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Structure and Diversity of the Vascular Epiphyte Community in the Overstory of a Tropical Rain Forest in Surumoni, Amazonas State, Venezuela

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Abstract. The structure of the vascular epiphyte community in the overstory (20–28 m) of a riverine tropical rain forest was studied with the aid of a large tower crane between April and December of 1997. The forest is located near Caño Surumoni, a small tributary of the Orinoco River, in Amazonas State, Venezuela. The overstory or upper canopy in the study plot contained 147 trees, representing 16 families and approximately 22 species. Of these trees, 20% bore at least one epiphyte. In this stratum, 243 epiphytic individuals were found, representing seven families and 22 species. The family Orchidaceae presented the greatest number of species (11). Five species, *Codonanthe crassifolia* (Gesneriaceae), *Microgramma baldwinii* (Polypodiaceae), *Cattleya violacea* (Orchidaceae), *Anthurium gracile* (Araceae), and *Aechmea tillandsioides* (Bromeliaceae), represented the highest number of individuals. No apparent relationship existed between any epiphyte in the study and the main architectural features of its phorophyte. A correlation was established, however, between epiphyte abundance and type of tree bark.

Key words: Epiphyte, overstory, Surumoni, Venezuela

Introduction

Epiphyte floristic composition and its contribution to total forest flora are known from only a few forests (Ingram et al. 1996). Particularly in Venezuela, little knowledge exits about epiphyte communities and their ecology. Epiphyte flora is not better known because of limitations in fieldwork. The most difficult to resolve is the compiling of epiphyte collections (Ingram & Lowman 1995).

The need for a permanent observation system could be satisfied, at least partially, with the use of a large tower crane. This system allows research scientists repetitive and more precise data collections, greater mobility, more horizontal and vertical access, and sampling from a number of trees at one site for a long study period with minimum damage to the forest ecosystem (Heatwole & Higgins 1993, Morawetz et al. 1996). In 1994, the Austrian Academy of Sciences installed a crane in the middle of a tropical forest in the Venezuelan Amazon to improve canopy research in the Neotropics.

A canopy study conducted in Venezuela between April and December of 1997 used tower crane technology to describe the composition and distribution of the vascular epiphyte flora in the overstory of a lowland rain forest. This article makes special reference to phorophyte and bark preferences.

Materials and Methods

The study site was located near Caño Surumoni, 40 km west of La Esmeralda, an indigenous community along the Upper Orinoco River, Amazonas State, Venezuela (3°10′24″N, 65°40′30″W). In this area, the Austrian Academy of Sciences installed a tower crane in a 1.5 ha forest plot with a reach in the shape of an ellipse, 200 m long and 80 m wide. According to Huber (1995), this forest is a lowland riverine tropical rain forest at 120 m elevation with evergreen trees reaching to a height of 30 m. Although vascular epiphytes are not abundant, non-vascular ones are. Annual precipitation in the area is 2600–2800 mm, with a December–March dry period, an April–November wet period, and a mean annual temperature of 28°C (Coomes & Grubb 1996).

The tower crane, running on a set of rails 120 m long, consists of a central vertical shaft 40.5 m high and a horizontal jib 40 m long, with a gondola suspended from it. Research scientists board the gondola at ground level and are driven upward, approaching the canopy from above. Epiphyte and phorophyte features were recorded, using the gondola, in the overstory of the Surumoni forest at nearby locations.

Every living tree with a diameter >25 cm dbh (measured at breast height) was sampled, and numbered, following the Austrian numeration of the trees. The main tree features recorded were position (X,Y), total height, crown dimensions, type and roughness of the bark (qualitative anal-

TABLE 1. Vascular epiphyte species recorded in the overstory of the Surumoni forest, 1997.

Family	Species	Stand occupancy %
Monocotyledons		
Araceae	*Anthurium gracile* (Rudge) Schott	7.2
	Philodendron venezuelense G.S. Bunting	0.4
Bromeliaceae	*Aechmea tillandsioides* (Mart. ex Schult.f.) Baker	6.6
	Aechmea setigera Mart. ex Schult.f.	2.0
	Tillandsia paraensis Mez	5.3
Orchidaceae	*Cattleya violacea* (Kunth) Rolfe	7.8
	Epidendrum sp. 1	1.2
	Epidendrum sp. 2	0.4
	Maxillaria sp. 1	0.4
	Maxillaria sp. 2	0.4
	Octomeria lancipetala C. Schweinf.	1.2
	Pleurothallis fockei Lindl.	3.3
	Polystachya amazonica Schltr.	0.4
	Orchidaceae sp. 1	0.4
	Orchidaceae sp. 2	0.4
	Orchidaceae sp. 3	0.4
Dicotyledons		
Gesneriaceae	*Codonanthe crassifolia* (H. Focke) C.V. Morton	33.0
Piperaceae	*Peperomia rotundifolia* (L.) Kunth	3.3
Pteridophytes		
Polypodiaceae	*Microgramma baldwinii* Brade	22.6
	Microgramma megalophyla (Desv.) de la Sota	1.6
	Microgramma tecta (Kaulf.) Alston	0.8
Vittariaceae	*Vittaria* sp. 1	0.8

ysis), and presence of vascular epiphytes. On each tree that bore at least one epiphyte, the number of epiphytic individuals or stands per species (sensu Sanford 1968) was determined. A stand was considered to be a collection of individual stems and/or plants spatially separated from another group of the same species either by a bare area of the tree or by an area occupied by another group.

Direct collecting of specimens is not allowed in the study plot; thus epiphyte and phorophyte species were identified by comparing photographs and digital images taken in the field with specimens deposited at the Herbario Nacional de Venezuela (VEN) and with taxonomic keys. Because of difficulties in determining sterile specimens and in the use of indirect methods of collection, the number of species reported should be regarded as a minimum, and species names should not be considered final.

Simple linear regression was used to show possible relationships between epiphyte frequencies and phorophyte features of height, crown dimensions, and dbh.

RESULTS AND DISCUSSION

A survey of the overstory of the Surumoni forest, including trees 20–28 m tall with dbh > 25 cm, found 147 individuals in 16 families and approximately 22 species. The Celastraceae, which accounted for the largest number of individuals with 48% of the total, was represented by only one species, *Goupia glabra.* Other families well represented inside the plot were Vochysiaceae (18% of individuals, two species), Caesalpinaceae (10% of individuals, five species), and Lauraceae (7% of individuals, two species). Of the 12 families accounting for the remainder each contributed one species.

In the overstory of the study plot, 243 stands with 22 vascular epiphyte species from 17 genera represented five angiosperm and two pteridophyte families (TABLE 1). Pteridophytes accounted for two genera and four species; monocotyledons for three families, approximately 13 genera, and 16 species; and dicotyledons for two families, two genera, and two species. The small number of epiphytic species and individuals is a noteworthy feature of the epiphyte flora in this study site. Most lowland neotropical forests are characterized by epiphytic flora less diverse and abundant than that growing at higher elevations (Gentry & Dodson 1987).

Orchidaceae were approximately four times more abundant than Bromeliaceae and Polypodiaceae, the second most species-rich family. Such a composition has been found in other neotropical forests (Bogh 1992, Ingram et al. 1996). The small number of species in the subtribe Pleurothallidinae in relation to the total orchid species number—a distinctive feature in the

TABLE 2. Epiphytic occupation of phorophytes in an overstory study plot at Surumoni, 1997.

Phorophyte		No. hosts	Total no. ind. trees	Occupancy rate %	Epiphyte %	Bark type
Family	Species					
Lecythidaceae	*Eschweilera* sp. 1	1	1	100	58.0	Rough, cracked
Euphorbiaceae	*Podocalyx loranthoides* Klotzsch	1	1	100	3.7	Not assessed
Chrysobalanaceae	Unidentified	1	1	100	1.2	Not assessed
Vochysiaceae	*Vochysia* sp. 1	6	8	75	7.1	Uneven
Sapotaceae	Unidentified	3	4	75	4.5	Rough, cracked
Caesalpinaceae	*Dialium guianense* (Aubl.) Sandw.	3	6	50	2.9	Rough, irregular
Lauraceae	*Nectandra* sp. 1	3	6	50	6.6	Rough, coarse
Icacinaceae	*Emmotum* sp. 1	1	2	50	0.4	Smooth
Vochysiaceae	*Qualea* sp. 1	3	10	30	6.6	Rough
Celastraceae	*Goupia glabra* Augl.	8	49	16	9.0	Irregular
Caesalpinaceae	*Sclerolobium guianense* Benth.	0	3	0	0	Smooth, flaky
Myrtaceae	Unidentified	0	1	0	0	Smooth, flaky

study plot—also has been found in other lowland forests (Bogh 1992).

Although Orchidaceae was the most species-rich family at the study plot, it did not have the highest number of epiphytic individuals or stands. Two species, *Codonanthe crassifolia* (Gesneriaceae) and *Microgramma baldwinii* (Polypodiaceae), comprised more than 50% of the total number of stands (TABLE 1). These species are characterized by their climbing habit, but because no terrestrial connection was found, they were regarded as true epiphytes. This type of habit appeared to be successful under forest conditions at the study site. *Cattleya violacea* ranked as the third most abundant species, with 8% of total epiphytic stands, whereas the remaining orchid species were represented by 0.5% or 3% of relative abundance. Species that exhibited ant relationships (growing in ant-gardens), *Anthurium gracile* and *Aechmea tillandsioides,* together represented approximately 15% of individuals. This type of relationship with ants could account for a greater abundance of these epiphytic stands (Kleinfeldt 1978) because of their relative independence from bark conditions. Epiphytic relationships with ants were particularly well represented in the low and middle canopy of the Surumoni forest (A. Cedeño pers. obs.).

A total of 30 trees (20% of sampled individuals) in nine families and ten species supported epiphytes (TABLE 2). Only 16% of individuals of *Goupia glabra,* the most abundant tree species, bore epiphytes; thus this species did not appear to be suitable for the establishment of epiphytes. In contrast, *Vochysia* sp. 1 and the Sapotaceae, both with 75% occupation by epiphytes, could be regarded as suitable supports for epiphytes. Among the species accounting for 100% occupation, this value is not statistically representative because only one individual tree was registered inside the plot.

Eschweilera sp. 1 exhibited the highest proportion of epiphytic stands (58%), with the remaining phorophytes only supporting up to 9% (TABLE 2). *Eschweilera* trees found outside the study plot bore a striking epiphytic load (J. Hernández-Rosas pers. obs.). Unequal distribution of epiphytic individuals also was found by Grubb et al. (1963) in a lowland forest of Ecuador, where more than 40% of epiphytes were established on just two or three trees. The noteworthy absence of epiphytic stands on *Sclerolobium guianense* may be related to a small number of suitable anchorage sites available for epiphyte colonization.

Simple linear regressions using dbh, total height, and crown dimensions indicated that generally none of these phorophyte features were correlated with epiphyte frequencies ($r_1 = 0.1889$, $r_2 = 0.0273$, $r_3 = 0.1539$, respectively). Bennett (1986) and Fontoura (1995) also did not find correlations, but Freiberg (1996) showed relationships between some architectural phorophyte features and epiphyte frequencies, depending on tree species.

The results of the Surumoni study suggest that epiphyte distribution is not influenced by architectural phorophyte features (dbh, height, crown dimensions) but could depend at least in part on phorophyte species. The characteristic most helpful in establishing differences among phorophyte species was the type or roughness of tree bark. No humus deposits were found in the growing sites of epiphytes. Non-vascular epiphytes were abundant in the study plot, but their influence on vascular epiphyte distribution was not assessed.

The type of bark was qualitatively recorded as smooth, flaky, irregular, coarse, rough, and rough with cracks (Table 2). Myrtaceae and *Sclerolobium guianense* have a smooth bark that tends to flake continuously, preventing epiphyte anchorage. These trees did not bear any epiphytes. Vochysiaceae, Lauraceae, and Sapotaceae exhibited bark roughness in different proportions, which appeared to present adequate conditions for epiphyte colonization (50–75% occupation). The most suitable support for epiphyte establishment was found in *Eschweilera* sp.1, whose rough, deeply cracked bark enhances opportunities for epiphyte colonization, anchorage, and growth of seedlings during root system development (Olivares 1986).

Conclusions

Climatic conditions in lowland forests are less favorable to epiphytes than in wet montane regions (Bogh 1992); this is particularly notable in the Surumoni forest, where a small number of epiphytic species and individuals per species were recorded. Although the Surumoni forest is not highly diverse, it has general patterns of epiphyte composition similar to those found in other forests; and the most species-rich epiphytic families were well represented in the plot area. Epiphytes with a climbing habit and/or ant-relationships were the most abundant species. The main architectural phorophyte features surveyed were not related to epiphyte distribution. With a lack of humus deposits on the phorophytes, the type and roughness of the tree bark apparently played a major role in epiphyte establishment and in the unequal occupation of phorophytes in the area.

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