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FLORISTIC COMPOSITION OF VASCULAR EPIPHYTES IN A NEOTROPICAL CLOUD FOREST, MONTEVERDE, COSTA RICA

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ABSTRACT. Neotropical montane forests are characterized partially by their great abundance and high diversity of epiphytes. We vouchered a species list of vascular epiphytes from a four-hectare lower montane site in Monteverde, Costa Rica, and compared the floristic composition of epiphytes to other epiphyte-rich communities. We collected at four different seasons using single-rope techniques to access the forest canopy. Collections included 56 pteridophyte species from 10 families, and 200 angiosperms from 27 families. Orchidaceae were approximately four times more speciose (92 species) than Bromeliaceae (22 species), the next most species-rich angiosperm family. Together, Orchidaceae, Pteridophyta, Bromeliaceae, Araceae, Ericaceae, Piperaceae, and Gesneriaceae accounted for 84% of the vascular epiphyte flora. The number of angiosperm families represented by epiphytes in the lower montane study site equals those present in all of Mexico, and exceeds the number for lowland sites in Costa Rica (La Selva) and Ecuador (Centinela and Río Palenque), and a montane site in Ecuador (Cajanuma).

INTRODUCTION

Neotropical montane forests feature unusually abundant and diverse epiphytes (Grubb *et al.* 1963, Sugden & Robins 1979). In the most diverse tropical forests, epiphytes account for up to 35% of the total vascular plant flora and nearly half of the individual plants (Gentry & Dodson 1987a). Epiphyte biomass can exceed the foliar biomass of terrestrial herbs and shrubs in lower montane forests (Nadkarni 1984). Epiphyte floristic composition and contribution to total forest flora is known for only a very few forests. Documenting the epiphyte flora of epiphyte-rich tropical forests will enhance our knowledge of these communities and is a first step in understanding the biotic and abiotic conditions that affect epiphyte distribution (Gentry & Dodson 1987b).

The terrestrial flora of Monteverde is well-known relative to that of other tropical cloud forests (Haber 1991), but the epiphyte flora is incompletely known because of the difficulty of making epiphyte collections (Ingram & Lowman 1995). Many species, especially orchids in the Subtribe Pleurothallidinae, are very small, vegetatively similar, and easily overlooked. In this study we used several methods to collect epiphytes from standing tree canopies within an established study site. The local vascular epiphyte flora compiled here constitutes part of a long-term study of the ecological roles of epiphytes in nutrient cycling (e.g., Nadkarni & Matelson 1992, Vance & Nadkarni 1990). We compare the familial composition of the vascular epiphyte flora with other neotropical sites rich in epiphytes. The epiphytic bryophyte flora from this site is in preparation (S. R. Gradstein, D. Griffin, S. Ingram, K. Ferrell-Ingram & N. Nadkarni unpubl. data).

STUDY SITE

The Monteverde Cloud Forest Reserve is located along the crest of the Cordillera de Tilarán in north central Costa Rica (10°18′N, 84°48′W). Our 4 ha study site is within primary "leeward cloud forest" (*sensu* Lawton & Dryer 1980), which is transitional between lower montane wet and lower montane rain forest, at 1500–1550 m elevation. The site lies on the Pacific (leeward) slope of the continental divide and receives about 2 500 mm of rain annually. Although Monteverde experiences a dry season from January to May, clouds and blowing mist may occur at any time of year. Trees (>10 cm diameter at breast height (dbh)) in the study site grow at a density of 559 individuals ha^{-1} (Nadkarni *et al.* 1995) and stand 18–30 m tall. Epiphyte bryophytes and associated organic matter cloak the inner canopy branches of large trees to depths of up to 20 cm (Ingram & Nadkarni 1993).

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METHODS

Vascular epiphytes and hemiepiphytes were collected from lower tree trunks, recently fallen trees and branches, the upper trunks and inner canopies of standing trees, and outer canopy branches of standing trees. Upper trunks and inner canopies of canopy-level trees were climbed using single-rope techniques (Perry 1978, Nadkarni 1988). Whenever possible, data on host branch circumference, height above ground, and tree zone were recorded (APPENDIX 1). Plants that occurred on trunks less than 1 m above ground were ignored to avoid terrestrial plants that occasionally ascend several dm up tree trunks. Epiphytes were categorized according to which of five tree zones they occupied (modified from Johansson (1974)): 1-lower trunk 1–2 m; 2-upper trunk > 2 m; 3-inner third of canopy; 4-middle third of canopy; 5-outer third of canopy. Almost all of the mature host trees were identified to species.

Twenty branches from among eight trees cut and lowered for a related biomass project (July, 1992) were also sampled for epiphytes. Branch lengths were measured, divided into thirds, and one 20 cm long plot that encircled the branch was marked at the center of each branch zone. The number of vascular species was determined within each plot and compared on a surface area (circumference [cm] × 20 cm) basis. Epiphyte species richness was compared among inner, middle, and outer canopy branch segments. Plant collections were made during the dry/misty season (February, 1992), the late dry season (April, 1993), the early wet season (July, 1992), and the late wet season (November, 1992). Voucher specimens are deposited at the Herbario Nacional de Costa Rica (CR) and Marie Selby Botanical Gardens (SEL). Specimens of four species collected within the study site during a previous study (Ingram 1989) reside at the Herbarium of the University of California, Santa Barbara (UCSB). Nomenclature follows R. C. Moran (*Flora Costaricensis,* in prep.) for pteridophytes, Dahlgren *et al.* (1985) for monocotyledons, and Cronquist (1981) for dicotyledons.

RESULTS

Two-hundred fifty-six vascular epiphyte species from 105 genera representing 27 angiosperm families and ten pteridophyte families occurred at the study site (APPENDIX 1). Pteridophytes accounted for 56 species, monocotyledons for 132 species, and dicotyledons for 68 species. At least 30 of these species constituted new records for Monteverde (Haber 1991). The epiphytes were collected from 31 different tree species belonging to 15 families, in addition to hemiepiphytic *Blakea, Clusia, Ficus,* and *Oreopanax* species, the parasite *Psittacanthus sheryi,* a tree fern (*Cyathea* sp.), and many unidentified shrubs, lianas, and understory trees. Approximately 14% of our collections and 11% of the species were collected from the dominant tree of this forest, *Ocotea tonduzii.* One large, recently fallen *Bourreria costaricensis* tree hosted 24 different epiphytes.

The five angiosperm families with the most epiphytes at our study site are the five most species-rich angiosperm families worldwide (Kress 1986). Orchidaceae were approximately four times more abundant than Bromeliaceae, the second most species-rich angiosperm family (FIGURE 1). Orchidaceae, Pteridophyta, Bromeliaceae, Araceae, Ericaceae, Piperaceae, and Gesneriaceae together accounted for 84% of the local epiphyte flora. Twenty-one angiosperm families accounted for the remainder, none containing more than five species; 11 of those families contribute a single species. One family (Cunoniaceae) was represented by an "accidental epiphyte" (*sensu* Benzing 1990). The ten most species-rich genera all belong to the six most epiphyte-rich families (including ferns) from the site (TABLE 1). Four families of epiphytic angiosperms not found at other neotropical sites where epiphyte floras have been documented (TABLE 2) include Alzateaceae, Campanulaceae, Convallariaceae (Liliaceae), and Lentibulariaceae. Epiphytes from Monteverde in the Grossulariaceae and Scrophulariaceae are sometimes treated as Saxifragaceae and Bignoniaceae, respectively, in other floras.

Orchids comprised 36% of the vascular epiphyte flora, and 46% of the angiosperm epiphytes at our site. The Subtribe Pleurothallidinae alone accounted for more than half of the orchid species. One species of *Lepanthes* and one of *Pleurothallis* collected during this study were previously undescribed (C. Luer pers. comm.). Four of the ten most species-rich genera belong to Orchidaceae (TABLE 1).

Of the epiphytic angiosperms collected 79% are predominantly or completely herbaceous, and 21% are classified as woody shrubs or trees (APPENDIX 1). At least 12 of the species grow hemiepiphytically, either ascending trunks and losing their terrestrial connection (e.g., *Marcgravia brownei* and some Araceae), or germinating in the canopy and growing roots down to the ground (e.g., *Ilex* and *Clusia* spp.). We include these species as epiphytes because they spend at least part of their life cycle under similar ecological conditions as other epiphytes. All hemiepiphytes were observed and collected from upper trunks or inner canopies (APPENDIX 1), except for two *Clusia* species collected from fallen

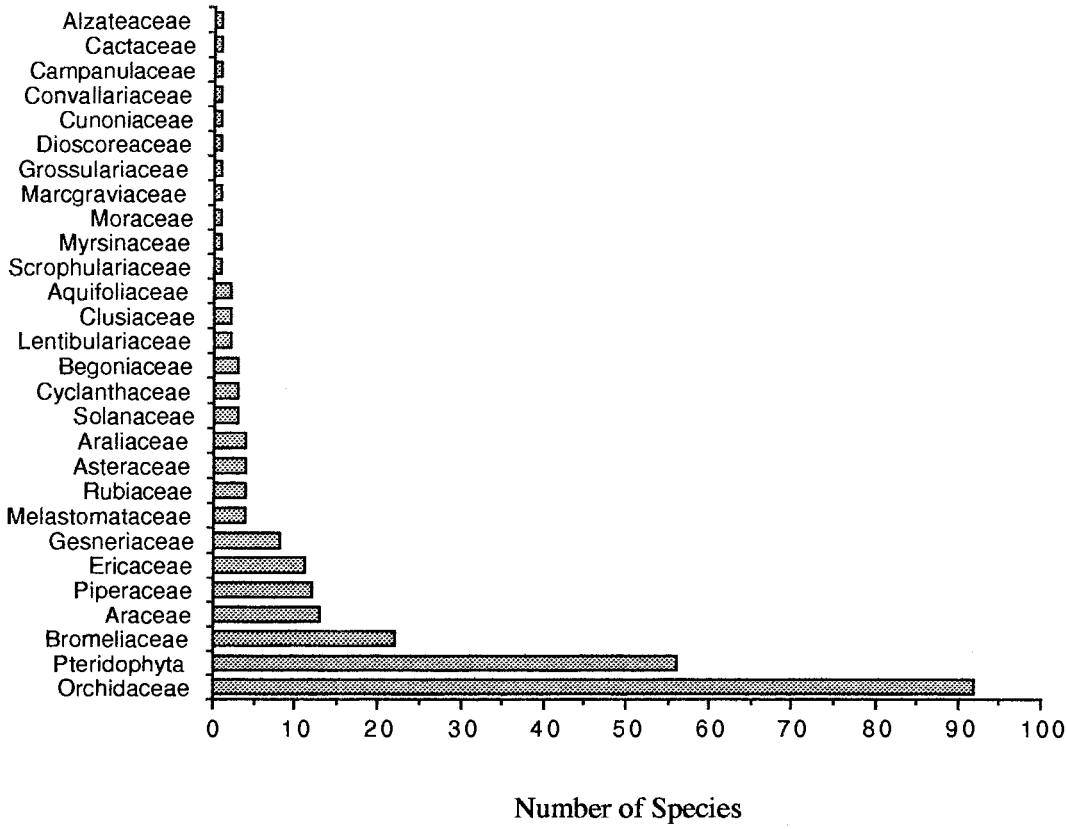

FIGURE 1. Familial composition of vascular epiphytes from 4 ha study site, Monteverde, Costa Rica.

branches that had probably been rooted in the inner or middle canopy of their host trees. Two or three additional species of *Clusia* probably also occur in the study site (W. Haber pers. comm.).

The branches sampled for species richness included 20 inner, 26 middle, and 50 outer canopy segments of varying lengths. There were no significant differences in species richness per branch area (dm^2) among the inner, middle, and outer canopy zones (TABLE 3). There was a significantly greater species richness on inner canopy branches (Kruskal-Wallis test statistic, $H=6.696$, $P < 0.05$) because of the greater surface area (circumference) of the inner branches. Plots from inner, middle, and outer canopy zones averaged 3.15, 2.58, and 2.06 species/plot, respectively. No correlation between branch circumference and species richness per branch area was evident. This finding is consistent with angiosperm species richness comparisons obtained from the inner canopy of *Ocotea tonduzii* in this forest (Ingram & Nadkarni 1993).

TABLE 1. Number of species and the family of the ten most species-rich genera in the 4 ha study site, Monteverde, Costa Rica.

Family	Genus	Number of species
Orchidaceae	*Pleurothallis*	20
Lomariopsidaceae	*Elaphoglossum*	14
Piperaceae	*Peperomia*	12
Orchidaceae	*Epidendrum*	11
Orchidaceae	*Maxillaria*	10
Bromeliaceae	*Vriesea*	10
Araceae	*Anthurium*	9
Aspleniaceae	*Asplenium*	8
Orchidaceae	*Lepanthes*	7
Bromeliaceae	*Guzmania*	6

The occurrence of epiphytes in specific tree zones listed in the Appendix indicates where they were collected, and not necessarily where they typically grow. Nevertheless, some observations of epiphyte occurrence are striking. Ferns, with the exception of Grammitidaceae and some *Elaphoglossum* species, usually grew in tree zones 1 and 2. Filmy ferns (Hymenophyllaceae) were

TABLE 2. Site characteristics and relative composition of the largest groups of the epiphyte flora from five neotropical forest sites.

Site	Río Palenque[a]	Centinela[b]	Cajanuma[c]	La Selva[d]	Monteverde[e]
Elevation (m)	150–220	600	2900	30–200	1500
Annual rainfall (mm)	2980	3000	2–4000	4000	2500
Area (ha)	167	ca. 100	0.0175	1500	4
No. of epiphytic angiosperm families	18	19	25*	19	27
No. Vascular Epiphyte Species	238	337	128	368	256
% Orchidaceae	34	39	37	30	36
% Pteridophyta	12	11	26	18	22
% Bromeliaceae	7.5	7	5	8	9
% Araceae	15	15	2	22	5
% Ericaceae	1	3	5.5	<1	4
% Piperaceae	8	6	2	3	5
% Gesneriaceae	5	5	<1	4	3

[a] Dodson & Gentry 1978 and Gentry & Dodson 1987b.
[b] Gentry & Dodson 1987b.
[c] Bøgh 1992.
[d] B. Hammel, pers. comm., in Gentry & Dodson 1987b.
[d] This study.
* Does not include Loranthaceae.

never observed higher than 6 m on tree trunks. *Epidendrum subnutans* and *Xylobium elongatum,* both common orchids, occurred only on tree trunks below 4.5 m. Most pleurothallid orchids (except *Dracula* cf. *erythrochaete* and several *Pleurothallis* spp.) were collected in tree zones 3, 4 or 5, or from small branches recently fallen from the canopy. A Spearman rank correlation test revealed a significant positive correlation (0.521 with 360 df, $p \leq 0.001$) between epiphyte height and host branch circumference.

DISCUSSION

The predominance of Orchidaceae, Pteridophyta, Bromeliaceae, and Araceae at the study site is consistent with the ranking of these taxa with respect to their total number of epiphytic species (Kress 1986). The relatively large number of epiphytic families, and the high species diversity of orchids are noteworthy characteristics of the epiphyte flora of this site.

TABLE 3. Branch dimensions, and epiphyte species richness (dm^{-2}) from within-tree canopy zones, Monteverde, Costa Rica. Kruskal-Wallis test indicated no significant differences ($H = 1.538$, $P = 0.464$) in species richness per unit area among canopy zones.

Canopy zone	Mean branch circum. (cm) (s.d.)	Range (cm)	Mean species richness dm^{-2} (s.d.)
Inner	28.7 (8.47)	12.3–48.7	0.58 (0.45)
Middle	20.7 (6.39)	10.1–29.6	0.68 (0.44)
Outer	14.3 (4.89)	4.7–28.9	0.82 (0.68)

The number of epiphytic angiosperm families that occur at our study site (27) is the same as that found in all of Mexico (Aguirre-Leon 1992). One reason for the high number of families represented by epiphytic members at Monteverde is the equability of the cloud forest canopy environment for arboreal plants. Accumulations of dead organic matter on branches make up more than half of the dry weight of canopy (non-tree) organic matter (Ingram & Nadkarni 1993), and provide moist, temperate substrate for epiphytes (Bohlman *et al.* 1995). *Dioscorea lepida,* for example, which characteristically grows as a vine from a subterranean tuber, was observed growing (and flowering) from a small tuber embedded within the dead organic matter of a recently fallen tree canopy. The typically terrestrial Cunoniaceae was represented by a 60 cm tall *Weinmannia wercklei* juvenile growing in the canopy of *Pouteria reticulata* next to a canopy-level *W. wercklei* tree. The high number of dicotyledonous epiphyte families found in Costa Rica, compared with paleotropical regions, indicates a moderate, moist climate during the past 10–20 million years (Burger 1980).

The high diversity of orchids at the study site is due partly (similar to the high family diversity) to a propitious combination of biogeography and climate (see Raven & Axelrod 1974). Costa Rica probably has a greater density of orchid species than any other neotropical country due, in part,

to its great habitat diversity (R. Dressler pers. comm.).

TABLE 2 compares the floristic composition of vascular epiphytes from our site with those at four other neotropical locations (TABLE 2). Although the sampled areas differ in size, the relative composition of the epiphyte floras at the family level reveal interesting patterns. La Selva, Río Palenque, and Centinela have well-documented floras and large proportions of epiphytes (Hammel 1990, Gentry & Dodson 1987a, 1987b). The four groups richest in epiphyte species (orchids, ferns, aroids, and bromeliads) are the four best represented groups at all sites from Table 2 other than Cajanuma, Ecuador. A greater number of families with epiphytic members occurs at the two higher elevation sites (though 17 of 25 families at Cajanuma are listed as "accidental" epiphytes) (Bøgh 1992). Orchids and pteridophytes comprise approximately 60% of the epiphytes at Cajanuma, and at our study site. Similarly, pleurothallid orchids account for 17% of the epiphytes from Monteverde and 19% from Cajanuma (Bøgh 1992). Araceae contribute more species than the pteridophytes at the three low-elevation sites (TABLE 2). Ericaceae are more species-rich at the two montane sites, and Gesneriaceae are represented by more epiphytic species at the three lower elevation areas.

Bromeliad species comprise a slightly greater percentage of the epiphyte flora at Monteverde than elsewhere, though all sites exhibit a similar proportion of Bromeliaceae. Cajanuma has proportionally more ferns and ericads, groups that generally tend to be more speciose at higher elevations, but fewer Araceae, Gesneriaceae, or Piperaceae than other sites. Conversely, Centinela and La Selva support especially diverse Orchidaceae and Araceae, respectively, and fewer Ericaceae than other sites for which records exist. Aroid diversity may increase substantially with slight decreases in elevation, and is generally greatest in very wet lowland forests (Croat 1992).

La Selva supports a comparatively diverse flora of which 25% is comprised of epiphytes (including parasitic Loranthaceae and Viscaceae) (Hammel 1990). Nineteen angiosperm families and ferns make up the vascular epiphyte flora from La Selva. The greater number of epiphyte families at the Monteverde site (4 ha) than at La Selva (1,500 ha) is probably mainly due to the addition of the temperate floristic element of the Monteverde flora. Epiphytic species of Aquifoliaceae, Asteraceae, and several tropical montane families fail to penetrate lowland elevations in the neotropics.

If the numbers of epiphytic species and families are plotted against annual precipitation, following Gentry and Dodson (1987b), the species diversity at Monteverde fits expectations, but the number of families is much higher (27 vs. ca. 15) than expected. Plant species richness generally increases with annual precipitation to about 4000 mm (Gentry 1988). Higher than expected epiphyte diversity at Monteverde is probably partly due to the greater amount of effective precipitation than measured with a standard rain gauge. The canopy at our study site intercepts 500-2000 mm of precipitation annually as mist and fog, in addition to 2500 mm of rainfall (Clark 1994).

Epiphyte diversity is generally greatest in wet aseasonal forests on fertile soils at "middle elevations" (Gentry & Dodson 1987b). In the Andes, plant species diversity decreases from 1500 to 3000 m, but little or no decrease in diversity is evident from lowland forests to around 1500 m (Gentry 1988). Our study indicates relatively high epiphyte diversity, especially at the family level, at a mid-elevation site in Costa Rica. Although the percentage of the Monteverde flora that grows epiphytically remains unknown, we expect it will exceed 25%. Whether epiphytes constitute as much as 35% of the flora, as at Centinela Ridge, Ecuador (Gentry & Dodson 1987b) before its deforestation, remains to be seen.

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LITERATURE CITED

AGUIRRE-LEON E. 1992. Vascular epiphytes of Mexico: a preliminary inventory. Selbyana 13: 72–76.

BENZING D. H. 1990. Vascular epiphytes. Cambridge University Press, New York, New York.

BØGH A. 1992. Composition and distribution of the vascular epiphyte flora of an Ecuadorian montane rain forest. Selbyana 13: 25–34.

BOHLMAN S., T. MATELSON, AND N. M. NADKARNI. 1995. Moisture and temperature patterns of canopy humus and forest floor soils of a montane cloud forest, Costa Rica. Biotropica 27: 13–19.

BURGER W. C. 1980. Why are there so many kinds of flowering plants in Costa Rica? Brenesia 17: 371–388.

CLARK K. L. 1994. The role of epiphytic bryophytes in the net accumulation and cycling of nitrogen in a tropical montane cloud forest. Ph.D. dissertation, University of Florida, Gainesville, Florida.

CROAT T. B. 1992. Species diversity of Araceae in Colombia: a preliminary survey. Ann. Missouri Bot. Gard. 79: 17–28.

CRONQUIST A. 1981. An integrated system of classification of flowering plants. Columbia University Press, New York, New York.

DAHLGREN R. M. T., H. T. CLIFFORD, AND P. F. YEO. 1985. The families of monocotyledons: structure, evolution, and taxonomy. Springer-Verlag, New York, New York.

DODSON C. H. AND A. H. GENTRY. 1978. Flora of Río Palenque Science Center. Selbyana 4: 1–468.

GENTRY A. H. 1988. Changes in plant community diversity and floristic composition on environmental and geographical gradients. Ann. Missouri Bot. Gard. 75: 1–34.

GENTRY A. H. AND C. H. DODSON. 1987a. Contribution of nontrees to species richness of a tropical rain forest. Biotropica 19: 149–156.

——— AND ———. 1987b. Diversity and biogeography of neotropical vascular epiphytes. Ann. Missouri Bot. Gard. 74: 205–233.

GRUBB P. J., J. R. LLOYD, T. D. PENNINGTON, AND T. C. WHITMORE. 1963. A comparison of montane and lowland rain forest in Ecuador. I. The forest structure, physiognomy, and floristics. J. Ecol. 51: 567–601.

HABER W. A. 1991. Lista provisional de las plantas de Monteverde, Costa Rica. Brenesia 34: 63–120.

HAMMEL B. 1990. The distribution of diversity among families, genera, and habit types in the La Selva flora. Pp. 75–84 *in* A. W. GENTRY, (ed.), "Four neotropical forests." Yale University Press, New Haven, Connecticut.

INGRAM S. W. 1989. The abundance, vegetative composition and distribution of epiphytes in a Costa Rican lower montane rain forest. M. A. Thesis, University of California, Santa Barbara, California.

INGRAM S. W. AND M. D. LOWMAN. 1995. The collection and preservation of plant material from the tropical forest canopy. Pp. 587–603 *in* M. D. LOWMAN AND N. M. NADKARNI, (eds.), "Forest Canopies." Academic Press, San Diego, California.

INGRAM S. W. AND N. M. NADKARNI. 1993. Composition and distribution of epiphytic organic matter in a neotropical cloud forest, Costa Rica. Biotropica 25: 370–383.

JOHANSSON D. 1974. Ecology of vascular epiphytes in West African rain forest. Acta Phytogeogr. Suecica 59: 1–129.

KRESS W. J. 1986. The systematic distribution of vascular epiphytes: an update. Selbyana 9: 2–22.

LAWTON R. AND V. DRYER. 1980. The vegetation of the Monteverde Cloud Forest Reserve. Brenesia 18: 101–116.

NADKARNI N. M. 1984. Epiphyte biomass and nutrient capital of a neotropical elfin forest. Biotropica 16: 249–256.

NADKARNI N. M. 1988. Tropical rainforest ecology from a canopy perspective. Pp. 189–208 *in* F. ALMEDA AND C. M. PRINGEL (eds.), "Tropical rainforests: diversity and conservation." California Academy of Sciences, San Francisco, California.

NADKARNI N. M. AND T. J. MATELSON. 1992. Biomass and nutrient dynamics of epiphytic litterfall in a neotropical montane forest, Costa Rica. Biotropica 24: 24–30.

NADKARNI N. M., T. J. MATELSON, AND W. A. HABER. 1995. Structural characteristics and floristic composition of a neotropical cloud forest, Monteverde, Costa Rica. J. Trop. Ecol. 11: 481–495.

PERRY D. R. 1978. A method of access into the crowns of emergent and canopy trees. Biotropica 10: 155–157.

RAVEN P. H. AND D. I. AXELROD. 1974. Angiosperm biogeography and past continental movements. Ann. Missouri Bot. Gard. 61: 539–673.

SUGDEN A. M. AND R. J. ROBINS. 1979. Aspects of the ecology of vascular epiphytes in Colombian cloud forests. I. The distribution of the epiphytic flora. Biotropica 11: 173–188.

VANCE E. AND N. M. NADKARNI. 1990. Microbial biomass and activity in canopy organic matter and the forest floor of a tropical cloud forest. Soil Biol. Biochem. 22: 677–684.

APPENDIX 1. List of vascular epiphytes from Monteverde study site. All collection numbers cited are those of S. Ingram; voucher specimens listed are deposite at SEL unless otherwise indicated. Tree zones used are modified from Johansson (1974): 1—lower trunk 1–2 m; 2—upper trunk > 2 m; 3—inner third c canopy; 4—middle third of canopy; 5—outer third of canopy. Two values for height above ground or branch circumference represent the range of measurement taken from additional collections. Plant habit given is typical for plants collected, but may vary with location on host tree. "H" preceeding growth forn designates a hemiepiphyte.

Name/Author	Coll. #	Tree zones	Hgt. above ground (m)	Branch circum. (cm)	Plant habit	Growth form
PTERIDOPHYTES						
Aspleniceae						
Asplenium cirrhatum Rich. ex Willd.	(1314)	1	1	345	erect	fern
A. cuspidatum Lam.	(1333)	2	4.5	13	erect	fern
A. dissectum Sw.	(1293)	2–3	7–15	36, 85	caespitose	fern
A. gomezianum Lellinger	(1357)	1	2	80	caespitose	fern
A. pululahuae Sodiro	(1668)	1–2	1.5, 4	40, 56	caespitose	fern
A. rosenstockianum Brade	(1355)	1	1	18	caespitose	fern
A. rutaceum (Willd.) Mett.	(1342)	1	1	16, 20	erect	fern
A. salicifolium L.	(1736)	2	4	100	caespitose	fern
Blechnaceae						
Blechnum fragile (Liebm.) C. V. Morton & Lellinger	(1358)	1	2	63	scandent	fern
Davalliaceae						
Nephrolepis pendula (Raddi) J. Sm.	(1574)	2	15	100, 250	pendent	fern
Oleandra bradei H. Christ	(1286)	3	10	120	scandent	fern
Grammitidaceae						
Ceradenia jungermannioides (Kotszsch) L. E. Bishop	(1843)	2	12	180	caespitose	fern
Cochlidium rostratum (Hook.) Maxon ex. C. Chr.	(1532)	5	13	4	caespitose	fern
C. serrulatum (Sw.) L. E. Bishop	(1509)	5	12, 13	6, 7	caespitose	fern
Lellingeria limula (H. Christ) A. R. Sm. & R. C. Moran	(1324)	treefall		16	erect	fern
Micropolypodium taenifolium (Jenman) A. R. Sm.	(1478)	3–5	11, 15	15, 33	erect	fern
Terpsichore alfarii (Donn. Sm.) A. R. Sm.	(1757)	1	1, 1.5	30, 65	caespitose	fern
T. taxifolia (L.) A. R. Sm.	(1520)	3–5	3.5, 13	4, 20	caespitose	fern
Hymenophyllaceae						
Hymenophyllum microcarpum Desv.	(1315)	1	1, 2	36, 345	scandent	fern
H. subrigidum H. Christ	(1844)	2	12	180	scandent	fern

APPENDIX 1. Continued.

Name/Author	Coll. #	Tree zones	Hgt. above ground (m)	Branch circum. (cm)	Plant habit	Growth form
Trichomanes capillaceum L.	(1345)	1–2	1, 3.5	34	scandent	fern
T. diaphanum H.B.K.	(1316)	1	1.5	20	scandent	fern
T. krausii Hook. & Grev.	(1356)	1	1.5	23	scandent	fern
T. ludovicinum Rosenst.	(1755)	2	6	35	scandent	fern
T. radicans Sw.	(1319)	1	1.5	13	scandent	fern
Lomariopsidaceae						
Elaphoglossum ambiguum (Mett. ex H. Christ) Alston	(1544)	1	1.5	34	erect	fern
E. atrobarbatum Mickel	(1322)	branchfall		25	erect	fern
E. auricomum (Klotzsch) T. Moore	(1458)	5	15.3	15	erect	fern
E. auripilum H. Christ	(1857)	3	13	80	pendent	fern
E. erinaceum (Fée) Hook.	(1472)	1	2	185	erect	fern
E. guatemalense (Klotzsch) T. Moore	(1503)	4	12	35	erect	fern
E. lanceiforme Mickel	(1746)	branchfall		12	erect	fern
E. latifolium (Sw.) J. Sm.	(1530)	1, 3	1, 13	29, 59	erect	fern
E. lingua Brack.	(1491)	3	11, 15	37	erect	fern
E. lonchophyllum (Fée) Moore	(1582)	1	1	19	erect	fern
E. pallidum (Baker) C. Chr.	(1557)	2–3	11–12	90, 120	pendent	fern
E. palmense H. Christ	(1825)	5	15.3	8, 31	erect	fern
E. peltatum (Sw.) Urb.	(1455)	1, 5	1, 15.3	10	scandent	fern
E. sherringii (Baker) C. Chr.	(1308)	branchfall		6, 60	erect	fern
Lomariopsis maxonii (Underw.) Holttum	(1849)	1–2	1–5	8, 19	scandent	fern
Lycopodiaceae						
Huperzia dichaeoides (Maxon) Holub	(1700)	3	11	13	pendent	fern
H. filiformis (Sw.) H. Christ	(1271)	fallen epiphyte			pendent	fern
Ophioglossaceae						
Ophioglossum palmatum L.	(1588)	3	16	320	erect	fern
Polypodiaceae						
Campyloneurum angustifolium (Sw.) Fée	(1361)	2, branchfall	9.5	70, 115	erect	fern
C. falcoideum (Kuhn ex Hieron.) M. Meyer ex Lellinger	(1672)	2, branchfall	14	16, 250	scandent	fern
C. sphenodes (Kunze ex Klotzsch) Fée	(1296)	1–2	1, 10	20, 486	scandent	fern
Niphidium crassifolium (L.) Lellinger	(1534)	treefall			erect	fern
Pleopeltis fructuosa (Maxon & Weath. in Weath.) Lellinger	(1811)	1, 5	2, branchfall	3, 43	scandent	fern

APPENDIX 1. Continued.

Name/Author	Coll. #	Tree zones	Hgt. above ground (m)	Branch circum. (cm)	Plant habit	Growth form
P. macrocarpa (Bory ex Willd.) Kaulf. var. *complanata* (Weath.) Lellinger	(1518c)	1	2	5	scandent	fern
Polypodium fraxinifolium Jacq.	(1318)	1–4	1.5, 15	24, 60	scandent	fern
P. furfuraceum Schldtl. & Cham.	(1671)	branchfall		22	erect	fern
P. myriolepis H. Christ	(1578)	branchfall		51	erect	fern
P. ptilorhizon H. Christ	(1280)	3, 4, treefall	8, 15	10, 60	scandent	fern
Vittariaceae						
Antrophyum chlorosporum Mickel & Beitel	(1791)	1	1	5	caespitose	fern
A. lineatum (Sw.) Kaulf.	(1278)	2	7.3, 9.5	115,120	pendent	fern
Vittaria lineata (L.) Sm.	(1344)	2	17	80	pendent	fern
ANGIOSPERMS						
Alzateaceae						
Alzatea verticillata Ruiz Lopez & Pavon	(1827)	3	15	80	erect	H treelet
Aquifoliaceae						
Ilex hemiepiphytica Hahn (ined.)	(1713)	2–3	10–17	80, 300	erect	H treelet
I. vulcanicola Standley	(1839)	2	8	200	erect	H treelet
Araliaceae						
Oreopanax capitatus (Jacq.) Decne. & Planchon	(1867)	2	treefall	140	erect	H treelet
Oreopanax oerstedianus Marchal	(1794)	2	7–11	200, treefall	erect	H treelet
Schefflera rodrigueziana Frodin ex M. J. Cannon & Cannon	(1871)	3	13	250	erect	H tree
S. robusta (A. C. Smith) A. C. Smith	(1569)	3	15	65, 90	scandent	treelet
Araceae						
Anthurium davidsoniae Standley	(1731)	1	1–1.3	10, 12	erect	herb
A. friedrichsthalii Schott	(1339)	2, 3, 4	10, 12	6, 63	pendent	herb
A. microspadix Schott	(1330)	1	1, 2	10, 61	scandent	herb
A. monteverdense Croat & R. A. Baker	(1551)	2–3	9.9, 15	80, 205	erect	herb
A. obtusilobum Schott	(1332)	1, 2	2, 4	38, 160	erect	herb
A. pittieri Engl.	(1581)	1	2	8	erect	herb
A. protensum Schott	(1714)	2	12	45, 150	erect	herb
A. ramonense Engl. & K. Kr.	(1795)	2	4	50	erect	herb
A. scandens (Aublet) Engl. ssp. *pusillum* Sheffer	(1470)	2–5	2, 16	5, 400	scandent	herb
Monstera dissecta (Schott) Croat & Grayum	(1826)	2	5	130	scandent	H herb

APPENDIX 1. Continued.

Name/Author	Coll. #	Tree zones	Hgt. above ground (m)	Branch circum. (cm)	Plant habit	Growth form
Philodendron wilburi Croat & Grayum	(1734)	2	8	200	scandent	herb
Stenospermation sessile Engl.	(1262)	3	12	20, 130	erect	herb
Syngonium glaucopetiolatum	(1553)	2	11.5	150	scandent	herb
Asteraceae						
Neomirandea parasitica (Klatt) R. King & H. Robinson	(1351)	3	12.2	12, 60	erect	herb
Pentacalia candelariae (Benth. ex Oerst.) H. Robinson	(1817)	branchfall		70	pendent	shrub
P. streptothamnus (Greenman) H. Robinson	(1848)	3	4	15	pendent	herb
Sinclairia polyantha (Klatt) Rydb.	(242-4-4/UCSB)	3			scandent	shrub
Begoniaceae						
Begonia glabra Aubl.	(1833)	1	2	15	scandent	herb
B. heydei C.DC.	(1667)	1, 2, 3	1, 12.6	4, 50	erect	herb
B. strigillosa A. Dietr.	(1676)	1, 3	1.5, 10	20, 190	erect	herb
Bromeliaceae						
Catopsis nitida (Hook.) Griseb.	(264/UCSB)	branchfall			erect	herb
Guzmania angustifolia (Baker) Wittm.	(1294)	1–4	1, 17	20, 39	erect	herb
G. compacta Mez	(1533)	1, 2, 3	1.7, 19	7, 30	erect	herb
G. coriostachya (Griseb.) Mez	(1524)	branchfall		60	erect	herb
G. nicaraguensis Mez & C. Baker	(1812)	branchfall		2, 6	erect	herb
G. plicatifolia L. B. Sm.	(1340)	2	15, 16	120, 200	erect	herb
G. stenostachya L. B. Sm.	(1321)	1	1	8	erect	herb
Pitcairnia atrorubens (Beer) Baker	(1679)	1	2.5	ca. 500	erect	herb
P. brittoniana Mez	(1317)	1, 2	2.5, 3	28, 60	scandent	herb
Tillandsia adpressa Andre var. *tonduziana* (Mez) L. B. sm.	(1754)	treefall		22	clumping	herb
T. excelsa Griseb.	(1855)	3	12	15	erect	herb
T. insignis (Mez) L. B. Sm. & Pittendr.	(1694)	3	15	7, 67	erect	herb
Vriesea comata (Mez & Wercklé) L. B. Sm. & Pittendr.	(s.n.)	no data			erect	herb
V. graminifolia Mez & Wercklé	(1737)	branchfall			erect	herb
V. hygrometrica (André) L. B. Sm. & Pittendr.	(1490)	5	11, 15	8, 16	erect	herb
V. notata L. B. Sm. & Pittendr.	(1305)	branchfall		13	erect	herb
V. pedicellata (Mez & Wercklé) L. B. Smith & Pittendr.	(1325)	1, branchfall	1	24, 70	erect	herb

APPENDIX 1. Continued.

Name/Author	Coll. #	Tree zones	Hgt. above ground (m)	Branch circum. (cm)	Plant habit	Growth form
V. stenophylla (Mez & Wercklé) L. B. Smith & Pittendr.	(1323)	treefall		11	erect	herb
V. tonduziana L. B. Sm.	(1701)	2, treefall	16	2, 150	erect	herb
V. umbrosa L. B. Sm.	(1845)	3	10	40	erect	herb
V. viridiflora (Regal) Wittm. ex Mez	(1539)	3, 5	15	14, 60	erect	herb
V. vittata (Mez & Wercklé) L. B. Sm. & Pittendr.	(1830)	3, branchfall	12	15, 90	erect	herb
Cactaceae						
Epiphyllum cf. *lepidocarpum* (Weber) Britton & Rose	(1602)	2, 3	10, 15	20, ca. 600	pendent	herb
Campanulaceae						
Burmeistera microphylla J. D. Smith	(1741)	3, branchfall	14	25, 28	erect	herb
Clusiaceae						
Clusia stenophylla Standley	(1265)	branchfall			erect	H treelet
Clusia sp. A.	(1801)	branchfall		210	erect	H treelet
Convallariaceae						
Maianthemum monteverdense LaFr.	(1526)	2, treefall	15	65, ca. 600	arching	herb
Cunoniaceae						
Weinmannia wercklei Standley	(1854)	3	12	140	erect	shrub
Cyclanthaceae						
Asplundia microphylla (Oersted) Harling	(1820)	2	6.5	230	scandent	herb
A. vagans Harling	(1725)	2	4	35	scandent	herb
Sphaeradenia irazuensis (Cuf.) Harling	(1802)	3, branchfall	9	15, 20	erect	herb
Dioscoreaceae						
Dioscorea lepida C. Morton	(1298)	3, branchfall	10	100	vining	herb
Ericaceae						
Cavendishia bracteata (R. & P. ex J. St.-Hill) Hoer.	(1283)	3	12	80	erect	shrub
C. capitulata J. D. Smith	(1688)	branchfall		63	erect	shrub
C. complectens Hemsley ssp. *complectens*	(1660)	2	14	15	erect	shrub
C. melastomoides (Klotzsch) Niedenzu var. *albiflora* Luteyn	(1496)	treefall			erect	shrub
Disterigma humboldtii (Klotzsch) Niedenzu	(1452)	2–5	11, 16.5	7, 140	scandent	shrub

APPENDIX 1. Continued.

Name/Author	Coll. #	Tree zones	Hgt. above ground (m)	Branch circum. (cm)	Plant habit	Growth form
Gaultheria gracilis Small	(1289)	3	12	75	erect	shrub
Psammisia ramiflora Klotzsch	(1724)	3	4	40	erect	shrub
Satyria warszewiczii Klotzsch	(1834)	2	5	35	arching	shrub
Sphyrospermum buxifolium Poeppig. & Endl.	(1492)	4, 5	12.7, 15	9, 30	erect	shrub
S. cordifolium Benth.	(1454)	5	12.5, 15.3	8, 15	erect	shrub
Vaccinium poasanum J. D. Smith	(1837)	4	treefall	150	erect	shrub
Gesneriaceae						
Capanea grandiflora (Kunth) Decne. ex Planchon	(1808)	1	2	20	arching	herb
Columnea anisophylla DC.	(1348)	1	2.5, 2.3	88, 48	erect	shrub
C. consanguinea Hanst.	(1705)	1	1.5	20	arching	herb
C. lepidocaula Hanst.	(1310)	3, treefall	14	40	arching	herb
C. microcalyx Hanst.	(1302)	2, 3	4, 22	305	pendent	herb
C. verecunda C. Morton	(1683)	2	22	19, 300	erect	shrub
Drymonia conchocalyx Hanst.	(1655)	2	2	30	arching	shrub
D. rubra C. Morton	(1304)	2, 3	4, 10	53, 15	arching	shrub
Grossulariaceae						
Phyllonoma cf. *tenuidens* Pittier	(235/UCSB)	2	treefall		erect	shrub
Lentibulariaceae						
Utricularia jamesoniana Oliver	(1756)	5	treefall	6	erect	herb
U. praetermissa P. Taylor	(1528)	4	12.6	18	erect	herb
Marcgraviaceae						
Marcgravia brownei (Triana & Planchon) Krug & Urban	(1690)	treefall		95	scandent	H shrub
Melastomataceae						
Blakea anomala J. D. Smith	(1733)	2, 3	7, 15	150	erect	shrub
B. tuberculata J. D. Smith	(1684)	2	16	ca. 600	erect	H treelet
Miconia grandidentata Almeda	(1822)	3	14	200	erect	shrub
Topobea brenesii Standley	(1805)	3	13	340	erect	H tree
Moraceae						
Ficus crassiuscula Warburg ex. Standley	(1840)	2	4–7	215	scandent	H shrub
Myrsinaceae						
Cybianthus costaricanus Hemsley	(1531)	3	13	35, 250	erect	shrub

APPENDIX 1. Continued.

Name/Author	Coll. #	Tree zones	Hgt. above ground (m)	Branch circum. (cm)	Plant habit	Growth form
Orchidaceae						
Acostaea costaricensis Schltr.	(1336)	5	12, 19	1, 6	caespitose	herb
Ada chlorops (Endres & Rchb.f.) N. Williams	(1735)	branchfall		13	erect	herb
Barbosella prorepens	(1677)	3	22	8	caespitose	herb
Brachionidium pusillum Ames & C. Schweinf.	(1556)	branchfall		95	scandent	herb
Campylocentrum longicalcaratum Ames & C. Schweinf.	(1501)	5	12	9	erect	herb
Cochleanthes picta (Rchb.f.) Garay	(1695)	1	1.3, 2	ca. 500	erect	herb
Cryptocentrum calcaratum (Schltr.) Schltr.	(1459)	branchfall		4, 55	erect	herb
Cyclopogon aff. *elatus* (Sw.) Schldl.	(1740)	branchfall		25	erect	herb
C. prasophyllum (Rchb.f.) Schltr.	(1274)	branchfall		8	erect	herb
Dichaea cryptarrhena Rchb.f. ex Kraenzl.	(1675)	1, 2	1, 10	20, 55	pendent	herb
D. lankesteri Ames	(1846)	1	2.5	75	pendent	herb
D. cf. *oxyglossa* Schltr.	(1592)	1	2.3	50	pendent	herb
Dracula cf. *erythrochaete* (Rchb.f.) Luer	(1836)	3	12	85	erect	herb
Elleanthus cf. *tonduzii* Schltr.	(1798)	branchfall		27	erect	herb
Encyclia pseudopygmaea (Finet) Dressler & Pollard	(1658)	3	22	100, 20	scandent	herb
Epidendrum cf. *albertii* Schltr.	(1593)	2	3.5	25	erect	herb
E. anoglossum Schltr.	(1476)	5	15, 19	5,8	erect	herb
E. laucheanum Rolfe ex Bonh.	(1868)	branchfall		14	arching	herb
E. myodes Rchb.f.	(1752)	treefall		45	arching	herb
E. palmense Ames	(1572)	branchfall		15	erect	herb
E. ramonianum Schltr.	(1477)	4, 5	15, 19	12, 17	erect	shrub
E. sancti-ramoni Kraenzl.	(1652)	treefall		78	erect	herb
E. selaginella Schltr.	(1483)	5	15	3	erect	herb
E. subnutans Ames & C. Schweinf.	(1545)	1	1	85	arching	herb
E. summerhayesii Hágsater	(1495)	treefall			erect	herb
Epidendrum sp. A	(1693)	3	7, 13	15, 100	erect	herb
Erythrodes killipii Ames	(1335)	treefall		110	erect	herb
Eurystyles cf. *auriculata* Schltr.	(1276)	branchfall	12	3.5, 75	erect	herb
Lepanthes acostae Schltr.	(1561)	treefall		200	caespitose	herb
L. confusa C. Schweinf.	(1529)	5	12.6		caespitose	herb
L. ferrelliae Luer	(1570)	branchfall		10	caespitose	herb
L. jimenezii Schltr.	(1467)	5 (treefall)		6, 12	caespitose	herb
L. mentosa Luer	(1312)	treefall		15, 120	caespitose	herb

APPENDIX 1. Continued.

Name/Author	Coll. #	Tree zones	Hgt. above ground (m)	Branch circum. (cm)	Plant habit	Growth form
L. minutilabia Ames	(1792)	branchfall		3	caespitose	herb
L. pygmaea Luer	(1297)	branchfall		4	caespitose	herb
Lockhartia hercodonta Rchb.f. ex Kraenzl.	(1793)	branchfall		8	arching	herb
Lycaste aff. *leucantha* Klatt	(1595)	1, 2	1.5, 6	280, 160	erect	herb
Masdevallia chontalensis Rchb.f.	(1653)	4	13	45	caespitose	herb
M. molossoides Kraenzl.	(1462)	3, 5	12, 19	2, 15	caespitose	herb
M. nidifica Rchb.f.	(1334)	5	15, 20	5, 10	caespitose	herb
M. schizopetala Kraenzl.	(1543)	5	15	3	caespitose	herb
M. striatella Rchb.f.	(1744)	branchfall		12, 24	caespitose	herb
Maxillaria cf. *brunnea* Linden & Rchb.f.	(1706)	1, treefall	5	90, 25	erect	herb
M. fulgens (Rchb.f.) L. O. Williams	(1571)	3	15	40	erect	herb
M. inaudita Rchb.f.	(1255)	2, treefall	6	7, 85	erect	herb
M. linearifolia Ames & C. Schweinf.	(1548)	treefall			arching	herb
M. cf. *microphyton* Schltr.	(1486)	5	15	15	erect	herb
M. minor (Schltr.) L. O. Williams	(1829)	treefall			scandent	herb
M. cf. *parvilabia* Ames & C. Schweinf.	(1788)	branchfall		15	erect	herb
M. reichenheimiana Rchb.f.	(283/UCSB)	3	16	60	erect	herb
M. sigmoidea (C. Schweinf.) Ames & Correll	(1814)	branchfall		70	erect	herb
M. umbratilis L. O. Williams	(1307)	treefall		48	erect	herb
Myoxanthus sempergemmatus (Luer) Luer	(1515)	3	12.6	30, 36	erect	herb
Oerstedella endresii (Rchb.f.) Hags.	(1279)	treefall		4	erect	herb
O. exasperata (Rchb.f.) Hags.	(1796)	branchfall		12	erect	shrub
Oncidium bracteatum Warsc. & Rchb.f.	(1687)	4	7	6, 12	erect	herb
O. globuliferum Kunth.	(1864)	branchfall		4	vining	herb
O. heteranthum Poeppig & Endl.	(1259)	branchfall		4, 6	erect	herb
Ornithocephalus aff. *gladiatus* Hook.	(1815)	branchfall		4	erect	herb
Platystele microtatantha (Schltr.) Garay	(1497)	branchfall		27, 30	caespitose	herb
Pleurothallis cardiothallis Rchb.f.	(1657)	branchfall		12	erect	herb
P. casualis Ames	(1267)	branchfall		15	caespitose	herb
P. cogniauxiana Schltr.	(1789)	2, treefall	4	10	caespitose	herb
P. costaricensis Rolfe	(1260)	tree-, branchfall		5, 55	caespitose	herb
P. crescentilabia Ames	(1326)	treefall	20	35	erect	herb
P. cuspidata Luer	(1710)	branchfall		5	caespitose	herb
P. eumecocaulon Schltr.	(1273)	5	15	7, 29	caespitose	herb
P. aff. *fractiflexa* Luer	(1723)	1	1.8	40	caespitose	herb
P. cf. *gonioglossa* Schltr.	(1598)	treefall		12	caespitose	herb

APPENDIX 1. Continued.

Name/Author	Coll. #	Tree zones	Hgt. above ground (m)	Branch circum. (cm)	Plant habit	Growth form
P. homalantha Schltr.	(1663)	1	1	35	caespitose	herb
P. immersa Linden & Rchb.f.	(1771)	branchfall		18	caespitose	herb
P. imraei Lindley	(1320)	branchfall		18	caespitose	herb
P. pompalis Ames	(1650)	branchfall			caespitose	herb
P. cf. *powellii* Schltr.	(1804)	3	10	20	erect	herb
P. rowleei Ames	(1552)	1, 2	1.3, 10.5	16, 200	caespitose	herb
P. ruscifolia (Jacq.) R. Br.	(1488)	2–5	8, 16	6, 200	caespitose	herb
P. segoviensis Rchb.f.	(1468)	treefall		17	caespitose	herb
P. segregatifolia Ames & C. Schweinf.	(1575)	2, 3	11, 22	7, 210	caespitose	herb
P. strumosa Ames	(1851)	treefall		4	caespitose	herb
Pleurothallis sp. nov. (aff. *homalantha*)	(1252)	branchfall		12	caespitose	herb
Restrepia subserrata Schltr.	(1250)	tree-, branchfall		10, 7	caespitose	herb
Scaphyglottis amparoana (Schltr.) Dressler	(1709)	treefall		90	caespitose	herb
S. cf. *lindeniana* (A. Rich & Galeotti) L. O. Williams	(1816)	treefall		90	arching	herb
Sobralia amabilis (Rchb.f.) L. O. Williams	(1696)	2, treefall	4.5	150	erect	herb
Stelis microchila Schltr.	(1576)	5 (treefall)		6	caespitose	herb
S. pardipes Rchb.f.	(1538)	5	15	17	caespitose	herb
S. parvula Lindley	(1716)	tree-, branchfall		5, 20	caespitose	herb
S. triangulabia Ames	(1479)	5	15, 16	6, 8	caespitose	herb
S. aff. *tristyla* Lindl.	(1475)	3	15	15	caespitose	herb
Stellilabium monteverdense J. Atw.	(1514)	5	12	2	erect	herb
Trichosalpinx cf. *cedralensis* (Ames) Luer	(1856)	4	12	16	caespitose	herb
Xylobium elongatum (Lindl.) Hemsley	(1659)	1, 2	2, 4.5	35, 55	erect	herb
Piperaceae						
Peperomia angularis C. DC.	(1567)	treefall		30	erect	herb
P. costaricensis C. DC.	(1680)	2, 3	7–25	ca. 200	scandent	herb
P. dotana Trel.	(1296)	1, 3	1.3, 10	90, 20	erect	herb
P. hylophila C. DC.	(1449)	4, 5	15, 16	20, 4	erect	herb
P. palmana C. DC.	(1288)	1	1, 2	29, 165	erect	herb
P. peltilimba C. DC. ex Trel.	(1329)	1	1.2–2	8, 362	scandent	herb
P. pittieri C. DC.	(1338)	treefall		63	erect	herb
P. serpens (Sw.) Loudon	(1702)	1	2	6, 37	scandent	herb
P. cf. *reptabunda* Trel.	(1453)	branchfall		22	erect	herb
P. rotundifolia	(1760)	branchfall		15	scandent	herb
P. tenella (Sw.) A. Dietr.	(1787)	branchfall		80	erect	herb
P. tenellaeformis Trel.	(1269)	branchfall		11	erect	herb

APPENDIX 1. Continued.

Name/Author	Coll. #	Tree zones	Hgt. above ground (m)	Branch circum. (cm)	Plant habit	Growth form
Rubiaceae						
Hillea tetrandra Sw.	(1869)	branchfall		50	scandent	shrub
H. triflora (Oersted) C. Taylor	(1254)	treefall		34, 70	erect	shrub
Psychotria maxonii Standley	(1290)	3	15	15	erect	shrub
P. pithecobia Standley	(1256)	3, 4, 5	12.6, 14	7, 250	erect	shrub
Scrophulariaceae						
Schlegelia fuscata A. Gentry	(1850)	2	12	200	scandent	H shrub
Solanaceae						
Lycianthes synanthera (Sendter) Bitter	(1858)	2, 3	13, 14	80, 520	erect	shrub
Markea neurantha Hemsley	(1343)	3	18	140	scandent	shrub
M. venosa Standley	(1251)	branchfall		80	erect	shrub