The E. W. Heier Teaching Greenhouse

A Self Guided Tour

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Brief History of the Greenhouses

The first university greenhouse on the Binghamton University campus was built in 1961 and was attached to the then-newly-opened Biological Sciences Department complex (present day Science I, at the location of today's 'Chenango Room' atrium). With the rapid growth of the University, a totally new Biological Sciences building was completed in 1973, leaving the greenhouse behind. The isolation of the greenhouse eventually necessitated a new structure - much larger and better equipped. The new, and present day 12,500 foot greenhouse was completed and occupied in 1981, adjoining the Biology Department building (Science III). This E. W. Heier Teaching Greenhouse holds nearly 2,000 plant species in four climate zones within it's four rooms: Warm Temperate (sub-tropical), Cool Temperate, Desert and Tropical. The entire greenhouse complex was expanded in 1996 to include a state-of-the-art research greenhouse to accommodate the expanding plant research conducted by students and faculty of the department. This separate complex has seven climate-controlled rooms, a headhouse, and two photoperiod rooms.

THE GREENHOUSE ENVIRONMENTS

Do a quick walk through, say 15-20 minutes total, of the four Biome/habitats in the Greenhouse while reading the information immediately below. Try to get a "feel" of each environment, taking notes on how the plants fill the space of each room and any other conspicuous differences (plant structure, temperature, humidity, fragrance, etc). You will not be held for the names of individual species and families. Fill in the separate work sheets on Plant Diversity and Functional Plant Morphology that focus on plants in the Desert and Tropical rooms, and the Carnivorous Plants in the Green house hallway. Record the relative humidit and temperature at the center of each room, and check the temperatures on the digital display outside the doors leading to each room from the main greenhouse hallway.

Warm Temperate (Subtropical) [55-65°F in winter, up to 95°F summer]

Plants in the Warm Temperate Room are kept at temperatures above 55 degrees; higher in the spring and summer months. In general, they are native to climates that do not freeze, but do have a cooler seasonal resting period. Notice that this room has a number of very interesting species including a large number of fruit-bearing plants and trees, the dry tropical cycads, a north wall dedicated to orchids, and large vines along the east wall and above the pool. The represented species include those native to Florida, Mexico, Central America, India, South Africa, Australia, Madagascar, etc.

Find a **Cycad**. What are some of the characteristics of this plant that make some scientists call it a "primitive" plant? Cycads can be found in the fossil records and have retained the same structure through the ages. Order Cycadales has been in existence since the early Mesozoic to the present. Within this order are 10 genre and our greenhouse holds representatives of 8 of these genre, such as **Zamia**, **Dioon** and **Cycas**. The armor of leaf bases on the stem can be used to roughly determine the age of a Cycad. It takes approximately 30 years for a Cycad to develop a recognizable trunk, and then a swirl of leaves should develop each year. The collection's oldest cycad is more than 80 years old and is situated in the planter box just opposite the two pools. Notice the reproductive strobili, or cones, on many of the cycads at their stem apex. Cycads produce either a male cone or a female cone, and fertilization is assisted in the wild by a particular species of beetle. The plants are found in the drier tropical regions and can be extremely long-lived, some gaining 1000 years in age. Their habitat is dwindling rapidly by encroachment and poaching, and they are now a protected order.

The bench along the north wall features most of the **orchid** collection. Several species will likely be in bloom at any given time, although the height of bloom is in January to February. Orchids species are found in all parts of the world and are highly desired by collectors and hybridizers, who devote a great deal of time to showing, cultivating, and enhancing their collections. Aficionados have donated many of the orchids in our collection.

Take time to search the room for the many edible fruit-bearing plants. On the south wall, behind the pools, is the species **grapefruit (Citrus x paradisi),** which normally has ripening fruit. This species is in the Family Rutaceae. The Family Myrtaceae (southern Brazil) includes the **pineapple gauva (Feijoa sellowiana)**, and the **jaboticaba (Myrciaria cauliflora)**. The jaboticaba tree can be found in the large planter box right inside the main door to the Warm Temperate Room. If you are lucky enough to be here when the flowers or fruits are on, note where on the plant they develop! Note also that the bark on the jaboticaba appears to have been sloughed off - this is an example of a plant with exfoliating bark. A **coffee tree (Coffea arabica)** is situated on the floor to your left as you enter the room from the hallway; note the developing coffee "beans," which are the edible fruit of this native of tropical mountain slopes.

Before you leave the Warm Temperate Room via the inside door to the Cool Temperate Room - look up! Note the massive expanse of vine that goes up this interior eastern wall and may hang over the pool. Actually, there are two vines to note here. One is the bottlebrush, which is another plant in the family Myrtaceae. The flowers are lovely, graceful tufts of red stamens that resemble brushes used to clean baby bottles; its foliage is narrow and pointed. The second vine is equally impressive - the **Aristolochia durior**, or Dutchman's Pipe Vine. This deciduous, woody climber produces rapid growth, is hardy in our climate zone, and produces flowers that display a brownish- purple veining pattern on the lobes with a "U" shaped tube lined with upward-pointing hairs. What would be the advantage to having the stamens and pistils at the base of such a pipe-shaped structure? Proceed into the Cool Temperate Room…

Cool Temperate [50-60°winter, up to 90°F summer]

What are your first impressions upon entering this room? Depending on the season, you will either find a room full of lush growth, bursting with flowers - or a landscape of bare branches and little greenery. A large proportion of the plants in the Cool Temperate room are deciduous. This room is kept just above freezing in the winter months, with a high of between 45-50 degrees Fahrenheit. In the summer this room is a pleasant retreat from the ambient high temperatures, as it is air-conditioned to maintain the climate of the cooler mountain or coastal biomes.

Find **Ginkgo biloba** and **Metasequoia glyptostroboides**. These plants are considered by many scientists to be "primitive" or "living fossils." The ginkgo, or maidenhair tree, is in the Family Ginkgoaceae, in which there is only the one genus, Ginkgo, and only the one species, biloba. This tree, a native to south-eastern China, is evidently extinct in the wild, but is widely used today as an ornamental or street tree, hardy to zone 5. The fossil records show that very similar plants existed in the late Paleozoic Era, and occurred widely throughout the mid-Mesozoic Era. Interestingly, ginkgos share characteristics of both the cycads and conifers; their sex-organs and gametophyte development are very similar to that of cycads, while their stems with their long shoots and spur shoots are similar to conifers.

The Cool Temperate Room contains several examples of plants in the phylum, Coniferophyta, specifically several in the family Taxodiaceae. Conifers are believed to have been widely spread throughout the northern hemisphere in the early Tertiary period, but today they occupy a narrow ecological zone. They have developed xerophytic (dryness) adaptations and some are deciduous, such as the **Metasequoia**, more commonly known as the Dawn Redwood. This genus was first described from fossil records in 1941, and amazingly enough, living plants were brought to the attention of botanists in 1948 after they were discovered in Szechwan, China (Hortus III). As with the other conifers, the lifecycle of the Metasequoia is similar to that of ferns, where the sporophyte generation is the dominant form and the gametophyte generation is dependent on the sporophyte. Other conifers in the Cool Temperate Room include the bald cypress (**Taxodium distichum**) and the buddist pine (**Podocarpus macrophyllus**).

By the door leading out of the Cool Temperate room into the greenhouse hallway is a planting box containing a uniquely beautiful small tree - a **Brugmansia versicolor** of the family Solanaceae. This graceful tree is also sometimes placed in the genus **Datura**, and bears the common name, Angel's Trumpet. If it is in flower, note the large, pendulous blossoms that are white, fading to apricot-peach with age. The Solanaceae Family (including potato, tomato, red pepper and tobacco) is known for having large numbers of poisonous or medicinal plants and plant parts, while at the same time being of high economic importance. The genus **Solanum** (nightshades, potato) contains a poisonous alkaloid originally termed solanine, which has various levels of toxicity. Species of **Brugmansia**, on the other hand, contain several solanaceous alkaloids, including atropine, hyoscyamine, and hyoscine. The total alkaloid content is very high, varying from 0.25 to 0.7 percent (Kingsbury) and is present in all plant parts. Although in some cultures Brugmansia or Datura have occasionally been deliberately used for their hallucinogenic effects, the onset of toxicity in humans and animals varies with relation to the concentration of the several alkaloids present and by individual body chemistry - most often to fatal ends (Kingsbury). Most of these chemicals are plant defenses against herbivory. Proceed into the Desert Room…

Desert [50-60°F winter, up to 110°F summer]

What immediately strikes you when you enter the desert room? What are some ways that plants in this room differ from those in the previous rooms? What do the desert plants have in common?

The desert room contains plants we consider to be adapted to a harsh environment - that of the desert with hot, dry days and cold nights. Plants along the western wall (toward the Cool Temperate room) are predominately native to Africa, with many representatives of the Euphorbiaceae Family. Plants on the eastern wall, along the Tropical Room glass, are primarily representatives of North and South America, with the Cactaceae Family predominating. Plants in the center planting bed represent natives from both Africa and the Americas. It is evident that there is a great deal of similarity between these two unrelated families, which are often at first glance all mistakenly viewed as "cacti." The majority of the plants in the desert room are all considered "succulents" - i.e. thick, fleshy plants with abundant sap that are predominantly native to arid or semi-arid regions, at least for part of the year (Hortus III). The succulents growing in the Desert room come from all over the globe and are representatives of many different families: Cactaceae, Agavaceae, Crassulaceae, Euphorbiaceae, Liliaceae, Aizoaceae, Compositae, Portulacaceae, and so on. The independent development of similar structures in unrelated, or distantly related, life forms is often displayed in individuals living in a similar environment, and is known as *convergent evolution*. Look around the species in the collection, and name some of these similar structures!

Succulents have a peculiar metabolic adaptation to living in arid conditions. Recall that a typical (non-succulent) plant opens its stomata in the day to take up CO_2 for photosynthesis, releasing O_2 in the process. Stored energy is used in metabolic activities during the night (respiration), which releases minor quantities of CO_2 into the air. Having open stomata during warmer, daytime conditions increases water loss from the plant. In 1813 Dr. Benjim Heyne conducted a simple experiment by tasting the leaves of the succulent **Kalanchoe** in the morning, midday, and in the evening. He discovered that the leaves were very acid in the morning, tasteless at midday, and nearing bitter by nightfall. He deduced that there was a build up of acids overnight and that these broke down during the day. Subsequent investigations discovered "Crassulacean acid metabolism" (C.A.M.), which is a distinct characteristic of succulents worldwide. Succulents open their stomata at night when the loss of moisture from the plant is less (relative humidity is almost always higher at night), and take up and store CO_2 as an organic acid (malic acid). This is the acid that Dr. Heyne tasted in the morning. In this manner, CO_2 for photosynthesis can be obtained from malic acid during the day without opening the stomata and losing excessive plant moisture.

A tour of the Desert room is not complete without a close look at some interesting species. In the center bed note the large **Euphorbia trigone**. The thick stem contains a latex-type sap that is poisonous if swallowed and can produce a dermal rash on the skin. The leaves are reduced in size, or even further reduced to spines. Across the aisle from the Euphorbia you should find one or two species of **Lithops**, a unique succulent in the Aizoaceae Family. Lithops are commonly called "Living Stones" because of their appearance. They are adapted to survival in the harshest of deserts, and with their translucent top surfaces

they can survive being buried for days in blowing sand while still conducting photosynthesis. On the eastern wall you will find a number of **Agave americana** specimens, the Century Plant. Some Agavaceae species are cultivated for fiber (sisal) or for the sap, which is fermented or distilled. Proceed into the Tropical Room…

Tropical [65-75°F winter, up to 90°F summer]

Stepping into the Tropical Room is like stepping into a mini-rainforest - vines and epiphytes (air plants) climb to the upper canopy, trees drape branches over the walks and the tallest reach towards the peak of the 25-foot glass roof. The 800 square foot, in-ground plant bed displays tropical plants in a situation fairly close to natural. What are the morphological adaptations of many of these plants? How do these adaptations address the limitations of their environment?

Plants in the tropical rainforest compete for light. Note the many **Bromeliads** (**Bromeliaceae**) in pots on benches or perched as epiphytes in tree branches, such as in the Banyon Tree (**Ficus benghalensis**) or the Common Fig Tree (**Ficus carica**). An **Allamanda** (Golden Trumpet) vine rises above the bench on the north wall, and a **Bougainvillea** (Paper Flower) has "pride of place" in the southeastern, sun-exposed corner. Large leaves are found on many plants in the tropics. Bananas (genus **Musa**), with their large, elongated leaves, are scattered throughout, both in the plant bed and on the benches. Many terrestrial or epiphytic ferns (**Pterophyta**) have adapted to the lower light levels of the tropical under story. Note the maidenhair ferns (**Adiantum**) and the holly ferns (**Cyrtomium**). What different kinds of microclimates exist in the under story? How are they created, and what does this imply about the number of niches and resulting diversity of plant life and overall biodiversity found in the tropics?

The plants in the tropical room flourish in the high humidity provided by an automatic misting system along the west and north walls above a plant propagation bench. The screw pine (**Pandanus**) in the southeastern corner of the planting bed, named after the spiral crown of leaves at the branch tips, requires constant moisture and heat and is native to the Old World Tropics, where their long, spiny-margined leaves are used as thatching. Note also the prominent aerial prop roots. What are the possible benefits of prop roots to plants such as the **Pandanus** or **Ficus**? How does this adaptation relate to their environment?

Along the south-facing window hang numerous pots of tropical cacti. How are they similar to the desert cacti? Are they adapted to the same stresses and limitations as their family members living in desert climates? Phenotypically, they look very similar to desert cacti. Consider the stresses in terms of where they would be found growing naturally in the tropical canopy.

Before leaving the greenhouse, think about what is most "artificial" about the greenhouse in terms of a model for ecological zones? There are several good answers to this question; make sure you know them. Proceed into the main Greenhouse Hallway to view the carnivorous plants terrarium just outside the Tropical Room door….

Carnivorous Plants

Carnivorous plants are sometimes called 'insectivorous' plants. Most are perennial herbs that inhabit very humid, boggy, sheltered but sunny, acidic environments. What is in short supply for these plants? Consider acid conditions, rate of decomposition, and available nutrients.

Our terrarium includes Venus Flytrap (**Dionaea muscipula**), sundews (**Drosera sp**.), Pitcher Plant (**Sarracenia sp**.) and Climbing Pitcher Plant (**Nepenthes sp**.). All of these plants have evolved unique mechanisms for trapping and digesting animal prey, primarily small insects, in order to obtain extra nitrogen. What plant part has evolved for this purpose? The plant traps are of various sorts, including the pit-falls of the pitcher plants, the sticky "fly-paper" of the sundews and butterworts, and the spring-loaded type action of the Venus flytrap. Carnivorous plants have a slow growth rate, so they are very suitable for existence in terrariums if the conditions mimic those of the bog.