EPIPHYTES

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Contents

Summary

Epiphytes are organisms that grow upon a living plant for support and are not parasites; they are usually independent of the host plant for water and nutrition. Epiphytism is present among many groups, such as fungi, algae and plants, and in associations such as the lichens. They comprise about 10% of vascular plants and are particularly abundant and diverse in the wet tropics. Epiphytes are part of the canopy community and can be of major importance for nutrient cycling of forests and are important for creating niche habitats for several animal species. Different morphological and physiological adaptations were necessary to conquer the epiphytic habit, many related to water economy. Epiphytes can be classified according to their dependence on the supportive tree; growth habit; water economy mechanisms, amongst others; and usually, the wetter the forest, the larger the number of epiphytes. Altitude also influences their abundance and richness. Other factors are also very important in explaining their diversity and the size of the supporting tree and the texture of the bark have a role to play. Epiphytes, among other canopy life forms are especially vulnerable to extinction because endemism is relatively frequent and the rate of deforestation scarily high. This chapter is dedicated to the biology of epiphytes; we introduce their diversity and discuss aspects

of their nutrition, photosynthesis and water relationships. The following groups received special attention: lichens, ferns, and two seed families, *Orchidaceae* and *Bromeliaceae*.

1. Introduction

The term epiphyte, from the Greek *epi* (upon) and *phyton* (plant), was first introduced by Mirbel in his book *Èlements de physiologie végétale et de botanique* (1815) and refers to an organism that grows upon a living plant for support. Epiphytes are not parasites, *i.e.* they are usually independent of the host plant for nutrition, although they may sometimes damage the host plant, often by shading. Also, they are not restricted to grow on a host plant, for instance, epiphytes can be found growing on wires (Figure 1). There are holo-epiphytes, which complete their life cycle without contact with the ground and the hemi-epiphytes, which, at some stage of their development, root in ground soil. Orchids are probably the most famous representative of holo-epiphytes and the stranglers *Ficus* are well known hemi-epiphytes. Field surveys may adopt wider classifications including accidental, facultative, hemi-epiphytes, true epiphytes, and parasites in the category "epiphytes" or narrower classifications including only facultative and true epiphytes in the list of the epiphytic species occurring in a given region.

Figure 1. Epiphytes, *Tillandsia stricta and T. tricholepis* (*Bromeliaceae*), growing on wires in the city of Rio de Janeiro

Epiphytism is considered a paraphyletic trait present among all large groups, such as bacteria, fungi, plants, and in associations such as the lichens. Epiphytes are extremely common among aquatic species growing on algae or on aquatic flowering plants.

Vascular and non-vascular epiphytes biomass production in many rain forest canopies is significant, especially in cloud forests. Among vascular plants, epiphytes comprise about 10% distributed among 84 families with over 25,000 species and they are particularly abundant in the wet tropics.

Epiphytes may occur from the basis of tree trunks up to the tree crowns on trees as high as 50m or even taller. These plants were observed and studied by naturalists since the 19th century, beginning with SCHIMPER in Central America, then in the 1940’s with priest RAMBO in the sub-tropical forest from south Brazil and in the 1960’s with HOSOKAWA in the forests of Micronesia. Nevertheless, regular studies of epiphytes in the tree crowns were improved recently by climbing techniques called “single rope techniques” consisting on rock climbing techniques adapted to peculiarities of climbing trees.

Because epiphytes are mostly found in the tree crowns, these plants are part of the canopy community where the full diversity of organisms remains to be mapped. Even though studies on the epiphytic community have begun two hundred years ago, the bulk of studies on epiphytes started on the 1980´s as a result of scientific studies developed in the forest canopy favoring the discussion of canopy access, ecological role, ecophysiology and conservation of epiphytes. Thus, in some tropical areas, the organic matter released by epiphytes is the most important flux of nutrients reaching the forest floor. Besides participating on the nutrient cycling of forests, these plants may increase the structural complexity of forests because of the frequently dependent fauna associated to these plants. For instance, DUELLMAN & PIANKA (1990) suggested that the diversity of frogs is larger in the Neotropics, partially because of the presence of bromeliads, which have a large number of epiphytic species. These plants would be responsible to the availability of abundant and diverse microhabitats for these vertebrates.

Epiphytes usually obtain water and nutrients from fog, dew, rainwater and through fall. Water availability for epiphytic plants is irregular and plants tend to endure drought stress between precipitation events, even in everwet regions. Dry periods are particularly crucial for juvenile plants and are a primary cause of death among them.

Different morphological and physiological adaptations were necessary to conquer the epiphytic habit. For instance, some species of orchids have bulbs, some species of pteridophytes loose their leaves in unfavorable periods of dryness, and many bromeliad species have superimposed leaves in a rosulate shape which withhold water and debris. Some orchids have a strong leaf reduction keeping their roots as the only organ to maintain the photosynthesis. Some other species are temporarily epiphytes because their development is composed by an initial phase on the tree top, an intermediate phase as hemi-epiphyte with roots growing down to the forest floor, and a final phase as a mature tree. This is the case of some *Ficus* which usually kill their host tree, reason why they are called “strangler trees”.

The variety of morphological and physiological adaptations and relationship with their supportive trees enabled different classification systems, resumed by BENZING (1990):

I – RELATIONSHIP TO THE SUPPORTIVE TREE

A. Autotrophs (plants supported mechanically by woody vegetation; no nutrient extracted from vasculature of phorophytes)

1. Accidental (predominantly terrestrial plants that accidentally germinate in the tree trunk crevices, e.g. *Kalanchoe* spp.)
2. Facultative (species that may grow either on the tree top or on the forest floor, e.g. species of sub-family Bromelioideae of Bromeliaceae; Figure 2)

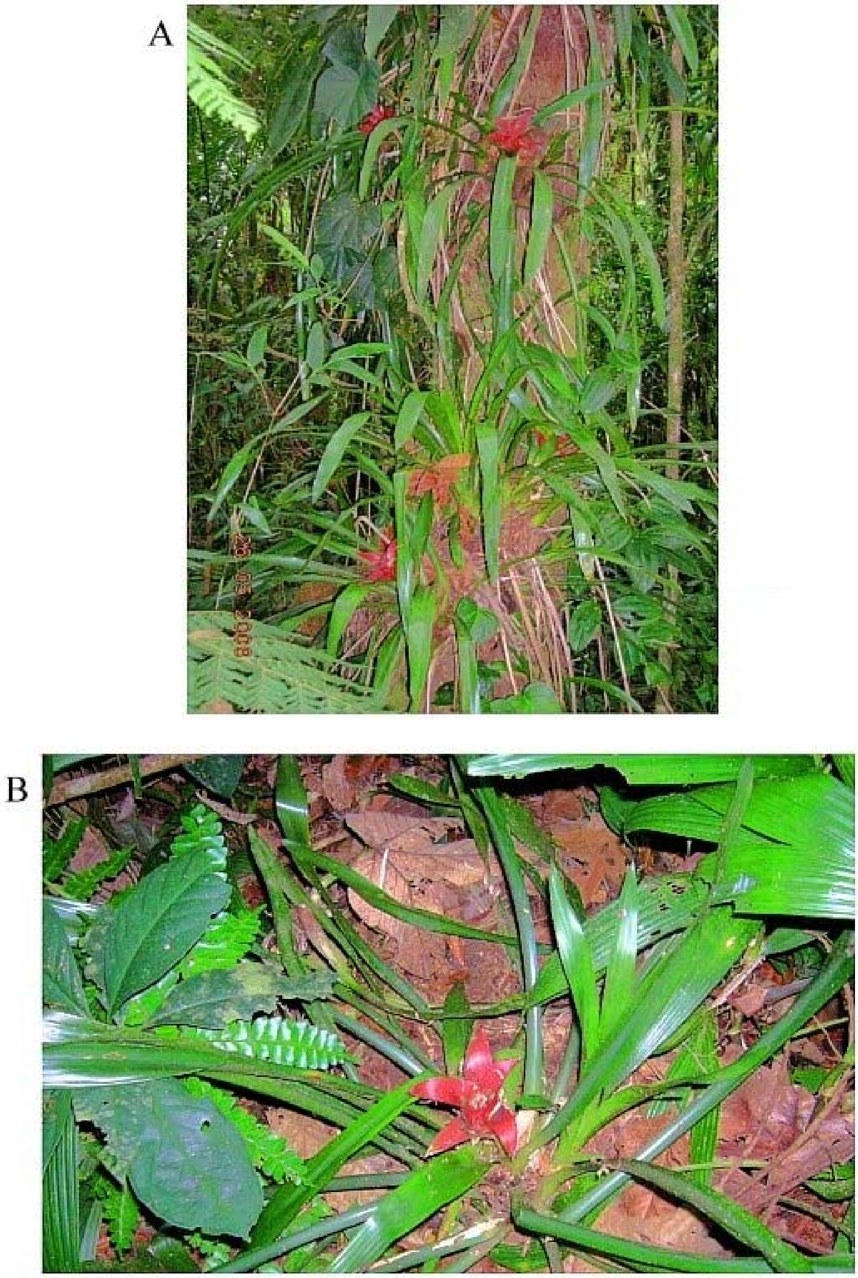

Figure 2. Facultative epiphytes: A- *Nidularium bicolor* (*Bromeliaceae*) on tree trunk; B- the same species as terrestrial a few meters away from the epiphytic individuals.

3. Hemiepiphytic

    - Primary (germination occurs in the tree top but the development of roots and stems occur down to the forest floor)

        a. Strangling (the stem becomes lignified around the supportive tree becoming a erect trunk. In this situation, the hemiepiphyte crown may overtop the supportive tree; Figure 3)
        b. Nonstrangling (e.g., *Clusia* species)

    - Secondary (germination occurs on the forest floor but the development of roots and stems occurs upward the supportive tree)

4. "Truly" epiphytes (the "holo-epiphytes" of Schimper; Figure 4)

B. Heterotrophs (plants subsisting on xylem contents of their supportive trees)

1. Parasites (also called "mistletoes", e.g. species of Viscaceae and Loganiaceae families)

Figure 3. Primary hemiepiphyte: A *Ficus* sp. tree (*Moraceae*). Note that the hemiepiphyte trunk enfolded the phorophyte and letft a few gaps from where one can see the dead tree.

Figure 4. True epiphytes: *Orchidaceae* on the tree branch of *Lecythis pysonis* (*Lecythidaceae*).

Figure 5. Herbaceous rosulated bromeliad: this leaf arrangement is characteristic of many Bromeliaceae species as this *Guzmania* sp.. Note water and debris impounded b the leaves.

II. GROWTH HABIT

A. Trees
B. Shrubs
C. Suffrutescent to herbaceous forms

1. Tuberous
    a. Storage: woody and herbaceous
    b. Myrmecophytic (plants associated to ants): mostly herbaceous
2. Broadly creeping: woody or herbaceous
3. Narrowly creeping: mostly herbaceous
4. Rosulate (Figure 5): herbaceous
5. Root/leaf tangle: herbaceous
6. Trash-basket: herbaceous

III. WATER BALANCE MECHANISMS

A. Poikilohydrous (many bryophytes, some pteridophytes and a few angiosperms)
B. Homoiohydrous

1. Hygrophytes
2. Mesophytes
3. Xerophytes
    a. Grought-endurers
    b. Drought-avoiders
4. Impounders

IV. LIGHT REQUIREMENTS

A. Exposure types (largely exposed to sites in full or nearly full sun; Figure 6)
B. Sun types (tolerant to medium shade)
C. Shade-tolerant types (tolerant to deep shade)

Figure 6. The bromeliad “spanish moss” (*Tillandsia usneoides*) on the external branches of trees, growing as exposed epiphytes.

V. SUBSTRATE REQUIREMENT

A. Relatively independent of root medium (obtain moisture and nutrition primarily from rain, mist and dew)

1. Mist and atmospheric forms (with minimal attachment to bark)
2. Twig/bark inhabitants
3. Species that create substitute soils or attract ant colonies (ant house epiphytes)

B. Tending to utilize a specific type of root medium for moisture and nutrition)

1. Humus-adapted
    a. Generalist types (root in shallow humus mats)
    b. Deep humus types (penetrate in trees knotholes or rooting wood)

c. Ant-nest garden and plant-catchment inhabitants (e.g., *Platycerium* spp., *Utricularia humboltii*)

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Biographical Sketches

Fernanda Reinert received her Bachelor degree in Biology-Ecology at the Universidade Federal do Rio de Janeiro (UFRJ) in 1989. Her PhD was done at the University of Newcastle upon Tyne in the UK under the supervision of Dr. Howard Griffiths in 1995. Since 1998, she has been an associate professor at UFRJ. Her areas of interest are: photosynthesis under stress, the crassulacean acid metabolism (CAM), epiphytes, Bromeliaceae, and stable isotopes. She was the director of a post graduation program in Plant Biotechnology from 2001-2005.

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