

PLANT ADAPTATIONS

As part of this laboratory exercise, we will walk through three sections of the CMU greenhouse to look at plant adaptations to various environments. The greenhouse includes a large central room dedicated to the tropical plants. On the west side are two smaller rooms, the aquatic plant room and the desert plant room.

TROPICAL ROOM

As you first enter the conservatory, you come into a room that is kept warm and moist in order to maintain plants from low elevation, wet tropical areas. This environment is one that northerners probably think of first in the connection of the tropics, but there are dry deserts and cold mountaintops in the tropics as well. In the low, wet tropics, humidity is high, temperatures are always freezing, and day length does not vary much from 12 hours throughout the year.

Look in the beds around the pond and you will see many of the major growth forms of plants in the tropics. There are many woody plants, including vines, shrubs, and trees. The tropics have many more kinds of trees than do the temperate zones. There are also large herbs. Notice the **bird of paradise** (#10 and #11) and the **bananas** (#30) to the left of the pond. These are large plants that live many years, but do not produce woody stems. In Michigan, such herbs would be frozen to the ground each winter.

To your right, as you stand at the pool, is an artificial tree (#14) covered with a form of plant not found in Michigan. These are **epiphytes**, which are plants that grow upon other plants as a support. Epiphytes do not derive food from the other plant; they are not parasites. They can live in this way on any object, and may be seen in the tropics growing on telephone wires. Epiphytes have no connection with the soil. They collect their nutrients from the air (and are sometimes called "air plants") or from debris falling from above. They get water in the same way.

Most of the epiphytes in this artificial tree are **bromeliads**; plants of the pineapple family. Other than the pineapple, a member of this family with which you may be most familiar with is Spanish moss. Most members of this family are epiphytes, although the pineapple (#15) and a few others grow on the ground, and can be seen below this artificial tree. Most bromeliads have an unusual leaf structure that creates a reservoir for water. The plant can store water when it rains, to use when it doesn't.

This reservoir also catches dead leaves and other detritus, which decompose and release nutrients. Further more, these small pools are used by many small animals that have no other standing water in the forest.

These are other kinds of epiphytes in the conservatory. You are familiar with some of these plants, but may not know they are epiphytes. Look around you for **orchids** (#35), **Christmas cacti** (#34), and **staghorn ferns** (#36), among the most well known.

AQUATIC PLANT ROOM

Fresh water environments present opportunities and problems for plants. Obviously, water is abundant. Usually, CO₂ for photosynthesis is abundant, a well. Oxygen for respiration may be in low supply, particularly at night. Light also can be in low supply because some of the light reflects from the surface, instead of passing through, and molecules in the water absorb more. Water molecules themselves (H₂O) absorb long-wavelength light. Finally, the buoyancy of water can provide support for the plant.

In the pond, you see four ways that plants live in water. Some plants have their roots in the soil and extend their leaves above the water. These aquatic plants are called **emergents**. Examples here are rice (#3) and papyrus (#1). Cattails live in the same way. The water lilies in the pond are rooted in the soil but have leaves that float on the surface instead of extending above the water. Hence, water lilies are an example of **floating** aquatic plants. Their stems grow horizontally on the bottom of the pond, and only the leaf petioles grow upward. The plant puts little material into supporting structures, allowing the buoyancy of the water to support its leaves. Leaves that float on the surface always have one side under water and one side out of water. The upper surface of water lily leaves have most of the stomata, which is the opposite arrangement from that found in terrestrial plants.

Under the water, you may also see plants that are rooted in the soil but do not grow to the surface. These plants are called **submergents**. *Myriophyllum* and *Elodea* are common examples. These plants can live in water too deep for emergent-leaved or floating-leaved plants, but run the risk of being shaded by plants growing above them. Some plants that may do that are floating plants, such as water hyacinths (#2), water lettuce, and several kinds of floating ferns. These plants have the advantage of access to light, but the disadvantage that their roots cannot reach

the soil, where nutrients may be more concentrated. In addition, they may blow away to less favorable places.

DESERT PLANT ROOM

On most days, when you enter the Desert House, you receive the sensation that the air is cooler. This is not correct. The temperature of the air in this room is kept higher than in the others, but the air is drier. Evaporation makes it feel cooler than it is.

Plants that live in desert areas must be able to endure tremendous physiological stress. The problem is not so much heat but drought. Plants almost constantly take up water from the ground and transport it to stems, leaves, and flowers. Most of the water transpires into the air.

The adaptations of desert plants are not limited to structural features. Many of them have distinctive biochemical characteristics, as well. Plants must photosynthesize in order to live. However, CO_2 is needed from the air, and whenever the plant opens its stomata, it loses precious water. To get around this, some **succulents** (including members of the Agavaceae, Aizoaceae, Cactaceae and Crassulaceae) have evolved a system called **crassulacean acid metabolism** (CAM). These plants only open their stomata at night when the transpirational stress is lowest. CO_2 is taken in that time and stored as the carboxyl portion of an organic acid. During the day, when light energy is available, the stomata close, and the plant releases the CO_2 from the acids to use for photosynthesis. In this way, the plant actually transpires less in the daytime than it does at night.

A similar biochemical modification of photosynthesis is **C₄-photosynthesis**. Plants that perform C₄-photosynthesis also have modifications of their leaf anatomy that facilitate uptake of CO_2 by production of an intermediate 4-carbon compound. C₄ plants have higher rates of photosynthesis than do other plants in dry, bright environments, but they lose more water in the process than do CAM plants.

As you look at the plants in the desert house, try to notice the differences among the families that cause them to be classified as unrelated. At the same time, notice the convergence of characteristics that occurs among the various families. The following six families are most abundant in the Desert House, but you will see other families as well.