Plants from the Past
Living Relatives of Ancient Plants in the Primitive Garden

By Philip Schretter

The Primitive Garden, located next to Jenkins Hall on the Armstrong Atlantic State University campus, allows you to take a walk through time by displaying living relatives of ancient plants. The following list describes some of the species and cultivars in our collection.

Cyathea cooperi - Australian Tree Fern
A fast growing fern with light green, lacy fronds, Australian Tree Fern certainly looks primitive enough, conjuring up images of a time long ago when forests were composed of mainly tree-sized fern relatives. Growing to 20 feet tall and with a spread of 12 feet, this species has endured temperatures in the Arboretum down to 17 degrees Fahrenheit with no signs of damage. Cyathea cooperi grows naturally in tropical lowlands along the coast of Queensland and New South Wales in eastern Australia.

Marsilea macropoda - Clover Fern
This unusual Texas native forms colonies that look more like the luckiest four leaf clover discovery ever than a spore producing fern. A creeping, six inch tall groundcover with soft, gray-green foliage with a silver sheen, Clover Fern can grow in full sun and dies back in only the coldest and driest weather. Clover Fern is unique in a way other than appearance. Of the 10,000 species of ferns living on earth, all but about 90 produce only one size spore to reproduce. Clover Fern belongs to one of two families of ferns that produce two different sized spores. This trait was an important step in the development of the seed. Read more about this in "A Simple History of Plant Development" on page 8 of this newsletter.

Osmunda cinnamomea - Cinnamon Fern
Cinnamon Fern is a common inhabitant of moist habitats from South America all the way to Minnesota and New England. Its three to five foot tall, light green fronds turn golden brown before dying back in the winter. Unlike most ferns that carry their spores on the underside of their fronds, Cinnamon Fern produces its spores on separate and distinctive fertile fronds that look like cinnamon sticks. Cinnamon Fern belongs to the Osmundaceae family, a very old group of plants with fossils known as far back as the Permian while Osmunda fossils have been found in Upper Cretaceous sediment.

Osmunda regalis - Royal Fern
One of the largest ferns occurring in North America, this impressive fern can have fronds up to six feet long. Growing naturally in Africa, Asia, Europe, and North
and South America, Royal Fern produces spores on separate fertile fronds like Cinnamon Fern. The genus is named for Osmunder (also known as Thor), the Saxon god of war.

*Thelypteris kunthii*- Southern Shield Fern
With a confusing array of common names including Southern Wood Fern, River Fern, and Widespread Maiden Fern, this fern met the cultural criteria we required of all the plants in the Primitive Garden; they must be able to grow in full sun. Finding ferns that can tolerate full sun in a Savannah summer was somewhat limiting, but this species has proven to be outstanding. *Thelypteris kunthii* grows two to four feet tall and produces long arching, triangular, bright sea green fronds. This easy to grow, quickly spreading colonizer is native to the Coastal Plain states from South Carolina to Texas and down through Central America.

*Equisetum hyemale*- Rough Horsetail
An upright, slender, bamboo-like perennial growing three feet tall, Rough Horsetail thrives in moist areas and is unbelievably invasive. It will spread under wide sidewalks, deep curbs, and probably 16-lane interstates with little trouble and gardeners are often more interested in how to get rid of it than how to grow it. Also called Scouring Rush, the stems of this plant contain sharp silica crystals making it good for cleaning pots and tough to eat if you are a dinosaur. The horsetails appeared in the late Devonian period and reached their greatest abundance and diversity late in the Paleozoic era. Horsetail trees dominated the Carboniferous forest reaching up to 60 feet tall. The genus *Equisetum*, the only living member of the *Equisetaceae* family, may be the oldest living genus of plants on earth. With around 35 species, *Equisetum* grows naturally worldwide except in Australia and New Zealand.

*Equisetum diffusum*- Himalayan Horsetail
A dark green, wiry perennial with round foliage and many side branches, this native of the Himalaya Mountains from India to Tibet grows to nine inches tall.

*Equisetum scirpoides*- Dwarf Horsetail
Growing only eight inches tall, this North American native is reportedly less invasive than *Equisetum hyemale*, but we are not taking any chances and have confined this species to plastic tubs with the rest of our *Equisetums*.

*Cycas revoluta*- Sago Palm
A well known landscape plant in the coastal South, Sago Palm was first described by Swedish botanist Carl Peter Thunberg in 1782 from plants on the southern islands of Japan. Sago Palm can slowly grow to 12 feet tall and belongs to a very ancient group of plants. Fossil cycads are known from the Lower Permian, 270-280 million years ago, and the Jurassic period is known as the “Age of Cycads” because of their abundance. The cycads are now greatly reduced in both numbers and distribution with about 250 species in 11 genera.

*Cycas tatawaniana*- Prince Sago
A slow growing cycad to 15 feet tall, Prince Sago has been long cultivated in its native home in eastern China but is now rare in the wild.

*Dioon edule*
This upright growing, palm-like cycad can grow to 11 feet tall with very long, stiff, pinnate leaves. Native to tropical deciduous oak forests in Mexico, Honduras, and Nicaragua, this easy to grow cycad prefers well-drained soils with plenty of moisture and light shade.

The unusual Clover Fern (*Marsilea macropoda*) produces two different sized spores.

*Zamia pumila*- Coontie
A small, palm-like perennial, Coontie grows slowly to form three-foot tall mounds of fine textured, evergreen foliage. Able to grow in full sun or shade, this cycad thrives in a woodland setting or under Live Oaks. Native to well drained soils throughout Florida, Coontie’s large, starchy storage root was used as a food source by Florida’s indigenous peoples and later by European settlers.

*Ginkgo biloba*- Ginkgo
Referred to as a living fossil by Charles Darwin in 1859,
Ginkgo has a remarkable history. An attractive, slow growing, deciduous tree reaching 70 feet in height, Ginkgo is considered the oldest living tree species. Ginkgo biloba represents the only living member of a family of gymnosperms dating back 270 million years ago to the Permian period. Cultivated for centuries in ancient Chinese and Japanese temple gardens, Ginkgo’s are remarkably resistant to disease, pests, and fires and are extremely tolerant of air pollution. The German botanist Englebert Kaempfer became the first European to describe and categorize Ginkgo biloba after discovering it in Japan in 1691.

Ephedra minuta- Miniature Joint Fir
Native to the high regions of Western China, this species has narrow, blue-green branches on five inch tall plants. The genus Ephedra, found in dry and desert regions of the Northern hemisphere and South America, contains about 40 species of much-branched, scraggly shrubs with slender green stems and represents the only member of the Ephedra family (Ephedraceae). Although classified as a gymnosperm and closely related to conifers, Ephedra’s exact relationship to other plant families is still not completely understood. Because Ephedra shares several characteristics with flowering plants (angiosperms), some botanists consider them a possible connecting link between gymnosperms and angiosperms.

Araucaria araucana- Monkey Puzzle Tree
This bizarre native of Chile and Argentina can grow to 150 feet tall in its native habitat but rarely over 30 feet tall in cultivation. The upwardly sweeping branches produce densely arranged, dark green, stiff, sharp, scale-like leaves. The leaves are so stiff and sharp that a comment by an Englishman in the 1800’s, who thought it would be a puzzle for a monkey to climb, contributed to its common name. A fascinating genus of about 18 species of coniferous trees, Araucarias are native to the southern hemisphere from South America to Australia and the Pacific Islands. Between 200 and 65 million years ago, the Araucarias enjoyed worldwide distribution, but when the dinosaurs became extinct 65 million years ago, the Araucarias ceased to exist in the northern hemisphere. The word araucaria is derived from “Arauco", a region in central Chile.

Cephalotaxus fortunei- Chinese Plum Yew
A large shrub or multi-stemmed small tree slowly growing to 20 feet tall, this conifer can grow in sun or shade and is a native of eastern and central China. Chinese Plum Yew was introduced to the western world in 1848 by British plant explorer Robert Fortune, who also introduced Japanese Plum Yew, Cephalotaxus harringtonia in 1849.

Cephalotaxus sinensis- Chinese Plum Yew
Although less well known than other members of the genus, this species shares the desirable traits of tolerating sun, shade, and deer. Native to central and western China, this conifer will develop into a small tree with shredding bark and long, dark green needles.

Cryptomeria japonica ‘Araucarioides’- Japanese Cryptomeria
A horticultural curiosity, this cultivar’s slender, rope-like branches with tight, short needles resemble green pipe cleaners and has a branching habit similar to Araucaria araucana, the Monkey Puzzle Tree. Cryptomeria japonica is the only species in its genus although more than 200 cultivars have been named.

Cunninghamia lanceolata- Chinafir
This large growing, pyramidal shaped, evergreen conifer develops drooping branches with needles arranged in a flattened spiral around the stem. An important, rot resistant, fast-growing timber tree in China, it was named for James Cunningham, who discovered it in China in 1702.

Cupressus chengiana var. kansuensis
Forming a fine textured column to 35 feet tall, this rare evergreen conifer is native to western China.

Keteleeria davidiana
Growing to 90 feet tall in its native habitat of Taiwan and southeast China, the soft whitissh-yellow, oily wood of this conifer is used for construction, furniture, and wood fiber. A member of the Pineaceae family, this species was discovered in 1869 by Pere David (1826-1900), a Lazarist missionary in the Franciscan order who was to travel to China to convert the populace to Roman Catholicism.
**Keteleeria evelyniana**
Slowly growing into an evergreen tree and adapted to climates with high heat and humidity, this conifer is native to Laos, Vietnam, and China.

**Metasequoia glyptostroboides**- Dawn Redwood
A fast growing pyramidal shaped tree, Dawn Redwood is the lone surviving member of its genus. Metasequoia was known only from fossils and thought to be extinct until discovered growing in an isolated Chinese valley in the 1940’s. Dawn Redwood makes an attractive landscape tree with light green, feathery, fern-like foliage.

**Podocarpus henkelii**
A native of South Africa, this conifer develops into a tall, straight stemmed tree reaching 60 to 90 feet in height. *Podocarpus henkelii* was named after Dr. J.S. Henkel (1871-1962) a conservator for forests in South Africa, and later director of forestry in Zimbabwe.

**Podocarpus macrophyllus**- Chinese Podocarpus
An upright growing shrub, or in time, a very narrow tree reaching 30 to 40 feet tall, this conifer makes an excellent woody foliage plant. Useful for topiaries and hedges because of its tolerance of shearing and pruning, this native of Japan and southern China can grow in sun or shade and grows well in the heat and humidity of the coastal south. Unlike other conifers that produce cones, the genus *Podocarpus* carry their seeds in round shells with a fleshy skin.

**Podocarpus totara**- Totara
A tall, slow growing coniferous tree to 90 feet tall, this New Zealand native is the largest growing member of the *Podocarpaceae* family. Totara timber was prized by the Maori as being the best for building their massive war canoes and for carving.

**Pinus patula**- Mexican Weeping Pine
Native to the highlands of Mexico, this attractive pine produces long, drooping needles up to 14 inches long that hang almost straight down.

**Pseudotaxus chienii**- White berry Yew
An extremely rare, understory shrub discovered growing in China around 1930, this evergreen, yew-like conifer represents the only member of its genus. Threatened with extinction in China because of habitat degradation and inadequate pollination of female plants, this species appears to be suffering from its inability to reproduce by seed.

**Taiwania cryptomerioides**- Coffin Tree
Discovered in the mountains of Taiwan in 1904, the stiff, prickly, awl-like juvenile leaves of Coffin Tree resemble the foliage of closely related *Cryptomeria japonica*. Developing into a pyramid shaped, bluish-green, evergreen tree with long drooping branches, the very light wood of this conifer is used in the making of coffins in its native Taiwan.

**Taxodium distichum**- Baldcypress
A large growing tree with buttressed trunks and tapered “knees” that stick up from the roots, Baldcypress evokes images of black water swamps of the Deep South. Unusual among conifers because of its deciduous habit, this southern icon grows as well if not better in average to dry soils and

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makes an excellent ornamental tree. With the exception of the American Chestnut, the Baldcypress has probably had the greatest reduction in number over the past century of any American tree because of the demand for its rot resistant wood. Taxodium belongs to the Taxodiaceae family, a very old group of conifers appearing first in the Jurassic period. Cryptomeria, Cunninghamia, Metasequoia, and Taiwania, all represented in the Primitive Garden, are also members of this ancient plant family.

Taxodium ascendens - Pondcypress
Similar to Baldcypress and at times hard to tell apart from a distance, Pondcypress is generally a smaller tree and not as prone to develop knees.

Tetraclinus articulata - Thyine Wood
A native of north Africa, southern Spain, and Malta, this coniferous, evergreen tree is the only member of its genus. A brittle resin collected from this tree, called sandarac, is used to manufacture varnishes. Called citron wood by the Romans, this is one of the last plants mentioned in the Bible (Revelations 18:12) as an article that would cease to be purchased when Babylon fell. The common name comes from the Greek word thuein, “to sacrifice,” because its fragrant wood was burned in sacrifices.

Torreya grandis - Chinese Nutmeg Tree
A slow growing coniferous evergreen tree from central and eastern China, this is one of six species of Torreya known with two occurring North America and the other four from Japan and China.

Widdringtonia nodiflora
Usually forming a scrubby shrub or small tree, this evergreen conifer occurs naturally in South Africa, Mozambique, and Zimbabwe.

Magnolia grandiflora ‘Little Gem’ - Southern Magnolia
The only flowering plant in the Primitive Garden, Southern Magnolia remains an icon of southern gardens. Noted for its large, white, fragrant flowers and dark green evergreen leaves, Magnolia grandiflora occurs naturally in the southeast from coastal North Carolina south to central Florida, and west to southeast Texas. According to Arthur Cronquist (Evolution and Classification of Flowering Plants, 1988), the most primitive of all living flowering plants belong to the subclass Magnoliidae. This subclass contains several primitive plant families including the magnolia family (Magnoliaceae).

### Arboretum Participates in Garden Expo

The AASU Arboretum participated in the 2006 Savannah Garden & Antiques Exposition by creating an exhibition garden and opening the campus for guided tours. Held annually, the Savannah Garden & Antiques Exposition benefits the Isaiah Davenport House Museum and Historic Savannah Foundation.

In this year’s exhibition garden competition, Arboretum staff constructed a miniature International Garden to interpret the theme, “The earth laughs in flowers…” a line from the Ralph Waldo Emerson poem ‘Hamatreya’. A special thanks to groundskeepers Andrew Fidler, Janice Nease, Donna Rigdon, and Chris Simon for their hard work, dedication, and creativity in constructing the exhibition garden.

On Sunday, April 2, a small but enthusiastic group of participants toured the Arboretum’s plant collections led by Master Gardeners and Grounds Superintendent Philip Schretter.

Cactus people in the Arboretum’s exhibition garden.
Putting Time into Perspective
Important Developments in Plant History

By Philip Schretter

Because of the shear immenseness of geologic time, it can be difficult to put into perspective the timing of important events in earth’s history. The time scale above shows the earth’s entire history. The time scale below narrows earth’s history down to just the last 570 million years when plant development occurs.

The first plants creep onto earth during the Ordovician, beginning a great new chapter in the story of life on earth.

The first fossil evidence of vascular plants appears in the Silurian.

Plants begin to adapt to life on land in many forms in the Devonian. By the end of the Devonian, ferns, horsetails, and seed plants had appeared, producing the first trees and forests.

Widespread, moist tropical conditions during the Carboniferous produced abundant, lush plant growth in swamp forests which eventually became large coal deposits—hence the name Carboniferous or “coal-bearing”. So vigorous was the growth of these ancient trees that they seemed to have removed much of the carbon dioxide from the atmosphere and produced enormous quantities of oxygen. Oxygen levels were higher during this time than during any other in earth’s history.

Climate change created drier conditions during the Permian which greatly reduced the large swamp forests of the Carboniferous. The conifers and ginkgos begin their rise to prominence.

Dry conditions during the Triassic continued to reduce the number and variety of swamp forest trees and ferns that needed a moist habitat. Triassic vegetation was dominated by conifers and other gymnosperms.

Gymnosperms are well represented during the Jurassic and cycads are so abundant that the Jurassic is also known as the “Age of Cycads”. Conifers remain the most diverse large tree during this time including representatives of many families still living today including Araucariaceae, Cephalotaxaceae, Pinaceae, Podocarpaceae, Taxaceae, and Taxodiaceae. The first flowering plants appear near the end of the Jurassic.

Flowering plants became the dominant type of plant on earth in the second half of the Cretaceous.
A Simple History of the Development of Land Plants

The Rise to Dominance with a Sticky Treat

By Philip Schretter

The invasion of land, along with the development of the seed and the appearance of flowering plants, represent the three most significant events in the history of plants.

The Invasion of Land

The first plants had it easy. They floated around supported by ocean, absorbed nourishment through their cell walls, and reproduced easily by releasing their reproductive cells in the water to meet and form tough capsules that could float around and find new places to live. Living on land was much tougher. Drying winds and large temperature swings prevented those early water plants cast ashore by waves or trapped in evaporating pools from living very long. To adapt to life on land, plants needed to develop substances to prevent their exterior surfaces from drying out, specialized cells for the transport of water and nutrients, and maybe most importantly, an effective method of sexual reproduction.

Early land plants found that effective method of reproduction utilizing spores and a unique process called alternation of generation. Alternation of generation is a cycle between adult plants and another stage that is kind of an intermediate phase. The intermediate phase is not the same thing as a juvenile stage. Juvenile plants eventually become adult plants while those in the intermediate stage will never become adult plants. The stages can be thought of as different generations within the same life cycle and is easy to see in plants that reproduce by spores. The adult generation, what we usually see when we look at plants, produces the spores. The spores germinate and develop into the intermediate generation. The intermediate generation produces sex cells—sperm and eggs. Union of these sex cells produces an adult plant and the cycle continues. The greatest limitation of this system, at least as it applies to early land plants like ferns and horsetails, is the necessity of a film of surface water for the sperm to swim in to unite with the eggs. No free water means no reproduction and explains why ferns don’t usually grow and reproduce in an arid environment. Within the plant kingdom, dominance of generations varies. The earliest land plants, like mosses and lichens, have the intermediate generation dominant. When you see moss growing on the ground, you are looking at the intermediate generation of its life. Ferns and horsetail produce small but completely independent intermediate generations. Through time, plants show a progression of increasing adult generation dominance and intermediate generation reduction from the ferns up to the flowering plants.

The Development of the Seed

Most early land plants produced one size of spore and upon germination, these spores grew into the intermediate generation, which produced both male and female sex cell-producing organs. In many of these plants it is possible for sperm to fertilize the eggs from the same intermediate plant. This causes problems when the success of a species relies on genetic variability in a population.

Some early spore producing plants produced two different sized spores, a larger spore that produced female sex cells, and a smaller one that produced male sex cells. At some point in time, the adult generation no longer released the female spore to develop into an independent, intermediate generation. Instead, the female spore developed into an egg producing intermediate generation on the adult and became completely
dependent on it. Male sex cells in the form of pollen were transported to the female eggs by the wind, thus freeing plants from their dependence on surface water to reproduce. Larger female spores contained a greater food reserve ensuring nourishment for the undeveloped, adult plant in the form of a seed. Seeds are dormant, protected, embryo adult plants. The role of dispersal once assumed by spores was taken over by the seed.

The development of the seed provided a major innovation in plant reproductive strategy and is certainly the primary reason for the dominance of seed plants in today’s flora. In examining the seedless plants, it becomes obvious that the adult generation can only grow where the intermediate generation can succeed. Because of its dependence on water, the intermediate is the weak link in the life cycle. The development of the seed allowed plants to reproduce sexually without the necessity of external water, and provided protection and nutrients for the developing embryo. Seeds can be dispersed long distances and can remain viable for long periods of time. (How long can seeds last? Carbon-14 dating has shown that 10,000-year-old seeds of Lotus are viable and will still germinate!) These traits allowed plants to expand their range away from streams and watery sites to higher and drier environments.

**Flowering Plants**

Most early seed plants relied on wind to transfer pollen to their female sex cells (eggs). Large quantities of pollen must be produced to ensure that some will reach its target. Wind pollination is most effective in plant communities where the wind-pollinated plants are dominant, common, and closely spaced. Coniferous forests and grasslands represent good examples of wind pollinated plant communities. Botanist theorize that some of the early wind pollinated plants produce resins and gums on their egg producing structures to increase the chances of pollen sticking to them. These gummy substances also possibly attracted insects interested in a sticky treat. The sticky insects unknowingly transferred pollen stuck to their bodies from one plant to the next and insect pollination was born. Plants continued to develop increasingly attractive structures and substances, like flowers, nectar, and fruit to increase the likelihood of animals assisting them in pollination and dissemination. Flowering plants took over most terrestrial habitats in an astonishingly short period of time displacing many ferns and non-flowering seed plants. How did flowering plants and their animal helpers so thoroughly take over most of the earth’s plant communities? Imagine a large coniferous forest made up of pines and spruces. A flowering plant on the fringes of this forest with help from an animal seed disperser could move into the under story and grow in an opening left by a tree fall. A wind pollinated plant would have little chance of being pollinated being so isolated from others of its species but the flowering plant with its mobile animal pollen vectors could be successfully pollinated. Structural differences also allow flowering plants to grow more rapidly than the non-flowering seed plants so our isolated plant in the forest quickly out competes any of the existing plants around it for sunlight and water. Animal pollination allows plants to be smaller, more isolated, and less common than wind pollinated plants. Animal pollinators will travel considerable distances from plant to plant to seek the reward of a “sticky treat”. 

Female cones on a Black Japanese Pine (*Pinus thunbergii*). Note the small, glistening droplets of sticky resin on the developing cones.
Floral Diversity
A Sampling of Spring Flowers in the Arboretum
Large, high grazing, long necked sauropods reached their peak during the Jurassic period as the giraffes of the Mesozoic. These and other high feeding dinosaurs were well adapted to eating in the treetops. At the end of the Jurassic, most of these high feeders became extinct, and were replaced by successive waves of beaked dinosaurs specialized for low feeding. This change in feeding pattern had a devastating impact on the low growing, slow growing, and slow to reproduce gymnosperms like cycads and conifers and opened the way for a take-over by plants with the ability to grow and reproduce rapidly. The fast growers could colonize a grazed area quickly and produce a new generation before the herbivores returned to crop the area again. One of the plant types best suited for such an environment would have been the angiosperms, or flowering plants. During the Cretaceous period, and at the same time as the low feeding dinosaurs were taking over as the major herbivores, the flowering plants flourished.