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Structural characteristics and floristic composition of a Neotropical cloud forest, Monteverde, Costa Rica

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ABSTRACT. The Monteverde Cloud Forest Reserve protects a variety of primary montane forest communities on volcanic parent materials. We describe the structure and composition of the forest to provide background information for epiphyte and nutrient cycling studies and for comparison with other tropical montane forests. In a 4-ha study plot in leeward cloud forest, density of stems (2062 individuals ha⁻¹ for stems >2 cm dbh, 555 individuals ha⁻¹ for stems >10 cm dbh) and stem basal area (73.8 m² ha⁻¹ for stems >2 cm, 62.0 m² ha⁻¹ for stems >10 cm dbh) were high relative to other montane forests. Stems in a subset of the plot (c. 1/3 of the area) were identified and assigned to 47 families, 83 genera and 114 species, which is rich compared with other montane forests. Large stems had a higher spatial variability of structural and floristic characteristics than small stems.

RESUMEN. Características estructurales y composición florística de un bosque nuboso neotropical en Monteverde, Costa Rica. La Reserva del Bosque Nuboso de Monteverde protege una variedad de ámbitos naturales de bosques primarios montañosos sobre suelos volcánicos. Describimos los bosques como fondo para el estudio de plantas epífitas y ciclos de nutrientes y como comparación a otros estudios de la estructura y florística de bosques tropicales montañosos. Las medidas de la densidad de los árboles >2 cm dbh (2062 individuos ha⁻¹) y de la área basal (73.8 m² ha⁻¹) fueron altas en relación a otros bosques montañosos. La especie de cada árbol fue 1/3 área determinada; tallos pertenecientes a 47 familias, 83 generos, y 114 especies fueron coleccionados, lo cual supera la diversidad de otros bosques montañosos. La variebilidad de las características estructurales y florísticas en varias escales espaciales es discutida en el contexto de la área investigada por clases distintas de tamaño de tallos.

KEY WORDS: cloud forest, Costa Rica, forest structure, montane wet forest, Monteverde, Neotropics.

INTRODUCTION

Knowledge of forest structure and floristics is necessary to the study of forest dynamics, plant–animal interactions and nutrient cycling. Considerable

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information of this type exists for montane forests (e.g. Grubb *et al.* 1963, Heaney & Proctor 1990, Proctor *et al.* 1988, Tanner 1977), but few inquiries have been based upon plots of larger than 1 ha. We documented forest structure as an adjunct to investigations of the epiphyte community and its role in nutrient cycling at a lower montane wet tropical forest site in Costa Rica. Specifically, we describe a 4-ha study area in terms of distribution of stem sizes, basal area and floristics, and compare these values with those reported for other forests at similar elevations in the tropics.

STUDY SITE

Fieldwork was conducted from April 1987 to August 1991 in the Monteverde Cloud Forest Reserve (MVCFR) (10° 18' N, 84° 48' W) (1480 m in elevation). The study area was in lower montane wet forest (Holdridge 1967). This primary forest, described as Leeward Cloud Forest (Lawton & Dryer 1980), is composed of trees 15–30 m tall, with a well-developed subcanopy. Epiphytes are diverse and abundant (Nadkarni 1984, 1986). Branch surfaces in the crown interior of nearly all trees support large hemi-epiphytes and bryophytes, herbs and woody shrubs in interwoven root-humus mats up to 25 cm thick. The continually moist soils of the forest floor are derived from volcanic rhyolites, and classified as Typic Dystrandep (Vance & Nadkarni 1990).

Although variable from year to year, the climate of Monteverde is divisible into three seasons (Lawton & Dryer 1980). The misty-windy season (November–January) is characterized by advective orographic clouds and substantial mist borne by the north-east tradewinds. During the dry season (February–April), some cloud water and mist deposition occur, but measurable rainfall is very low. Strong winds abate at the end of this season. The wet season (May–October) is characterized by low windspeeds and convective storms, most of which originate on the Pacific slope. Annual precipitation ranges between 2000 and 2500 mm y^{-1} (Figure 1). Air temperatures are fairly constant through the year (15°–21°C, mean = 17.7°C).

METHODS

Study plots

In April 1987, a study plot consisting of four contiguous hectares (200 m \times 200 m) in primary forest was measured without slope correction, permanently marked and subdivided into 100 20 m \times 20 m sub-plots (Figure 2). The plot included a variety of slopes, several recent and recovering gaps, and appeared representative of the surrounding forest with respect to physiognomy, gap size and distribution, stature and composition. We used a variety of subsets of these plots to characterize the stem density, basal area and diversity (Table 1).

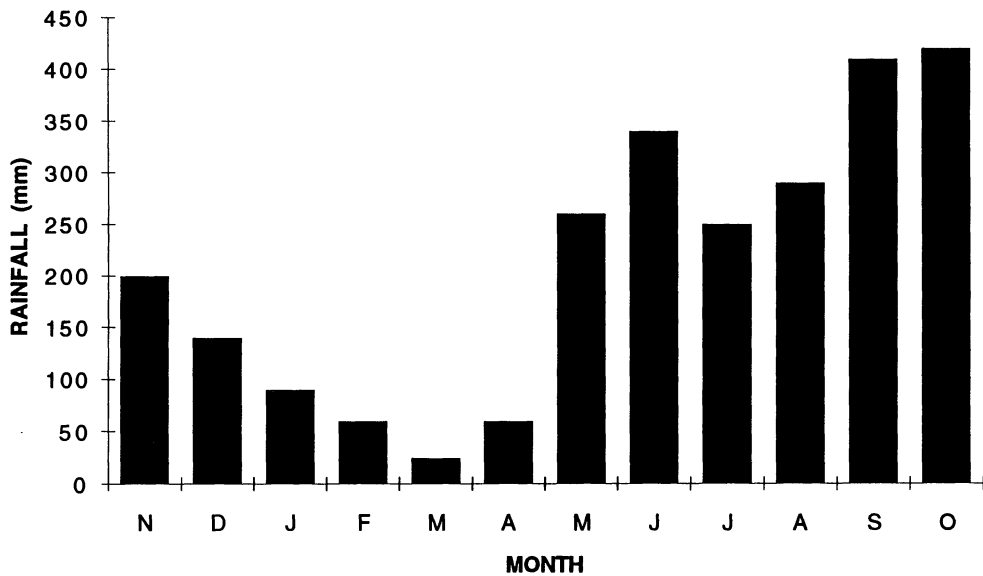


Figure 1. Monthly precipitation (mm) in Monteverde, Costa Rica, taken from a weather station *c.* 1 km from the study plot. Means of 26 years (1965–1991) are presented.

Structural characteristics

Stems in our plot were categorized into large (>30 cm dbh, diameter at breast height), medium (10–30 cm dbh) and small (2–10 cm dbh) stem size classes. All large stems in all the 100 sub-plots, and all medium stems in 50 of the sub-plots were tagged and measured for dbh to the nearest 0.1 cm. Small stems in seven randomly chosen sub-plots throughout the 4 ha were tagged and measured. Strangler figs with multiple closely spaced ‘trunks’ were measured by passing a diameter tape around the periphery of all of the anastomosed roots. Snags (snapped and standing dead trees) were tagged, but not measured for dbh, and were not included in the total counts of live stems or in calculations of basal area.

Floristic composition

Assignment of stems to species were made in 75 of the sub-plots for all large stems, in 30 sub-plots for medium stems and in seven randomly chosen sub-plots for small stems. Trees were identified by W. Haber and E. Bello, the nomenclature following Haber (1991). Names and authorities of plants are given in Appendix 1. Vouchers are deposited in W. Haber’s collection for the Flora of Costa Rica Project (MO).

RESULTS AND DISCUSSION

Structural characteristics

We measured a total of 1851 stems: 638 large, 791 medium and 422 small stems. Overall density of live stems in all size classes was calculated to be 2062

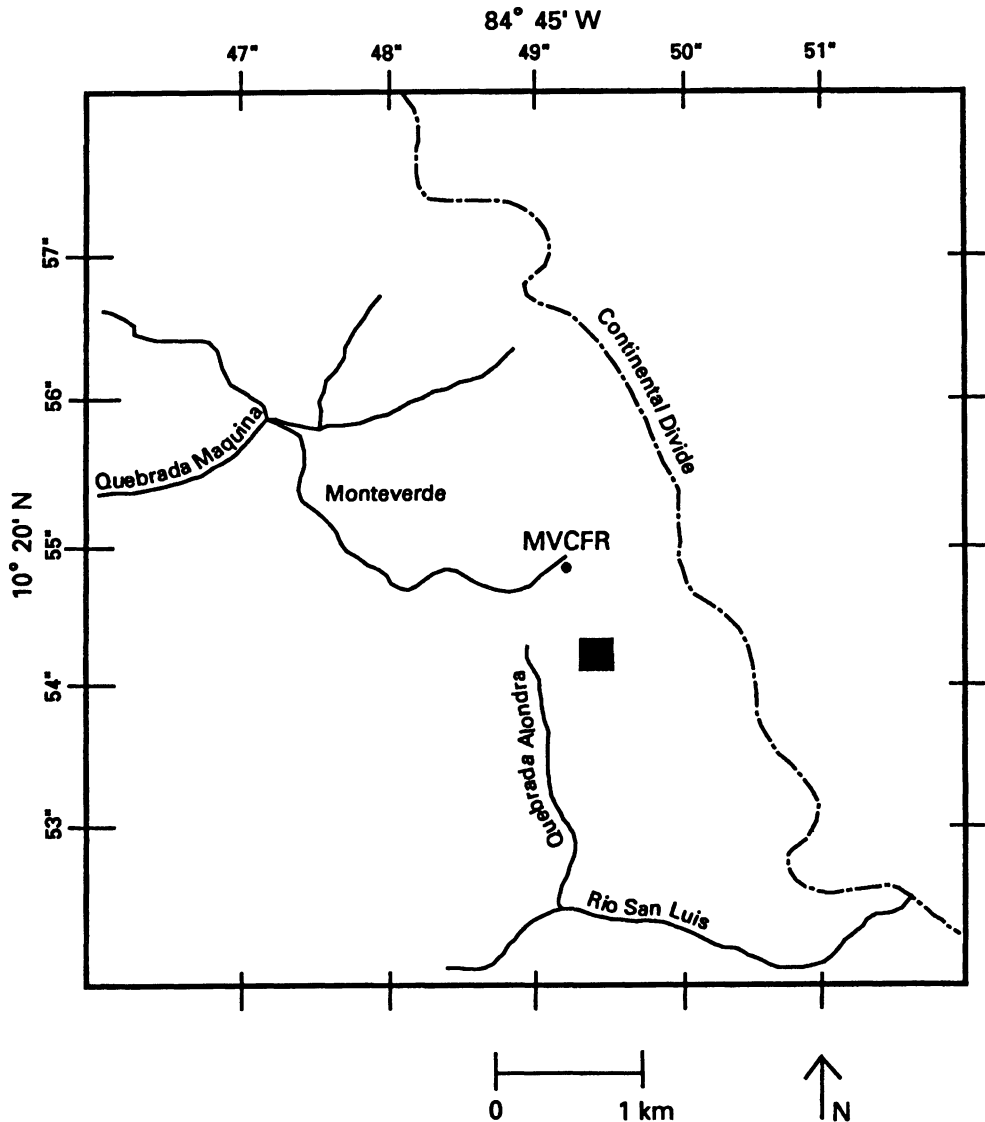


Figure 2. Map of study site, Monteverde, Costa Rica. Small circle indicates the field station of the Tropical Science Center. Black square represents the 4-ha study plot.

individuals ha^{-1} . Densities of large, medium and small stems were 159, 396 and 1507, respectively. Stem density showed a reversed J-shape (Figure 3), which is typical for a mature stand, with many small stems compared to few large ones.

Total basal area (sum of the stem cross-sectional area at breast height extrapolated to a per-hectare basis) for the study area was $73.8 \text{ m}^2 \text{ ha}^{-1}$, partitioned into large ($52.4 \text{ m}^2 \text{ ha}^{-1}$), medium ($9.6 \text{ m}^2 \text{ ha}^{-1}$) and small ($11.8 \text{ m}^2 \text{ ha}^{-1}$) stems. Over half of the total basal area was represented by trees $>50 \text{ cm dbh}$. The

Table 1. Density of stems (number of stems per 400 m² plot), total basal area (m² ha⁻¹) per plot, and total taxa per plot for each stem size class among sub-plots. Coefficients of variation (CV) are provided in parentheses after the standard deviations (SD).

	Stem size class		
	2–10 cm	10–30 cm	>30 cm
Structural characteristics			
Number of sub-plots	7	50	100
Mean density	60.3	15.8	6.5
SD (CV)	16.8 (27)	6.5 (41)	2.5 (38)
Total basal area	0.5	0.4	2.1
SD (CV)	0.2 (40)	0.2 (50)	1.6 (76)
Floristic characteristics			
Number of sub-plots	7	30	75
Mean number of families	17.7	9.1	4.3
SD (CV)	1.8 (10)	2.7 (30)	1.7 (40)
Mean number of genera	24.6	10.2	4.7
SD (CV)	2.3 (9)	3.4 (33)	2.0 (43)
Mean number of species	26.6	10.7	4.9
SD (CV)	3.3 (12)	3.7 (35)	2.2 (45)

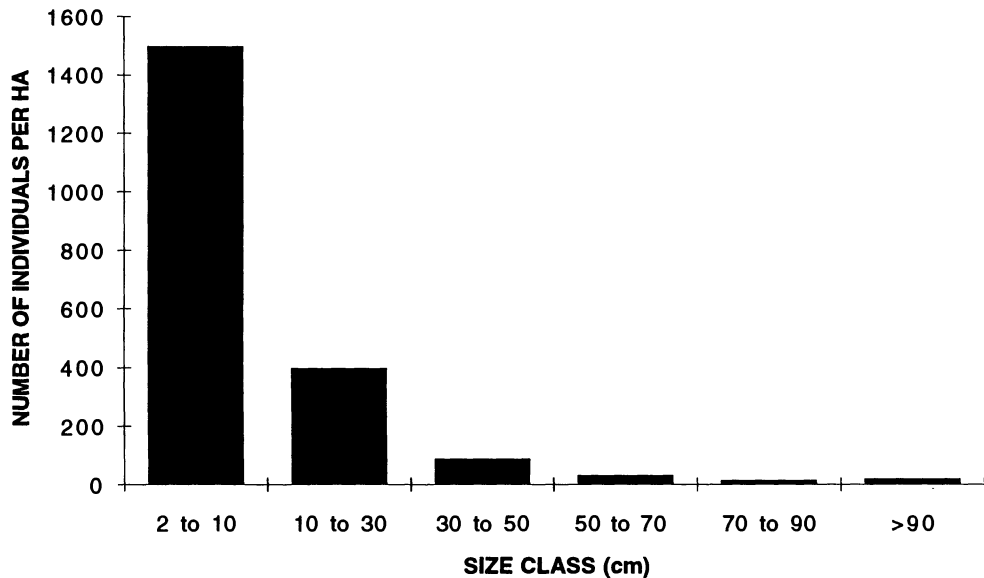


Figure 3. Size class distribution of stem density (number of individuals ha⁻¹) calculated for the 4-ha study area in the Monteverde Cloud Forest, based on sample areas of different sizes (see text).

largest trees (>90 cm dbh), which constituted only 1% of the tabulated stems, accounted for 30% (23.2 m² ha⁻¹) of the total basal area (Figure 4).

Floristic composition

Stems represented 47 families, 83 genera and 114 species. Taxonomic richness (total number of taxa) was quite high at our site relative to other montane

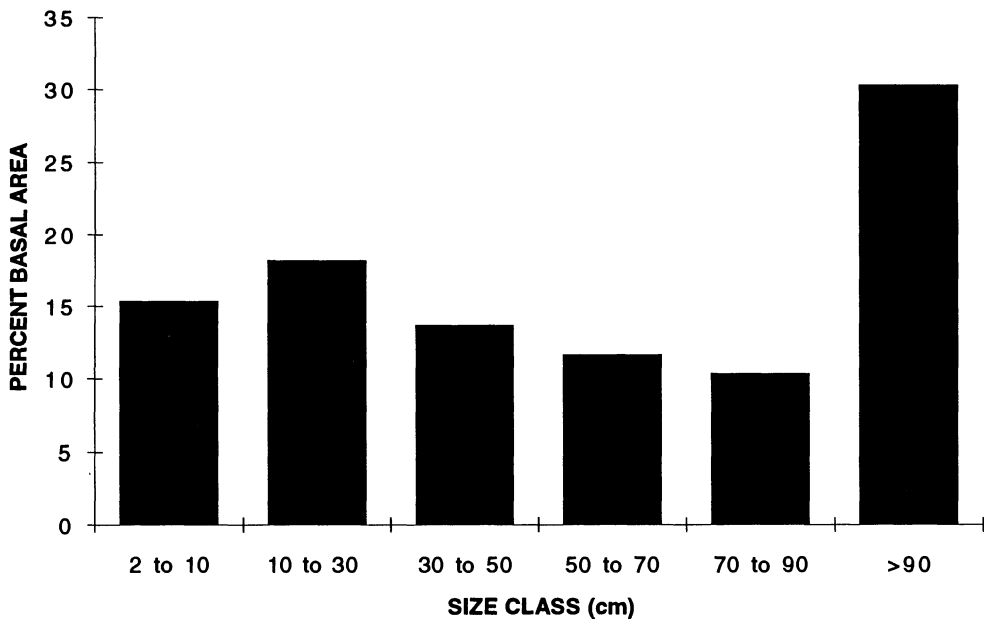


Figure 4. Relative basal area of stems by size class calculated for the 4-ha study area in the Monteverde Cloud Forest, based on sample areas of different sizes (see text).

forests (e.g. Grubb 1963, Heaney & Proctor 1990, Tanner 1977). The distribution of stems among taxa was uneven. Over half the individuals belonged to members of the three most common families, and the stems of 26 plant families accounted for less than 1% of the relative basal area (Table 2).

A dominance–diversity curve was computed at the species level for medium and large stems (plotted on a linear scale) by ranking the relative basal area of all stems >10 cm for trees in the sub-plots for which species were identified. All but six species constituted less than 2.5% of the percentage basal area, illustrating the strong dominance by relatively few species (Figure 5). A single dominant species, *Ocotea tonduzii*, made up 23% of the total basal area.

Species–area curves were calculated with a random sequence of sub-plots. The order was then reversed and values were averaged to avoid end–end bias. We are confident that we sampled a large enough area to document richness for large and medium stems, as the taxa area curves level off at 1 ha for large stems, and 0.6 ha for medium stems (Figure 6a,b). Curves for the small size class of stems do not appear to level off (Figure 6c). Interpretation is difficult because of the small number of sub-plots sampled. Although over 400 stems in the small size class were sampled, small trees in more plots should be identified to verify that an adequate sample area was taken to accurately assess the floristic diversity of this size class.

At the family level, stem density and relative basal area differed between the three stem size classes (Table 2). Thirty-one, 37 and 38 families of trees were represented in the large, medium and small classes. Corresponding numbers of

Table 2. Tree families with percentage of mean total basal area and mean density (numbers of individual trees ha⁻¹). The dominant three families for each category are indicated by bold. t = trace (<1% basal area).

Family	Stem size class							
	2–10 cm		10–30 cm		>30 cm		All stems	
	% BA	No.	% BA	No.	% BA	No.	% BA	No.
Annonaceae	1.9	14	1.1	4	1.5	3	1.5	21
Apocynaceae	1.2	21	0.4	2			0.1	23
Aquifoliaceae			0.5	2	1.3	2	1.2	4
Araliaceae	0.5	7	0.4	1			0.1	8
Arecaceae	2.3	86	0.1	3			0.1	89
Asteraceae	10.6	161	4.4	27			0.6	188
Bombacaceae	0.5	11	4.8	13	1.6	6	1.9	30
Boraginaceae	1.7	18	0.4	1	2.4	7	2.2	26
Cecropiaceae	0.9	18	10.9	32	3.3	10	3.9	60
Celastraceae			0.2	1	0.4	1	0.4	2
Clusiaceae	t	4	3.7	17	0.2	1	0.5	22
Cunoniaceae	t	4	0.2	1	2.2	2	2.0	7
Cyatheaceae	28.7	164	1.2	13			0.7	177
Ebenaceae	0.1	4					t	4
Elaeocarpaceae					1.6	1	1.4	1
Euphorbiaceae	2.4	25	0.6	3			0.1	28
Fabaceae	5.4	71	6.0	27	3.2	3	3.6	101
Flacourtiaceae	1.1	25	3.2	11	4.1	8	3.9	44
Hippocrateaceae	0.1	4					t	4
Icacinaceae	2.4	50	0.9	3	t	1	0.2	54
Juglandaceae					0.3	1	0.2	1
Lauraceae	6.2	121	6.3	18	33.9	37	30.9	176
Malpighiaceae	1.2	18					0.1	18
Malvaceae	0.9	25	3.3	13	2.1	6	2.1	44
Melastomataceae	1.9	50	9.5	27	1.4	7	2.2	84
Meliaceae	6.0	89	9.6	36	4.2	9	4.7	134
Moraceae	2.5	54	1.4	5	15.2	4	13.7	63
Myrsinaceae	2.0	18	10.5	30	0.9	5	1.9	53
Myrtaceae	1.7	36	0.5	3	2.6	5	2.3	44
Nyctaginaceae	0.2	11					t	11
Piperaceae	t	4					t	4
Proteaceae			0.4	1	0.3	1	0.3	2
Rhizophoraceae			0.1	1			t	1
Rubiaceae	10.5	196	7.5	37	0.7	3	1.6	236
Rutaceae	0.5	4	0.2	2	1.0	3	0.8	9
Sabiaceae	0.8	18	1.1	3	4.0	7	3.7	28
Sapindaceae	0.7	21	0.4	1	0.5	1	0.5	23
Sapotaceae	0.7	14	1.5	3	3.4	3	3.1	20
Simaroubaceae	t	4					t	4
Solanaceae	3.4	121					0.1	121
Staphyleaceae			0.3	1			t	1
Symplocaceae	0.2	4	0.9	2	0.2	1	0.3	7
Thymelaeaceae	0.1	4	0.3	1	0.5	1	0.3	6
Tiliaceae			0.4	3	6.3	10	5.6	13
Urticaceae	0.3	7	4.6	18	0.2	1	0.6	26
Verbenaceae	0.4	4	1.8	3	0.5	1	0.6	8

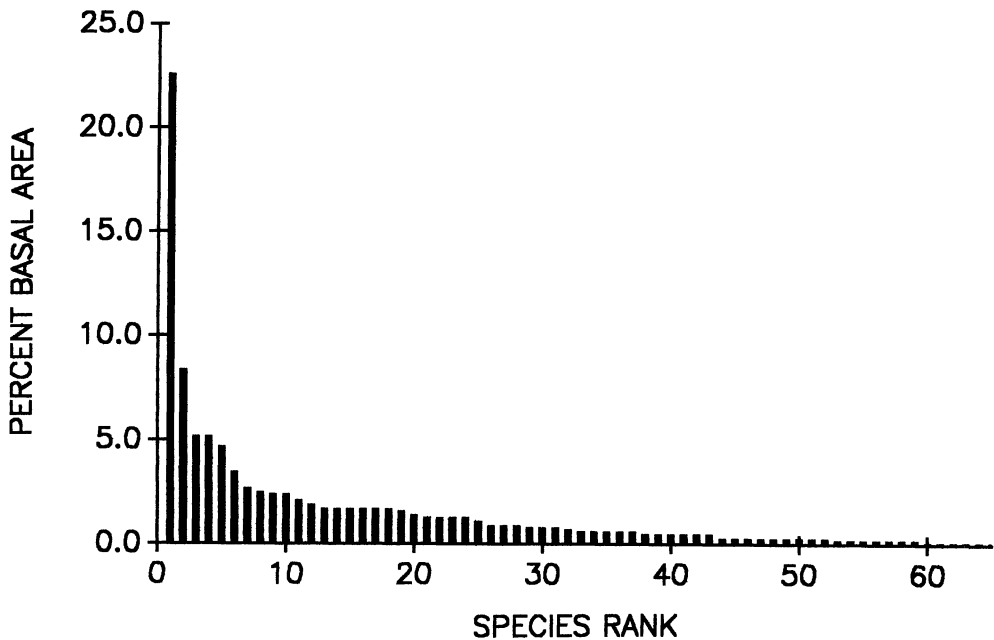


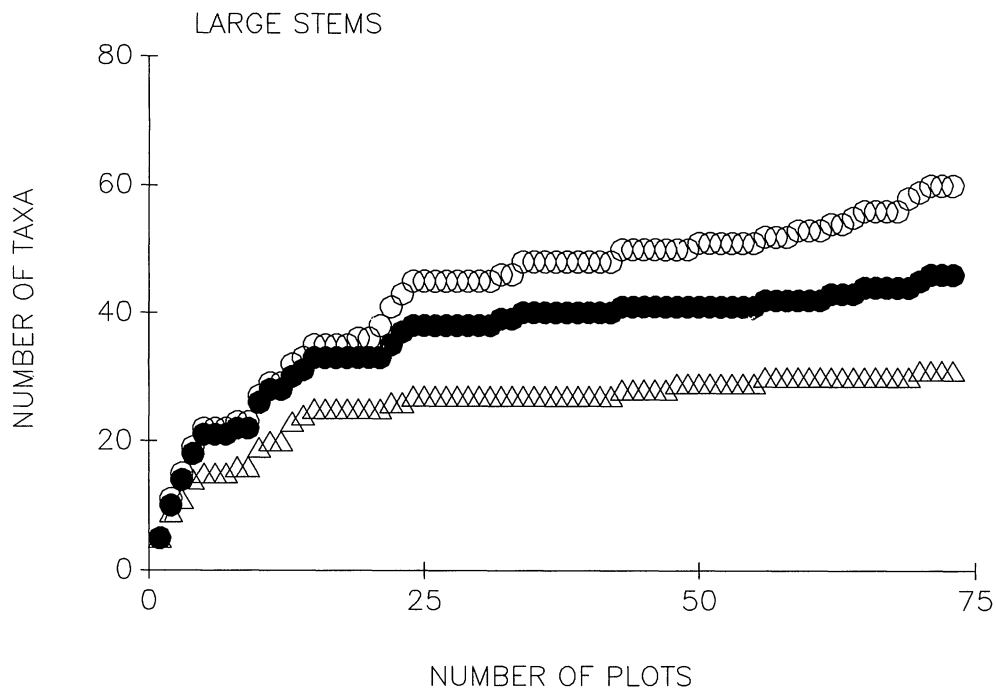
Figure 5. Dominance-diversity curve for all medium and large trees (>10 cm dbh) in the study area in the Monteverde Cloud Forest. The relative basal area of each species (sum of the basal area for each species divided by the total calculated basal area) is plotted against the species rank.

Table 3. The three taxa with the highest stem density for large (>30 cm dbh), medium (10–30 cm dbh) and small (2–10 cm dbh) size class of stems within the study area. Tree ferns were excluded because species could not be identified. Note that in only three cases (indicated by *), the dominant taxa in the large size class are represented in one of the smaller size classes.

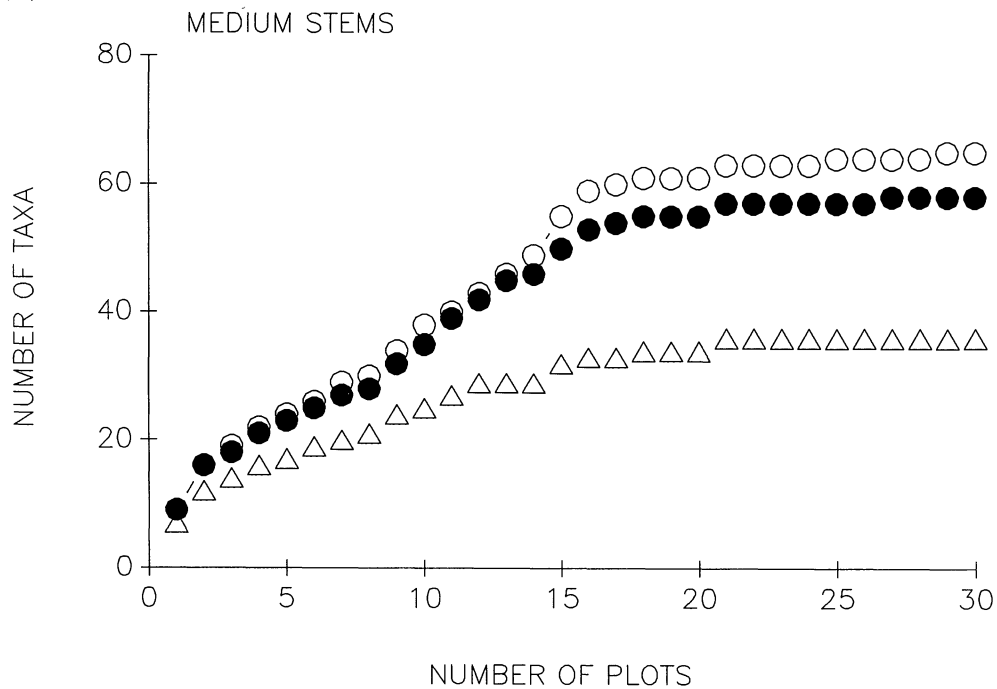
Stem size class		
Large	Medium	Small
Family		
Lauraceae*	Rubiaceae	Rubiaceae
Cecropiaceae*	Meliaceae	Asteraceae
Tiliaceae	Cecropiaceae	Lauraceae
Genus		
<i>Ocotea</i> *	<i>Guarea</i>	<i>Koanophyllon</i>
<i>Cecropia</i>	<i>Koanophyllon</i>	<i>Psychotria</i>
<i>Heliocarpus</i>	<i>Coussarea</i>	<i>Ocotea</i>
Species		
<i>Heliocarpus appendiculatus</i>	<i>Eugenia guatemalensis</i>	<i>Koanophyllon pittieri</i>
<i>Cecropia polyphlebia</i>	<i>Koanophyllon pittieri</i>	<i>Psychotria panamensis</i>
<i>Ocotea tonduzii</i>	<i>Coussarea austinsmithii</i>	<i>Inga longispica</i>

genera were 47, 57 and 65 and for species, 62, 68 and 79, demonstrating that many species occur at the site only as smaller stems (Table 2). There was little concordance of the dominant taxa between the size classes, i.e. the dominant three taxa of the largest size classes were among the dominant taxa of the smaller size classes in only three cases (Table 3).

(a)



(b)



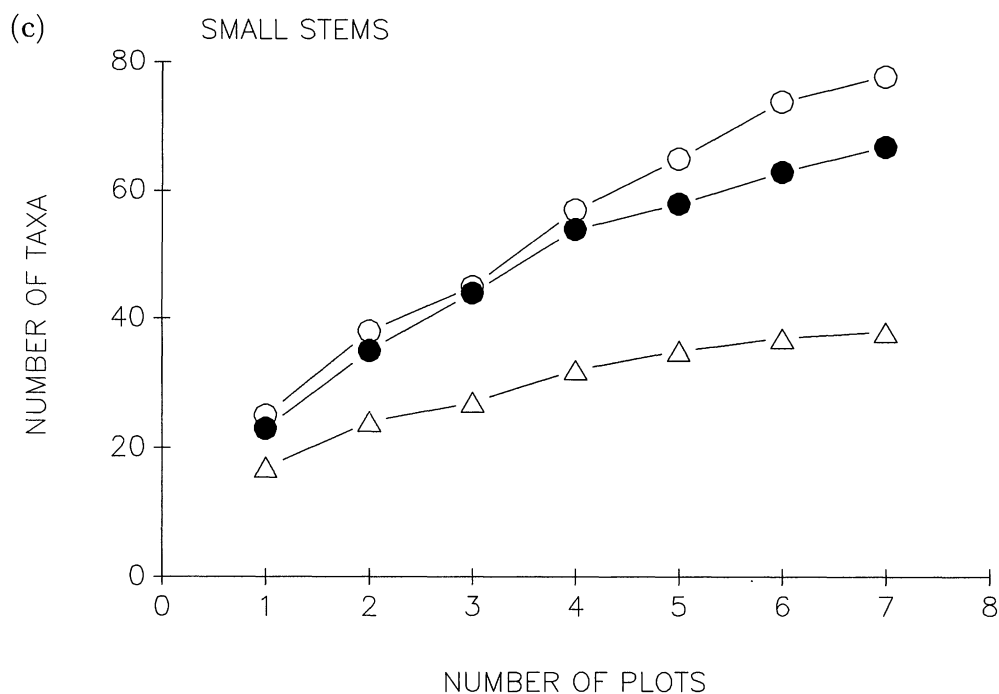


Figure 6. Taxa-area curves of large stems (a), medium stems (b) and small stems (c) in the study area in Monteverde Cloud Forest, Costa Rica. Open triangles represent number of families, closed circles represent number of genera, and open circles represent number of species tallied in the study area. Each plot is 400 m².

A noteworthy characteristic of this forest was dominance by Lauraceae (31% of the total basal area) (Table 2). Lauraceae commonly occurs elsewhere at this elevation, but has never been reported as being as predominant in forests at similar elevations (Heaney & Proctor 1990, D. & M. Lieberman, pers. comm.). Dominance of Lauraceae at this site may reflect the abundance of several avian dispersers of this family (e.g. the Resplendent Quetzal (*Pharomachrus mocinno*), Three-wattled Bellbird (*Procnias tricarunculata*) and Black Guan (*Chamaepetes unicolor*)) noted by Wheelwright *et al.* (1984).

Spatial variability

Stem densities and basal areas varied considerably between sub-plots. For stem density and basal area, variability was higher in the medium and large size class than in the small size class (Table 1). Spatial variability for richness at all taxonomic levels was highest in the large size class and lowest in the small size class of stems. Coefficients of variation (CV) for all these characteristics were lowest for the small size class stems (Table 1). The larger size classes of stems were more variable spatially than small stems, so a larger sample area would be needed to characterize composition and structural attributes of larger trees than small trees.

Comparisons with other studies

We compare the structural and floristic characteristics of our site with seven other studies of other areas identified as lower montane wet forest or lower montane rainforest (Table 4). Sampled areas in comparable studies ranged from 400 m² (Proctor *et al.* 1988) to 40,000 m² (this study). The densities we report for the medium (10–30 cm) and larger size classes fell in the middle of the range of densities reported elsewhere. Only one other study (Edwards 1977) reported a higher total basal area and species diversity than ours.

Vegetation at the 1500 m site on Volcan Barva, Costa Rica (Heaney & Proctor 1990), *c.* 40 km from our study area, presents the most interesting comparison with our site due to its geographical proximity and similar elevation and rainfall. It has a somewhat more recent geological history (Induni 1989). Stem density (trees >10 cm dbh) at the two sites was nearly identical (553 individuals ha⁻¹ at Barva, 559 at our site). However, basal area at Barva was 29.2 m² ha⁻¹, less than half that at our site (66.3 m² ha⁻¹) (Table 4). We identified twice as many species (111 total, Appendix 1) compared with the 65 species at Barva. Note that our values come from a larger area (3 ha *v.* 1 ha). However, in the one hectare for which identifications were determined for all stems >10 cm dbh at our site, the Monteverde forest was slightly richer in species and families (39 families and 76 species in Monteverde compared with 34 families and 65 species at Barva). There were 28 families for trees >10 cm dbh in common between the Monteverde and Barva sites; 18 families occurred only at the Monteverde site, and seven families occurred only at the Barva site.

Dominance was imposed by different taxa at the two sites. At Barva, the dominant family was Euphorbiaceae (14.5% of basal area), whereas this taxon comprised only 1.1% of the total basal area at our site. The dominant family at Monteverde, Lauraceae (31% of total basal area), comprised only 5.8% of the basal area at the Barva site. These differences may result from different forest disturbance regimes; the dominant trees at Barva tend to be early gap colonizers, in contrast to the long-lived primary forest trees which dominate in Monteverde. The much higher basal area (2.5 times greater) in Monteverde compared with Barva also suggests disturbance was more frequent. However, no direct comparable measurements of forest dynamics for the two sites exist at this time.

The current data on tropical montane forests suggest that similar elevation and environmental conditions do not dictate similar structure and floristics in tropical montane vegetation. A larger body of information on the environmental factors, especially those that influence patterns of disturbance and regeneration, are necessary to explain the great variation exhibited in tropical montane forests.

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We thank the Tropical Science Center and the Monteverde Cloud Forest Reserve for access to, and protection of, the field site, E. Bello for help with

Table 4. Structural and floristic characteristics of seven tropical montane cloud forests. nr = not reported.

Location	Forest type	Elevation (m)	Annual rainfall (mm)	Plot size (m ²)	Tree density (ha ⁻¹)	Basal area (m ² ha ⁻¹)	Tree species richness (sp. ha ⁻¹)	Source
Luquillo Mountains, Puerto Rico	Colorado Lower montane Wet	725	3725	4000	185 ^a	40	40	Weaver & Murphy 1990
Volcan Barva, Costa Rica	Lower montane Wet	1500	3426	10000	553 ^b	29.2	65	Heaney & Proctor 1990
Blue Mountains, Jamaica	Mull Ridge	1550	3000	1000 ^c	52 ^b	nr	35	Tanner 1977
Papua New Guinea	Lower montane Rain	2500	3960	600 ^d	19 ^e	98	119	Edwards 1977, Edwards & Grubb 1977
Ecuador, Eastern Andes	Lower montane Rain	1710	nr	465 ^f	28 ^e 46 ^b	nr	59 ^e	Grubb <i>et al.</i> 1963
Gunung Silam, Sabah	Lower montane	870	2011	400	1596 ^b	26.7	19	Proctor <i>et al.</i> 1988
Monteverde, Costa Rica	Lower montane Wet	1480	2500	40000	1507 ^g 396 ^h 159 ⁱ 2062 ^j	11.8 ^g 9.6 ^h 52.4 ⁱ 73.8 ^j	111	This study

^a stems >4 cm dbh^b stems >10 cm dbh^c ten 10 m × 10 m plots^d three 20 m × 10 m plots^e stems >20 cm dbh^f one 61 m × 7.6 m plot^g stems 2–10 cm dbh^h stems 10–30 cm dbhⁱ stems >30 cm dbh^j stems >2 cm dbh

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Appendix 1. Species list for plants identified from the study plot. Nomenclature follows Haber (1991).

Family	Genus and Species
Annonaceae	<i>Guatteria verrucosa</i> R. E. Fries
Apocynaceae	<i>Tabernaemontana</i> cf. <i>longipes</i> J. D. Smith
Aquifoliaceae	<i>Ilex lamprophylla</i> Standley
Araliaceae	<i>Dendropanax querceti</i> J. D. Smith
Arecaceae	<i>Oreopanax xalapensis</i> (Kunth) Decne. & Planchon
	<i>Bactris</i> cf. <i>mexicana</i> Mart.
	<i>Chamaedorea tepejilote</i> Liebm.
	<i>Geonoma seleri</i> Burret
Asteraceae	<i>Prestoea longepetiolata</i> (Oersted) H. Moore
	<i>Koanophyllon pittieri</i> (Klatt) R. King & H. Robinson
Bombacaceae	<i>Ouararibea costaricensis</i> Alv.
Boraginaceae	<i>Bourreria costaricensis</i> (Standley) A. Gentry
	<i>Cordia cymosa</i> (J. D. Smith) Standley
	<i>Cordia</i> cf. <i>lucidula</i> I. M. Johnston
Cecropiaceae	<i>Tournefortia glabra</i> L.
	<i>Cecropia polyphlebia</i> J. D. Smith
Celastraceae	<i>Maytenus</i> cf. <i>schippii</i> Lundell
	<i>Perrottetia longistylis</i> Rose
	<i>Symphonia globulifera</i> L. f.
Clusiaceae	<i>Tovomitopsis allenii</i> Maguire
	<i>Tovomitopsis psychotriifolia</i> Oersted, Planchon & Triana
	<i>Weinmannia pinnata</i> L.
Cunoniaceae	<i>Weinmannia wercklei</i> Standley
Cyatheaceae	Fern spp.
Ebenaceae	<i>Diospyros</i> sp. nov.
Elaeocarpaceae	<i>Sloanea brenesii</i> Standley
	<i>Sloanea faginea</i> Standley
Euphorbiaceae	<i>Alchornea latifolia</i> Sw.
	<i>Sapium oligoneurum</i> Schumann & Pittier
Fabaceae	<i>Dussia macrophyllata</i> (J. D. Smith) Harms.
	<i>Inga hintoni</i> Sandw.
	<i>Inga longispica</i> Standley
	<i>Inga mortoniana</i> Leon
	<i>Inga qqaternata</i> Poeppig
	<i>Inga tonduzii</i> J. D. Smith
	<i>Lonchocarpus</i> sp. nov.
	<i>Pithecellobium costaricense</i> (Britton & Rose) Standley
	<i>Casearia tacanensis</i> Lundell
	<i>Hasseltia floribunda</i> Kunth
<i>Macrohasseltia macroterantha</i> (Standley & L. O. Williams) L. O. Williams	
<i>Xylosma oligandra</i> J. D. Smith	
Hippocrateaceae	<i>Salacia</i> cf. <i>petenensis</i> Lundell
Icacinaceae	<i>Calatola costaricensis</i> Standley
Juglandaceae	<i>Alfaroa costaricensis</i> Standley
Lauraceae	<i>Beilschmiedia brenesii</i> Allen
	<i>Beilschmiedia pendula</i> (Sw.) Hemsley
	<i>Nectandra</i> cf. <i>salicina</i> Allen
	<i>Nectandra smithii</i> Allen
	<i>Ocota floribunda</i> (Sw.) Mez
	<i>Ocotea meziana</i> Allen
	<i>Ocotea pittieri</i> (Mez) van der Werff
	<i>Ocotea tonduzii</i> Standley
	<i>Ocotea valeriana</i> (Standley) W. Burger
	<i>Persea americana</i> Miller
	<i>Persea</i> cf. <i>nubigena</i> L. O. Williams
	<i>Pleurothyrium palmanum</i> (Mez + J. D. Smith) Rohwer
	Malpighiaceae
<i>Bunchosia veluticarpa</i> W. R. Anderson, ined.	

Malvaceae	<i>Hampea appendiculata</i> (J. D. Smith) Standley
	<i>Malvaviscus palmanus</i> Pittier & J. D. Smith
Melastomataceae	<i>Centronia phlomoides</i> Triana
	<i>Conostegia rufescens</i> Naudin
	<i>Miconia brenesii</i> Standley
	<i>Ossaea micrantha</i> (Sw.) Macfad. ex Cogn.
Meliaceae	<i>Guarea bullata</i> Radlk.
	<i>Guarea glabra</i> Valh.
	<i>Guarea kunthianba</i> A. Juss
	<i>Guarea rhopalocarpa</i> Radlk.
	<i>Ruarea glabra</i> Triana & Planchon
	<i>Trichilia havanensis</i> Jacq.
Moraceae	<i>Ficus crassiuscula</i> Warb. ex Standley
	<i>Ficus hartwegii</i> (Miq.) Miq.
	<i>Ficus macbridei</i> Standley
	<i>Ficus tuerckheimii</i> Standley
	<i>Ficus velutina</i> Humb. & Bonpl. ex Willd.
	<i>Pseudolmedia oxyphyllaria</i> J. D. Smith
	<i>Sorocea trophoides</i> W. Burger
Myrsinaceae	<i>Ardisia palmana</i> J. D. Smith
	<i>Parathesis</i> sp. nov.
Myrtaceae	<i>Calyptanthes pittieri</i> Standley
	<i>Eugenia</i> cf. <i>guatemalensis</i> J. D. Smith
	<i>Eugenia</i> cf. <i>valerii</i> Standley
	<i>Myrcia splendens</i> (Sw.) DC.
	<i>Myrcianthes</i> cf. <i>fragrans</i> (Sw.) McVaugh
Nyctaginaceae	<i>Neea amplifolia</i> J. D. Smith
Piperaceae	<i>Piper austinii</i> Trel.
	<i>Piper euryphyllum</i> C. DC.
Proteaceae	<i>Panopsis suaveolens</i> (Klatt & Karsten) Pittier
Rhizophoraceae	<i>Cassipourea elliptica</i> Sw.) Poirét
Rubiaceae	<i>Chione sylvicola</i> (Standley) W. Burger & C. Taylor ined.
	<i>Cousarea austinii</i> Standley
	<i>Elaeagia auriculata</i> Hemsley
	<i>Guettarda poasana</i> Standley
	<i>Hoffmannia psychotriifolia</i> (Benth.) Griseb.
	<i>Hoffmannia ramonensis</i> Standley
	<i>Psychotria panamensis</i> Standley
	<i>Randia</i> sp. nov.
Rutaceae	<i>Zanthoxylum procerum</i> J. D. Smith
Sabiaceae	<i>Meliosma idiopoda</i> S. F. Blake
	<i>Meliosma vernicosa</i> (Liebm.) Griseb.
Sapindaceae	<i>Matayba</i> sp. nov.
Sapotaceae	<i>Pouteria exfoliata</i> Penn.
	<i>Pouteria fossicola</i> Cronq.
	<i>Pouteria reticulata</i> (Engl.) Eyma
Simaroubaceae	<i>Picramnia teapensis</i> Tul.
Solanaceae	<i>Cestrum megalophyllum</i> Dunal
	<i>Cuatresia riparia</i> (Kunth) Hunz.
	<i>Solanum ramonense</i> C. Morton & Standley
	<i>Solanum rovirosanum</i> J. D. Smith
	<i>Turpinia occidentalis</i> (Sw.) Don
Staphyleaceae	<i>Symplocos costaricana</i> Hemsley
Symplocaceae	<i>Daphnopsis americana</i> (Miller) J. Johnston
Thymelaeaceae	<i>Heliocarpus appendiculatus</i> Turcz.
Tiliaceae	<i>Urera caracasana</i> (Jacq.) Griseb.
Urticaceae	<i>Citharexylum viride</i> Mold.
Verbenaceae	