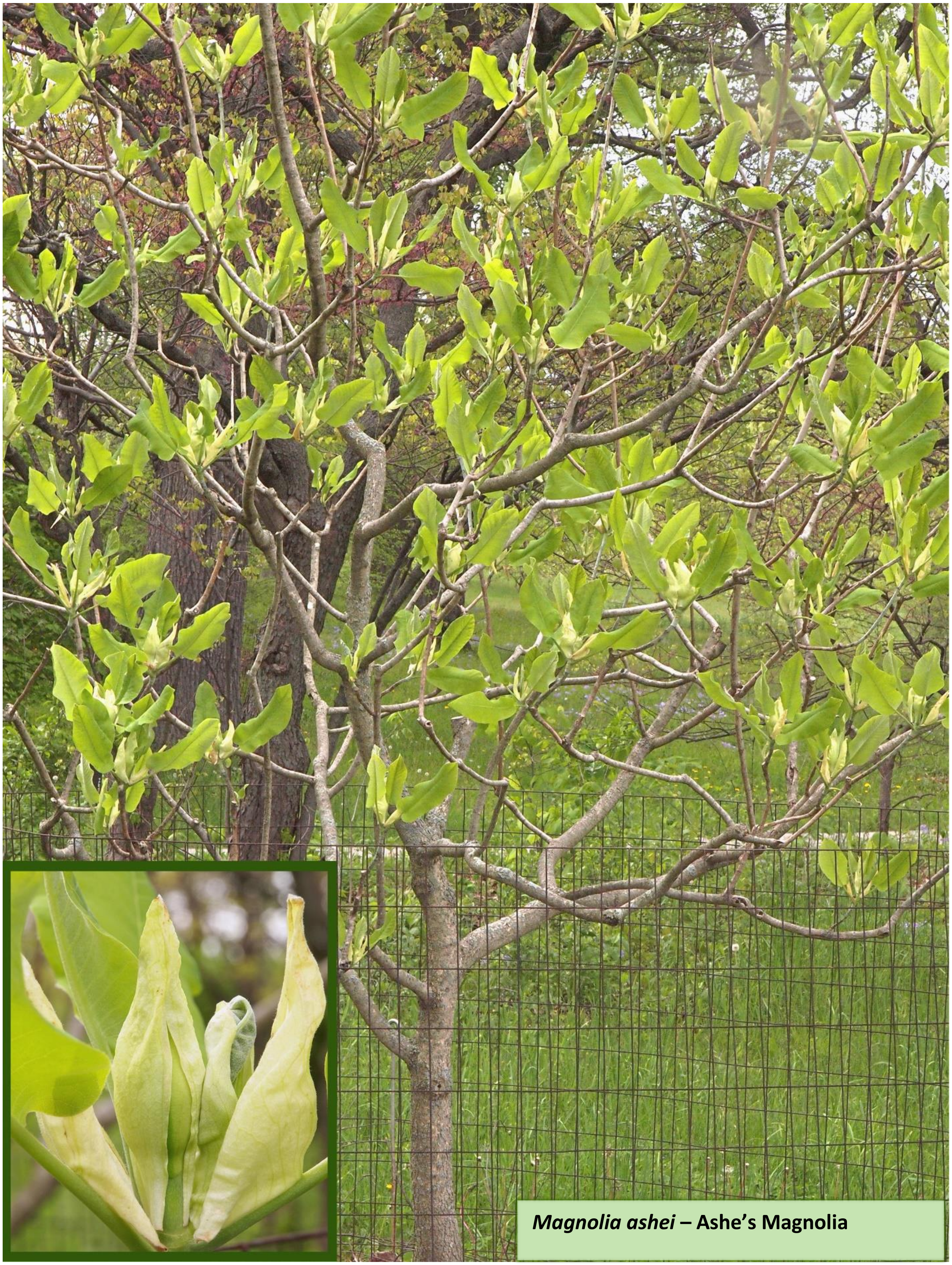
Magnolia 'Two Stones'

North American Native Magnolia species

The photographs below include seven of the eight native Magnoliaceae species.

***Liriodendron tulipifera* – Tulip-tree**

Magnolia acuminata – **Cucumber-tree**

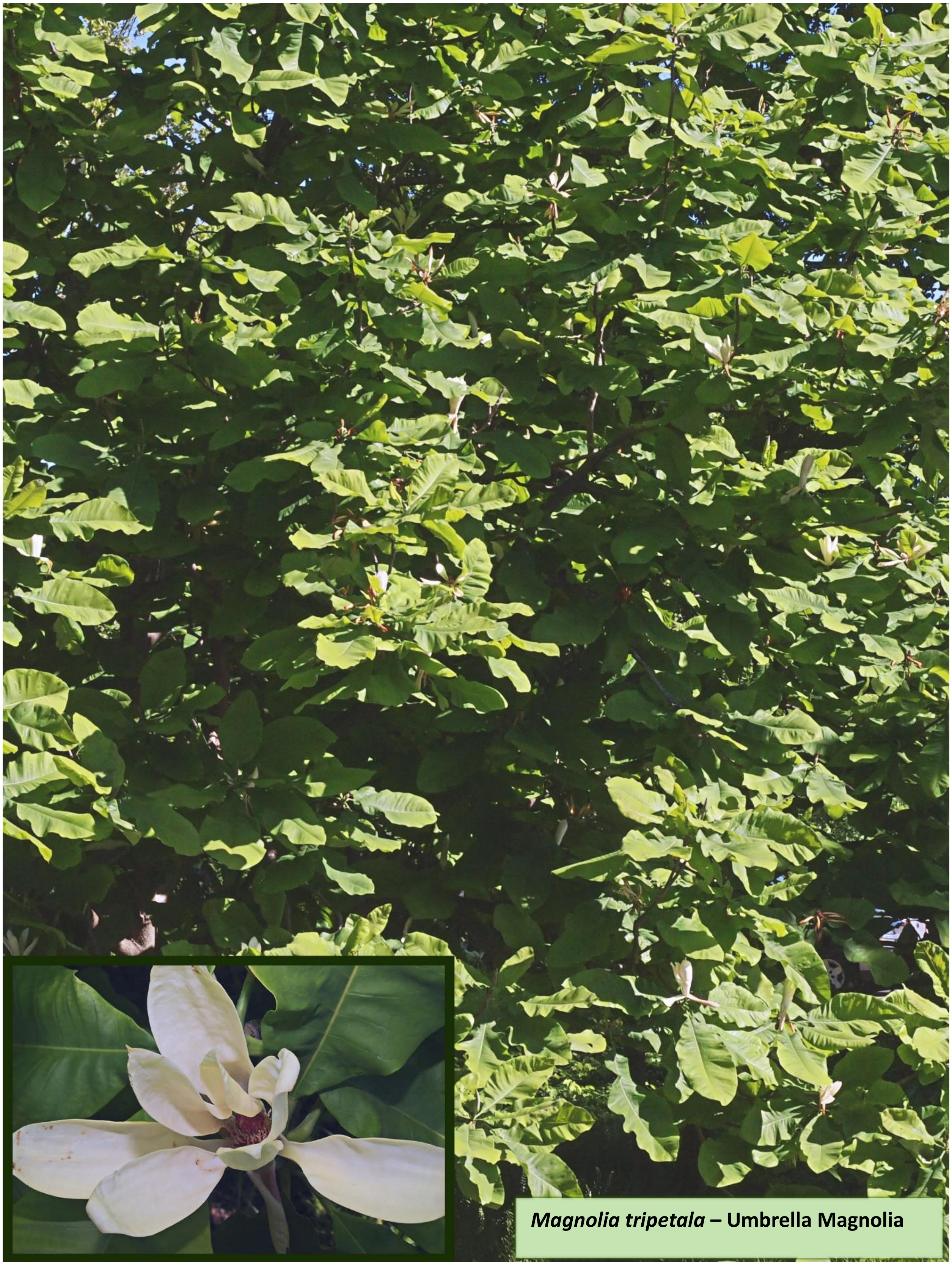


Magnolia ashei **– Ashe's Magnolia**

Magnolia fraseri – **Fraser's Magnolia**

Magnolia grandiflora **– Southern Magnolia**

Magnolia macrophylla – **BIgleaf Magnolia**



Magnolia tripetala **– Umbrella Magnolia**

Magnolia virginiana **– Sweetbay**