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HORTICULTURAL ASPECTS OF GROWING AND DISPLAYING A WIDE VARIETY OF EPIPHYTES

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ABSTRACT. Epiphytes can be grown on various substrates. Water availability is a crucial factor, though many epiphytes can survive under less than optimal treatments. Accurate environmental habitat simulations can be valuable tools for both research and education. There is some difficulty in developing simulations due to a general lack of adequate information on environmental conditions of natural habitats. Misinterpretation of "adaptive" features is also a problem. Substrate mixes, careful placement within growing area, and nutrient needs for simulating environmental situations are significant factors for horticultural success. Working with epiphytes on trees is optimal, as demonstrated by several examples.

Aspectos hortícolas del cultivo y exposición de una gran variedad de epifitas.

RESUMEN. Epífitas pueden ser cultivadas en varios materiales. La cantidad de agua disponible es crítica, aunque epífitas pueden sobrevivir si su ambiente no es el optimo. La simulacíon exacta de ambiente puede ser valiosa en investigaciones y en la educación. Hay algunas dificultades en el desarroyo de simulaciones por la falta de informaciones sobre las condiciones ambientales de los habitats naturales. La mala interpretación de características adaptivas es otro problema. La adición de materiales a la tierra, la cuidadosa colocación en el area de cultivación, y nutrición adequada para simular el ambiente son requisitos para el éxito en la horticultura. El uso de árboles es optimo para cultivar epifitas, demostrado aquí varios ejemplos.

INTRODUCTION

Although house-plant growers may not be familiar with the term "epiphyte," they have probably grown one when raising plants. One reason is that there are no special rules that govern growing all epiphytes, just as there are no general rules for growing all terrestrial plants. A person buying a "vase plant" at his or her local supermarket may read on the care tag that the plant should periodically have water poured into the vase-like cavity in the center of the plant, and that the soil can remain dry for long periods without any detrimental effects to the plant. The care tag seldom mentions that the plant can take this treatment because it is a tree-dwelling member of the pineapple family.

Discussing the horticultural aspects of growing epiphytes is complicated because of the impressive, if not overwhelming, variety of plant material of epiphytes (Kress, 1986). These plants do not inhabit a single ecological niche. Different species have adapted to a wide range of environmental exposures and differing amounts of moisture, nutrients, and light (Benzing, 1987). This paper examines the challenges in growing epiphytes for research and educational displays. The information is based on observations of plants growing in their native habitats, personal experience in growing a wide range of epiphytes at several botanical gardens, and years of discussions with fellow growers.

Many commonly grown epiphytes can be grown on a wide variety of substrates, including ordinary potting mixes with soil, commonly used soil-less mixes, and unique mix combinations assembled by growers specializing in particular groups of non-terrestrial plants. The majority of epiphytic plants share many similar environmental characteristics with their terrestrial relatives. For many, water access in their native habitat is relatively constant and available by having their roots grow into either an accumulation of humus which has good water-retaining capabilities (Johansson, 1974), a well developed bryophyte layer with high moisture content potential (Madison, 1977), or by the entire plant being surrounded by clouds, providing consistent high humidity the majority of the time (Sugden & Robins, 1979). The hardier epiphytes, especially the more xerophytic groups (including many orchid genera with swollen pseudobulbs or terete leaves, the grey-leaved *Tillandsia* spp., epiphytic cacti such as *Deamia, Epiphyllum, Rhipsalis,* and *Schlumbergera*), are adapted to survive in what are less than optimal growing conditions for most terrestrial plants.

For effective horticulture of epiphytes outside of the natural habitat, one should simulate the particular set of growing conditions for the epiphytes in question. If the growing conditions can be duplicated for a particular plant, then the plant will grow as it would in its native setting, rather than adjusting to different conditions and potentially growing in a manner not seen in nature. The main difficulty in creating an accurate environmental simulation is usually a lack of adequate quantitative data for the species. In most taxonomic works, species are described as epiphytic, but little information beyond the general ecological heading of the habitat is provided, which leaves a variety of epiphytic niches possible. Studies focusing on epiphytes as a group have provided general guidelines towards ecological types (e.g., Benzing, 1987), but this information does not cover all environmental aspects for optimum growth under artificial conditions. Another challenge to environmental habitat duplication is that the various adaptive features on epiphytes do not always indicate similar needs or safeguards against environmental stresses. The numerous shapes and functions of trichomes are an example of this interpretative difficulty. Do trichomes serve to reflect light, increase air movement, attract a pollinator, catch minute amounts of water, or keep herbivores away? The vase or tank-type bromeliad, including the majority of *Guzmania* and *Vriesea* spp. and many *Aechmea* spp., offers another example of an interpretive challenge, since their water-holding capacity does not necessarily indicate an adaptation to a pronounced dry season or particular light levels.

Despite these difficulties, there are ways to ascertain aspects of the ecological niches occupied by wild plants. The most general differentiating characteristic pertains to the type of water and nutrient availability (Benzing, 1986); the more xerophytic, pulse-supplied epiphytes can be separated from the constant-supplied plants. Characters generally indicating a pulse-supplied, xeric habit include thickened leaves, leaves greatly reduced in size or with a waxy cuticle, deciduousness, leaf trichomes that maximize retention and absorption of water and nutrients, thickened, often velamentous roots, the virtual absence of roots (Bromeliaceae), and storage type stems (Cactaceae, Orchidaceae). Several of these features, especially deciduousness and substantial storage stems, are often present in epiphytes from seasonally dry forest areas. The other characters are more often present in epiphytes that experience more short-term fluctuations in water availability.

The need and availability of water is perhaps the most significant factor to be considered by growers (Benzing, 1986). Water in the forms of both humidity around the leaves and moisture levels and air circulation around the roots must be accurately duplicated for optimal growth. Most epiphytes are exposed to regular moisture availability in some form. In addition, most have some form of xeromorphic adaptations to assist in acquiring and/or storage of water (Madison, 1977). The extreme xeromorphic developments are exemplified by shootless, more accurately leafless (aphyllic) orchids including members of the genera *Camplyocentrum, Dendrophylax, Polyradicon,* and *Chiloschista,* which are often found in warm moist, shady niches and virtually rootless bromeliads, including many in the genus *Tillandsia* and several in the genus *Vriesea,* found in much more exposed environments. These plants can tolerate high levels of water stress (Benzing, 1987). For the majority of epiphytes, brief fluctuations in water availability can be tolerated, by both drought-enduring and drought-avoiding types. How long that toleration lasts and how a plant demonstrates a decrease in tolerance varies dramatically, with some plants lost through rotting or through desiccation before the problem is apparent to a grower.

Substrates hold water and make water available in varying amounts. For extreme xerophytes, such as many of the "grey-leaved" *Tillandsia* spp. (Bromeliaceae), a small amount of a non-toxic adhesive ("Hard as Nails" construction adhesive, and many of the hot glue gun adhesives) can serve as a means of attachment which will not restrict growth. The precise amount of adhesive will vary, depending on the size and weight of the plant being anchored. This attachment method is especially appropriate for epiphytes whose primary function of roots is anchorage. At the other end of the moisture-retention spectrum, sphagnum moss, mixed with small particulate soil-less media such as vermiculite or composted manure, retains moisture for a long time and provides moisture to the plant. Using osmunda fiber as a substrate allows for moderate moisture availability and air circulation.

Research collections of epiphytes not accessible to the general public can be grown in pots, although natural root patterns and in some cases vegetative reproduction may be compromised. Slatted wood baskets or sphagnum-lined wire baskets, usually suspended, reduce root confinement and allow for better air circulation, provided that a well-drained mix is used with them. A variety of quick-draining materials is used, especially for orchids, to allow for air circulation and to supply ample water and nutrients. These substrates vary in their porosity, their rate of decomposition, their ability to make nutrients available, and cost. A story is often repeated among growers who, having heard an "expert grower" extol the virtues of a specific mix, repotted their own collections into that mix, only to start losing their plants. Substrate materials chosen by a grower must take into account not only the needs of the plant, but also the habits and knowledge of those responsible for the plants, how much time is spent working with the collection, and the cost and availability of the material.

Epiphytes whose roots grow through moss or a moderate layer of humus in the wild can be grown well in a mix of milled sphagnum moss, composted bark, coarse sand, and some additional drainage material such as extra-fine grade charcoal or ground tree fern root. The proportions vary with the amount of aeration or drainage required; often a 1:1:1:1 mix works well, although an additional part of sphagnum moss can be used for greater moisture retention. Generally the pH of humus and "soil" accumulated in the canopy is more acidic than that of substrates commonly used by growers (Johansson, 1974; ter Steege & Cornelissen, 1989), so dolomitic lime or other amendments are not needed to offset the acidity of the moss products.

Careful attention to location in the greenhouse or growth area assists in simulating other environmental conditions. More exposed, high-light plants should be placed close to the light sources, in high light. Lower-light plants may be placed on or under benches, or a shade cloth can be suspended over the plants. Lower-light plants can often be recognized by the presence of red-purple anthocyanins on the abaxial leaf surfaces, which serve to reflect the lower light levels back up through the photosynthetic tissue (Lee *et al.,* 1979). Not all red pigments on abaxial leaf surfaces serve this purpose however, so some knowledge of the plant's ecological niche is helpful. Red or other pigments on the upper leaf surfaces are generally an indicator of a more exposed, high-light plant, with the other pigments serving to protect the photosynthetic tissue. Exceptions make knowledge of the ecological niche, including pollination strategy, especially useful. Cooler-growing epiphytes, generally from mid- and upper-elevation rainforests, can be placed near wet-pads or other air cooling system, which provides cooler temperatures and higher humidity. Extra humidity may be needed, which can be supplied through a fog system or misting by the grower.

Fertilizer should be supplied sparingly, either constantly in low concentration; or periodically as the plants indicate need. Knowledge of habitat is useful, especially concerning the substrate. Epiphytes generally acquire, use, and store resources in ways similar to the terrestrial flora (Benzing, 1987). The awareness of how plants react to lower food levels by slowing growth and showing standard signs of nutrient deficiencies is important (Bloom *et al.,* 1985).

Large-scale habitat simulations have been developed at botanical gardens, display gardens, and zoological centers. In such simulations, many epiphytes are planted on trees, both real and fabricated, expressly for supporting epiphytes. In this way, epiphytes may be arrayed in "communities" as they grow in nature (Johansson, 1974; ter Steege & Cornelissen, 1989).

Plants are initially attached to the tree with coated bell wire or heavy (20 lb.) monofilament. Monofilament is especially good for tank bromeliads, as copper in bell wire is toxic. The wire or monofilament is used to hold the substrate and the root area of the plant firmly to the tree until the plant attaches with its own roots. When possible, epiphytes should be mounted immediately prior to the onset of new root and subsequent shoot growth. This allows the plant to anchor onto the bark substrate more quickly, and in many cases the wire or monofilament can be removed before the end of the growing season, often in six to eight weeks. Care should be taken when removing the wire to be sure that the plant is well-anchored and can support itself, even when it is heavy with recent watering. The wire can then be removed, along with as much of the substrate as is necessary to better simulate the actual growing conditions of the plant.

The following examples of epiphyte plantings are from my experiences and observations carried out at Cheekwood Botanical Gardens, Nashville, Tennessee, and The University of North Carolina at Charlotte Botanical Gardens, Charlotte, North Carolina.

Zamia pseudoparasitica Yates (Zamiaceae) is a constant-supply epiphyte that grows with its lower stem and roots in moist humus. It is usually seen growing in tree crotches in the lower part of the canopy where it receives moderate light. To anchor this species to a tree, the roots are wrapped in osmunda fiber combined with long-fiber sphagnum moss and charcoal which provides constant moisture, a slightly acid substrate, and good drainage. When the plant is thriving, its roots, with nodules containing blue-green algae, can be clearly seen growing through the fiber "nest" provided.

Another epiphyte suited to the same substrate is *Gibsoniothamnus* sp. (Scrophulariaceae), a fibrous-rooted plant that obtains small shrub stature. There is no information on the location of this plant in the wild, but it grew well when placed in a niche where water and nutrients were readily available and where the potential weight of the plant would not damage the tree.

Several species in the orchid genus *Gongora* were planted at various locations on both a fabricated tree and a live tree. Plants were initially attached with coated bell wire that anchored the roots wrapped with osmunda fiber on the fabricated tree and sphagnum moss on the live tree. The wire was removed following the attachment of new root growth to the tree bark. During the past year, all individuals have flowered, some repeatedly, and negatively geotropic roots have initiated growth. The flowers of the different species, blooming at different times of the year and each with their own fragrance, are noticeably more odorific at different times of the day. With all growing as they would in nature and exposed to the same environmental factors, these timing and fragrance differences may lead to taxonomic clarification.

A member of the Gesneriaceae (genus undetermined) was attached with a small amount of osmunda fiber mixed with sphagnum moss. Its growth habit and other characters indicated it was a member of the genus *Drymonia,* but the characteristic anther structure (Moore, 1955) has not been seen on flowers. More study can be done without returning to locate the plants in Brazil.

In several rosulate species in the genus *Anthurium* (Araceae), negatively geotropic roots have formed the characteristic "trash-basket" root system which serves in the wild to catch debris falling from overhanging branches. In the accumulated humus, other plants lodge and root, or germinate from seed, and grow. Small *Peperomia* spp. (Piperaceae) have been planted in, readily taking advantage of the anchoring substrate and moisture. An artificial arboreal ant garden, formed with a mix of sphagnum moss, charcoal, composted cow manure, and wrapped with mix-inundated osmunda fiber has been successfully planted with known ant garden species (Madison, 1979). In the year since the "garden" has been planted, *Coryanthes speciosa* (Hook.) Hook. (Orchidaceae) has put out five new healthy leads after flowering for the first time. *Codonanthe luteola* Wiehler (Gesneriaceae) is gradually covering the "nest," sending fibrous adventitious roots into it as it grows and flowers. *Anthurium gracile* (Rudge) Lindl. (Araceae) and a succulent *Peperomia* sp. (Piperaceae) have flowered and fruited. The resulting seeds have germinated and several seedlings are now growing into the substrate.

A variety of methods can be used to accurately simulate the environmental niches in which epiphytes occur. Accurate simulations have provided information on growth patterns and ecological adaptations which need to be verified in the field. Accurate displays of how these plants grow is also a valuable educational tool which may serve to help preserve these plants in nature.

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