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The Epiphytic Lifestyle

by Sue Bottom, sbottom15@gmail.com

There are some terrestrial and semi-terrestrial orchids that grow in soil and leaf litter, but many orchids moved up the tree canopy during their evolutionary history, searching for light and leaving the moisture and nutrient rich soil behind. Many are epiphytes, so called because epi- means "on top" and -phyte means "plant", so these orchids grow on top of other plants. Some grow on tree trunks or branches; others grow on twigs.

True epiphytes spend their entire lives without contacting the forest floor. In locations where moisture and nutrients are supplied more or less continuously, such as in ever-wet forests, epiphytes differ little in form and physiology from the ground rooted vegetation. Epiphytes are particularly abundant in cloud forests, where the air is constantly saturated and leaves are dripping from cloud condensation.

In dry forest environments, water and nutrients are supplied in pulses and there can be extended periods of droughty conditions between storms. Specialized canopy dwellers have adapted to the dry, xeric conditions obtaining their water and mineral ions through their unusual plant forms and physiology. There are two general types of xerophytes, those equipped to avoid and those adapted to endure prolonged drought.

1. Catasetums are drought avoiders. They drop their leaves and go into a deep sleep when the dry season deprives them of the moisture they need.

2. Cattleyas are drought endurers. They sustain themselves during droughty periods by consuming energy and moisture stored in their pseudobulbs.

- *Drought avoiders* are seasonal growers that restrict most of their vegetative growth to humid periods of the year. During the droughty season that does not support their normal heavy water use, foliage is shed and the plants lapse into dormancy. Carbohydrates and moisture are held in reserve in fat pseudobulbs or tubers. When favorable weather returns, new growths emerge to repeat the cycle. Commonly grown drought avoiders are most of the Catasetinae and certain dendrobiums, habenarias and lycastes.

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- *Drought endurers*, like many in the cattleya alliance, require quick adjustments to abrupt environmental challenges to maintain a favorable water balance. Each time an epiphyte's moisture source dries out, a process that sometimes takes only an hour or two; there is the potential for an extended drought to follow. Adaptations to the epiphytic lifestyle revolve around water relations; acquiring moisture and preventing the loss of acquired moisture are critical to a xerophyte's success. The pulse supplied epiphytes survive as a result of their high water storage capacity and high water use efficiency. These drought enduring epiphytes have high water storage capacity in succulent leaves and bulbs, velamentous roots for quick water and nutrient absorption as well as the ability to photosynthesize while moisture is scarce.

Roots. Epiphytic orchids have roots also adapted to life in the canopy. The roots anchor the orchid to its host plant, holding tight even when buffeted by winds. The unique root structure consists of a nonliving, thick air filled layer called velamen that surrounds the living cortex of the central conductive filament. This adaptive velamen structure acts like a sponge, becoming engorged almost instantaneously after contact with liquids so moisture and nutrients can move through the cortex and into the vascular system. This velamen becomes almost impermeable during dry periods to prevent water from being exuded through the roots. The velamen has special cells for gas exchange absorbing oxygen for respiration, and, where chloroplasts are present, carbon dioxide for photosynthesis. High porosity potting mixes are recommended for orchids to help ensure that the roots can be bathed with air. When the organic matter in a potting mix starts to break down, the mix begins to compact and effectively smothers the roots. It is not too much water that kills your orchids, it is the lack of air around the roots that orchids cannot tolerate.

3. The living filament is surrounded by velamen, nonliving spongy tissue once it reaches maturity that continues to absorb water and mineral nutrients.

4. Catasetums can grow rapidly during the wet season, storing lots of carbohydrates and moisture in their fattened pseudobulbs.

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Pseudobulbs. Many epiphytic orchids have short, thick bulb shaped stems called pseudobulbs. These structures store water and carbohydrates, similar to the humps on a camel. The pseudobulbs swell or shrink as moisture is stored or withdrawn, allowing orchids to sustain themselves in areas with seasonal rainfall where the plants experience months without rainfall. You can use the plant morphology as a general guide to basic orchid culture. The fat pseudobulbs with thick leaves typical of cattleyas suggest the plant is more drought tolerant than thin leaved plants like many oncidiums. Phalaenopsis rely on fat roots and leaves for energy and water reserves.

Leaves. The leaves of xerophytes are often thick and succulent, covered by an evaporation retarding waxy cuticle. The more succulent the leaf, the more the leaf interior assumes a water storage role. Additional less conspicuous features promoting water retention include recessed stomata (pores used for gas exchange), usually on the leaf undersides, and reflective surfaces.

5. Most cattleya leaves are thick allowing some internal water storage. They often have a waxy cuticle to and prevent excess water loss.

6. Cattleyas are busy absorbing carbon during the cooler night hours when humidity is higher, storing it for photosynthesis during the daylight hours.

Photosynthetic Pathway. Many epiphytic orchids have a specialized adaptation to minimize water losses in their arid living environment. More conventional plants open their stomata during the day to absorb carbon dioxide for photosynthesis. The open stomata allow water to escape and evaporate in a process called transpiration. In these so-called C3 plants, more than 90% of the water they absorb through the roots is lost through transpiration, a process that would result in the death of the epiphytic orchid living in xeric environment. Because carbon gain and transpiration water loss both occur through the same stomatal pathway, some epiphytic orchids use a specialized adaptation called CAM photosynthesis (Crassulacean Acid Metabolism) to minimize water losses. The more succulent the leaf, the more likely the plant absorbs carbon dioxide during the nighttime hours while the stomata are open, storing the carbon for subsequent photosynthesis during the daytime hours after the stomata close. Keeping the stomata closed until the humidity levels are higher and temperatures cooler at night minimizes transpiration losses so CAM plants have a very high water use efficiency. Of course, the intermediate storage of carbon has an energy cost, so CAM plants grow more slowly than do their C3 counterparts. The more succulent the plant, the more likely the plant uses CAM metabolism. Thick leaved cattleyas and phalaenopsis often use CAM metabolism, while the thin leaved oncidiums often use the more conventional photosynthetic pathway. The slower growth rate of CAM plants suggests less fertilizer is needed to support growth than is required for C3 plants.

Nutrition. Orchids living in the tree canopy have modest nutritional demands in keeping with their stress adapted nature. Poole and Sheehan wrote:

> Rainfall is a valuable source of nutrients for epiphytic plants since it washes dust particles out of the air and onto them. The atmosphere is also an excellent source of nitrates, especially during electrical storms. Water flowing over leaf surfaces leaches mineral and organic nutrients from the leaves. Thus the leaf canopy of the host tree becomes a nutrient source that enriches the water before it reaches the orchid plant. The major source of nutrients, however, is probably the slow decomposition of organic matter (both flora and fauna) that accumulates in tree crotches and among the bark, roots, rhizomes and leaves of orchid plants.

The availability of nutrients in the wild is inconsistent, depending on what has accumulated since the last storm. The velamen of orchids which is so efficient at absorbing water also helps absorb mineral nutrition, especially given that the nutritive fluids arrive sporadically and the first solutions to arrive during a storm are the most heavily charged with nutrients.

Courtney is a firm believer in mimicking nature in his orchid cultural practices. During the spring when humidity levels are low, he advocates nighttime watering to allow orchids to become properly hydrated and he encourages the use of dilute fertilizers:

> If you ever visit the tropics where many cultivated orchids originated, it is surprising to read the prohibition to never water at night. In their natural habitat, orchids are soaked at night by rain or dew. Rarely, will you ever find an orchid with rot in nature. In the wild, orchids grow very slowly and are very limited by nutrients. Their leaves are thick and hard; even immature plants.
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> Bacteria require nutrients to grow and the presence of water laden with nutrients in and on leaves is an invitation for bacterial and fungal invasions that cause rots. Orchids can grow quickly if pushed with lots of fertilizer. However, cell walls are thin and soft on these orchids making it easy for fungi and bacteria invasion. Cells also are loaded with excess nutrients providing fuel to any invader.

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Growing under lower nutrient conditions does cause slightly slower growth and causes orchids to put more energy into root growth. This produces a better rooted orchid, less susceptible to disease, even if you water at night.

Our epiphytic orchids have adapted to ecological constraints with unique mechanisms to tap limited resource pools, prolong contact with passing canopy fluids and promote water and mineral nutrient use efficiency. Commercial orchid growers have to keep a roof over their heads and feed their children, so they often try to maximize growth rates, and this may result in softer growths that require chemicals to control pest and disease outbreaks. As hobbyists, it is better to use buoyant air movement and proper cultural conditions rather than a chemical arsenal to produce healthy plants with lots of blooms. A slow growing oak with a strong trunk and branches can better weather a storm than can a fast growing willow.

Citations and Additional Reading

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