MISSOURI
BOTANICAL
GARDEN

Allpahuayo: Floristics, Structure, and Dynamics of a High-Diversity Forest in Amazonian Peru

Author(s): Rodolfo Vasquez Martinez and Oliver L. Phillips

Reviewed work(s):

Source: *Annals of the Missouri Botanical Garden*, Vol. 87, No. 4 (Autumn, 2000), pp. 499-527

Published by: [Missouri Botanical Garden Press](#)

Stable URL: <http://www.jstor.org/stable/2666143>

Accessed: 12/07/2012 11:15

Your use of the JSTOR archive indicates your acceptance of the Terms & Conditions of Use, available at

<http://www.jstor.org/page/info/about/policies/terms.jsp>

JSTOR is a not-for-profit service that helps scholars, researchers, and students discover, use, and build upon a wide range of content in a trusted digital archive. We use information technology and tools to increase productivity and facilitate new forms of scholarship. For more information about JSTOR, please contact support@jstor.org.

Missouri Botanical Garden Press is collaborating with JSTOR to digitize, preserve and extend access to *Annals of the Missouri Botanical Garden*.

<http://www.jstor.org>

ALLPAHUAYO: FLORISTICS, STRUCTURE, AND DYNAMICS OF A HIGH-DIVERSITY FOREST IN AMAZONIAN PERU¹

Rodolfo Vásquez Martínez² and
Oliver L. Phillips³

ABSTRACT

This paper describes the results of a floristic inventory at the Allpahuayo Reserve, near Iquitos in Amazonian Peru. Two long-term one-hectare plots were established using a pre-determined sampling grid, with each individual tree and liana over 10 cm diameter collected at least once, except for palms. The plots were re-censused after 5 years to quantify forest dynamics. Floristic analysis shows that the Allpahuayo forest is among the most diverse site yet inventoried, with 281 to 311 species per hectare, and at least 466 species and 61 families in the 1277-stem two-hectare sample, confirming that upper Amazonia is a world center of tree biodiversity. The ecologically most dominant and speciose family in the plots is Fabaceae sensu lato, with 231 stems and 89 species; no other family represents more than 7% of the species or 10% of the stems. In contrast to the exceptional floristic diversity, both the structure and the dynamics of the Allpahuayo forest are similar to those recorded from other old-growth neotropical forests. Many tree and liana canopy species were previously unknown to both the Iquitos area and to Amazonian Peru, which demonstrates the significance of Amazon ecological studies to systematic botany.

RESUMEN

Este documento describe el estado actual de los resultados de un inventario florístico a largo plazo, en la Reserva Biológica de Allpahuayo, cerca de Iquitos, en la Amazonía Peruana. Allí se establecieron dos parcelas de una hect. cada una, usando un muestreo pre-determinado, cada árbol, palmera o liana, mayores o iguales que 10 cm de diám. fué marcado y colectado, excepto las palmeras que fueron colectadas solo una vez por especie. Las parcelas fueron re-censadas despues de 5 años para cuantificar el proceso de la dinámica del bosque. El análisis de los resultados nos muestra que el bosque de Allpahuayo, está entre los bosques mas diversos hasta ahora inventariados, con 281 a 311 especies por hect., y al menos 466 especies y 61 familias en 1277 individuos en dos hect. muestreadas; éstos datos apoyan la idea de que el oeste de la Amazonía es un centro mundial de diversidad de árboles. En las parcelas la familia Fabaceae s.l., es la mas dominante ecologicamente y en número de especies, contiene 231 tallos y 89 especies; ninguna otra familia representa más que el 7 por ciento de las especies o el 10 por ciento de los tallos. En contraste a la excepcional diversidad florística, tanto la estructura del bosque como la tasa de mortalidad en Allpahuayo, están dentro los rangos de otros sitios neotropicales. El valor de los estudios ecológicos para la botánica sistemática, se demuestra en tanto que, antes de que empezáramos a tomar datos ecológicos e instalar parcelas permanentes, muchas especies de árboles y lianas eran desconocidas tanto en el área de Iquitos, como en la Amazonía Peruana.

Key words: Amazonia, floristics, inventory, Neotropics, species richness, species turnover.

¹ We gratefully acknowledge the help of institutional support from Instituto de Investigaciones de la Amazonía Peruana (IIAP) for permission to work in Allpahuayo Reserve and for logistical support for our work; the John D. and Catherine T. MacArthur Foundation for long-term support of the Missouri Botanical Garden's floristic and ecological research at Allpahuayo and elsewhere in Peruvian Amazonia; the National Geographic Society for support for forest dynamics research in Amazonian Peru (grant #5472-95), and the U.K. Natural Environment Research Council for a Research Fellowship (OP). Melchor Aguilar, César Grández, Rosa Ortiz de Gentry, Nestor Jaramillo, Dennis Milanowski, John J. Pipoly III, Peggy Stern, Henk van der Werff, and Arturo Vásquez Martínez assisted in establishing, inventorying, and re-censusing the Allpahuayo plots. Herbarium determinations were provided by numerous systematists at MO and other herbaria, and we are especially grateful to: C. C. Berg (BG); T. Pennington, Sir G. Prance (K); A. Chanderbali, R. Gereau, R. Liesner, J. J. Pipoly III, G. Schatz, C. Taylor, M. Timaná, H. van der Werff, and the late A. H. Gentry (MO); D. Daly, S. Mori, and M. Stern (NY). The maps were drawn by A. Manson at the School of Geography Graphics Unit, University of Leeds. We thank V. Hollowell, Sir G. Prance, and H. van der Werff for their constructive suggestions to improve our manuscript.

² Missouri Botanical Garden, Apartado 020, Jaén, Cajamarca, Peru.

³ Centre for Biodiversity and Conservation, School of Geography, University of Leeds, Leeds LS2 9JT, U.K.

Figure 1. Map showing location of study region in relation to Iquitos and Peru. —A. Peru. —B. Iquitos region, showing location of Allpahuayo. Modified from Kalliola et al. (1998).

Biodiversity is at risk in much of the tropics. Yet biological research and conservation initiatives are hampered by inadequate baseline information. Thus, sufficient data on the numbers, kinds, and abundance of most major plant and animal taxa are not available. Moreover, knowledge of species associations and biogeographic distributions of taxa remain meager (McNeely et al., 1990; National Science Board, 1990; National Research Council, 1992; Phillips & Raven, 1996).

In the Neotropics, the extraordinary species richness, our limited taxonomic understanding, and the physical inaccessibility of most areas are formidable barriers to phytogeographic investigation. Traditional biological inventory efforts that rely mostly on ad hoc collection efforts and lengthy monograph studies cannot address the knowledge gap alone. Alternative methods are critical to improve our understanding of the factors determining species composition and the ecological dynamics of tropical forest ecosystems. In recent years there has been growing scientific interest in more ecological, plot-based work as a means of understanding tropical forests (e.g., Gentry, 1988a, b; Phillips & Gentry, 1994; Phillips et al., 1994; Dallmeier & Comiskey, 1998a, b). This approach can contribute greatly to

floristic understanding by generating large numbers of new collections that are associated with site-specific ecological information. Botanical institutions play a vital role in initiating and supporting this work, and contribute essential expertise for ensuring accurate voucher determination. Equally, ecological inventories generate much biogeographical data of relevance to monographic and phylogenetic studies. Such eco-floristic research has recently been initiated in several tropical countries, including Madagascar (Lowry et al., 1997; Rakotomalaza & Messmer, 1999), Colombia (Rudas, 1996), and Peru (Gentry, 1988a, b). This paper reports the results of a similar research program at the Allpahuayo Reserve, near Iquitos in northern Peru.

STUDY SITE

The Allpahuayo Reserve (3°57'S, 73°26'W) lies southwest of Iquitos in Amazonian Peru, between the blackwater Rio Nanay on the northwest and the Iquitos–Nauta road to the southeast (Fig. 1). This 2750-ha reserve is administered by the Peruvian Institute for Amazonian Research (IIAP). The climate is humid and hot (with the mean annual precipitation about 3000 mm and an average temper-

Figure 2. Diagram showing the arrangement of plots within a 500 x 500 m sampling grid at Allpahuayo. The permanent 500 x 20 m plots ("1" and "2") are located at the edges of the grid. Additional parallel temporary samples of 500 x 2 m were established 100 m in from the edges (Transects "E" and "U," shaded in the figure). For comparison we also show the relative positions of additional 500 x 20 m plots that incorporate transects "E" and "U" at other sites in Peru (Cusco Amazónico and Sucusari/ACEER) but not at Allpahuayo.

ature of 26°C; Marengo, 1998). Allpahuayo Reserve lies between 110 m and 180 m above sea level. Edaphic conditions are variable, representing a mosaic of patches ranging in texture from clayey to almost pure sand, and in drainage from water-logged swamps to well-drained hill tops. Vegetation is mature, old-growth forest, although some palm trees (*Oenocarpus bataua* Mart.) have been cut to harvest their fruits. Allpahuayo and neighboring Mishana comprise one of three locations within 100 km of Iquitos where the Missouri Botanical Garden has been conducting a long-term floristic inventory effort with the institutional collaboration of IIAP and Explorama Tours S.A. (Vásquez, 1997). The other two sites, Reserva Ecológica Explorama Lodge (Yanamono) and Reserva Ecológica Sucusari (ACEER), have rather different soil conditions and floristic composition. The 3750 ha of Allpahuayo-Mishana is extremely species-rich, with more than 10% of the plant species reported from the whole of Peru (Brako & Zarucchi, 1993) recorded here (Vásquez, 1997).

METHODS

Sampling took place within a 500 × 500 m grid in the Allpahuayo Reserve, sufficiently far from the Iquitos-Nauta road (> 2 km at its nearest point) to minimize human disturbance, yet close enough to the research station (3 km) to allow us to commute daily. Within the sampling grid, two long-term plots were established in a pre-determined location within the grid (Fig. 2) to eliminate subjective bias. Each plot is 20 × 500 m, with each plant ≥ 10 cm DBH (diameter at breast height, 1.3 m) marked with sequentially numbered aluminum tags. Additional narrower samples of 2 × 500 m with all plants ≥ 2.5 cm DBH collected but not tagged were made at pre-determined points in the grid: the results of these inventories will be reported in a future publication. The linear nature of all our plots means that they each traverse a mixture of edaphic formations. Soil conditions within the grid ranged from poorly to adequately drained clay soils ("Shapaja") to well-drained white sand soils at topographic high points ("Varillal").

In the long-term plots, every tagged plant's height was visually estimated and its diameter measured at 1.3 m with diameter tape. Herbarium collections (Vásquez 14592–15829) were made in 1990 and 1991 from every individual plant (except for palm tree species, which were only collected once each) using extendable aluminum collecting poles and, where necessary, spiked climbing irons for climbing trees. A full set of duplicates is de-

posited in two Peruvian herbaria (AMAZ, USM) and at MO, with partial collections existing at IIAP and the Universidad Agraria La Molina (MOL), as well as distributions to family specialists worldwide.

Fertile collections were made on occasion whenever flowers or fruits of plot species were seen, but in common with other tropical plot inventories most species (90%) are represented only by sterile material. At MO every collection number was first identified to family by the first author and Ron Liesner, with each family set then distributed to family specialists (Anacardiaceae, Apocynaceae, Bignoniaceae, Burseraceae, Chrysobalanaceae, Dilleniaceae, Fabaceae, Lauraceae, Lecythidaceae, Malpighiaceae, Melastomataceae, Meliaceae, Moraceae, Myrtaceae, Rubiaceae, Sabiaceae, Sapindaceae, Sapotaceae, Simaroubaceae, Violaceae). For most species at least three fertile Peruvian collections were noted for verification (MO), most deriving from the Iquitos Florula project (Vásquez, 1997).

Re-census of both plots was done in February 1996, with the re-measurement of all trees and lianas. Plants that had died in the intervening period of 5.25 years were noted as such, with evident cause of death. Each new recruit into the 10 cm DBH class was measured, tagged, and given a unique number. New recruits were collected and vouchers distributed to herbaria as for the original collections.

In order to maximize potential comparability with other forests, diversity values for each plot were expressed in terms of both species richness and Fisher's Alpha, using various subsets of our data. We estimated "species richness"—the sum of the number of tree species—as this measure is easily understood and widely reported from other forests. We also estimated Fisher's Alpha, where:

$$\text{species richness} = \text{Alpha} * \ln(1 + \text{stems/Alpha})$$

Fisher's Alpha values from small tropical forest tree samples provide good estimates of the overall diversity of each forest (Condit et al., 1998). Both species richness and Fisher's Alpha values were calculated on a per-area basis (i.e., for each one-hectare plot), and on an area-independent basis (i.e., for the first 500 stems encountered in each plot) in order to remove the complicating effect of varying stem density. Finally, each diversity index was also estimated separately for all woody stems, and for trees alone.

In order to compare stem densities of individual species and families, average per-hectare values were calculated. The most speciose families across

Table 1. Allpahuayo forest diversity in 1990, for stems ≥ 10 cm diameter in 1-ha plots. The values given for species richness and Fisher's Alpha are for the minimum and the most likely (underlined) estimates, respectively. The diversity values are calculated for (A) all woody stems (i.e., trees and lianas), and (B) for trees only. See text for further details.

	Stems	Species	Fisher's Alpha	Species per first 500 stems	Fisher's Alpha, first 500 stems
(A) All woody stems					
Plot 1	643	281/293	190/208	233/242	170/185
Plot 2	634	306/ <u>311</u>	233/242	250/255	199/208
Plots 1 and 2 combined	1277	466/ <u>480</u>	264/280	N/A	N/A
(B) Trees only					
Plot 1	616	264/275	175/191	228/237	162/176
Plot 2	608	290/295	218/226	243/248	186/195
Plots 1 and 2 combined	1224	433/ <u>444</u>	239/250	N/A	N/A

our whole sample were tabulated on the basis of the total species recorded in both hectare plots. The degree of departure from randomness in species' distribution with respect to soil type was explored using a binomial test based on the relative frequency with which individuals were recorded in clay soil and sandy soil forests.

Standard measures of forest structure (density of stems and total basal area of stems ≥ 10 cm DBH) were computed for each hectare plot. Annual mortality and recruitment rates were estimated using standard procedures that use logarithmic models that assume a constant probability of mortality and recruitment through each inventory period (Phillips et al., 1994; Swaine & Lieberman, 1987), and computed separately both for woody stems and for woody basal area. Turnover rates for each period were represented by the mean of recruitment and mortality rates (Phillips, 1996).

RESULTS AND DISCUSSION

(A) TAXON IDENTIFICATION

Of the 1277 plants in the plots in 1991, 100% were identified to family, 1249 (97.8%) to genus, and 1168 (91.5%) to species (Appendix 1). We made 1160 collections from the two plots, of which 1053 (90%) were sterile, 22 (2%) were in bud, 33 (3%) were in flower, and 52 (5%) were in fruit. The high proportion of sterile material complicated the identification process. Near-complete identification was possible only because of the large number of fertile collections from Allpahuayo and nearby localities available for comparison at MO. For most of the unidentified species, it was possible to allocate collections to morphospecies (i.e., to allocate collections to a morphological species concept, al-

beit unnamed), but for a few even this was not possible.

(B) SPECIES RICHNESS AND DIVERSITY

Because of the difficulties with identification there is some uncertainty about the exact number of species in our samples. We estimated a "most likely value" for species richness ($\hat{S}$) by multiplying the number of unidentified plants per sample that could not be allocated to morphospecies (U) by the ratio of species:individuals for the plants in that sample that were identified to species or morphospecies (R), and adding this value to the number of morphospecies and species concepts actually distinguished (D).

$$\text{Thus, } (\hat{S} = (U * R) + D.$$

This estimate probably errs on the conservative side because the most difficult plants to identify tend to be the rarest, and therefore it is likely that the ratio of species to individuals will be greater for non-identified plants than it is for identified plants.

Diversity values for each plot and for both plots combined are presented in Table 1, with results given separately for all stems and for trees alone. These reveal that the Allpahuayo plots are some of the richest 1-ha samples ever reported. The best estimate of Fisher's Alpha for trees in our plot 2 (226) is the greatest value ever recorded for trees ≥ 10 cm DBH in 1-ha plots, comparing with 221 at Yanamono in Peru (Condit et al., 1998), 211 at Cuyabeno in Ecuador (Condit et al., 1998), and 191 in Allpahuayo plot 1 (this study), all of which are upper Amazonian sites. In terms of published results of numbers of species per 500 stems, the All-

pahuayo plots are surpassed only by Yanamono (Phillips et al., 1994). There are also some published inventory results of, variously, lianas, hemiepiphytes, trees, and saplings from this part of Amazonia (e.g., Gentry, 1988a, b, 1992; Valencia et al., 1994; Clinebell et al., 1995; Duivenvoorden & Lipps, 1995). These confirm that the region's unflooded forests generally have globally exceptional levels of diversity for woody plants.

Within-community ("alpha-") diversity in neotropical forests is closely correlated with climatic conditions, with the richest forests found in the hot and aseasonal equatorial lowlands (Clinebell et al., 1995). High levels of local diversity may also be a consequence of close juxtaposition of different topographical and soil formations in western Amazonia (Tuomisto et al., 1995) with "mass-effect" processes causing species to spill over from adjacent edaphically defined communities. Each Allpahuayo plot traverses contrasting substrates, of sandy and clayey soils, which contributes to the high diversity values, as some species are apparently specialized on each particular soil type (cf. (c) below). However, the Allpahuayo plots were placed without regard to forest type, so these diversity values are presumably typical for most 1-ha patches within the Allpahuayo forest. Data are also available from one 0.1-ha sample of plants ≥ 2.5 cm DBH, purposively laid out at Allpahuayo by A. Gentry and the first author so as to only sample clay soil forest (Clinebell et al., 1995; http://www.mobot.org/MOBOT/research/applied_research/gentry.html). Here 275 species of trees, lianas, and hemiepiphytes were found in 401 individuals, giving a Fisher's Alpha value of 386, the highest species richness and Fisher's Alpha value of all Gentry's 227 0.1-ha samples worldwide (Phillips & Miller, in prep.).

(C) FLORISTIC COMPOSITION

The Allpahuayo forest is not only very species-rich, but also has a very low degree of dominance by any one species. The ten most common species together represent less than 20% of all stems (Table 2A). Most of the families that physically dominate the forest (Table 2B), such as Fabaceae, Myristicaceae, Euphorbiaceae, Sapotaceae, and Moraceae, do so by virtue of having many species almost all of which are present at a very low density. The palm family is atypical in that its status as the second-most stem-dense family is due mostly to the high density of one species (*Oenocarpus bataua* Mart.).

The most speciose families in our entire Allpahuayo sample (Table 2C) are the same families that

dominate other Amazonian forests (Gentry, 1988a). Fabaceae are by far the most species-rich, and even when treated individually the three legume subfamilies each have about as many species as the other top-five largest families (Moraceae, Lauraceae, Annonaceae, Burseraceae).

The plots each traverse two contrasting soil types, richer clay soils (the "Shapaja" series) and poor white sand soils (the "Varillal" series), and the strong local edaphic contrasts might be expected to result in some floristic differentiation within the plots. Because of the high diversity, few species were sampled frequently enough in the two plots to allow us to test the extent to which they are habitat specialists or generalists. However, among the 56 species that were relatively common, with five or more individual plants in the two hectares, a binomial test reveals that a greater number are confined to one soil type or another than would be expected under a null model of random distribution (Table 3). This analysis reveals a large number of species that are apparent specialists on the poor white sand soils (for example, *Macrolobium microcalyx*, *Ocotea aciphylla*, *Tachigali ptycophysca*, Table 3A), and a smaller group mostly confined to the relatively rich clay soils (for example, *Leonia glycyarpa*, *Lindackeria paludosa*, *Senefeldera skutchiana*, Table 3B). Note that these results are not proof of specialization, since apparent specialists could arguably be constrained to one patch of forest by chance alone, especially if they have poor dispersal mechanisms. However, a parallel study at Allpahuayo (Vormisto et al., 2000) demonstrated that the local-scale distributional pattern of soil types is closely related to plant distributional patterns, not only for tree species but for other plant groups as well, and these spatial patterns are congruent among different groups. This research confirms that the local distributional patterns of many plants within the Allpahuayo plots are influenced by edaphic conditions. The high diversity of the Allpahuayo plots is therefore not only due to high intra-community diversity, but also derives from the contrasting edaphic conditions evident within each plot.

(D) STRUCTURE AND DYNAMICS

Although the Allpahuayo plots are exceptionally species-rich, they do not appear to be particularly remarkable in terms of their physical structure. This is indicated by the fact that both their stem density and tree basal area appear to be well within the typical ranges for most lowland Amazonian forests (Table 4). However, we could find no published

Table 2. Dominant woody plant taxa at Allpahuayo.

A. The 10 species with the highest density of stems $\geq$ 10 cm diameter per hectare, on average and by soil type. The two plots included 1.16 ha of clay soil forest, and 0.84 ha of sandy soil forest.				
Family	Genus	Stem density	Stem density, clay soil forest	Stem density, sandy soil forest
Palmae	<i>Oenocarpus bataua</i> subsp. <i>bataua</i>	39.0	26.3	55.2
Myristicaceae	<i>Iryanthera ulei</i>	14.5	8.8	20.8
Myristicaceae	<i>Virola pavonis</i>	11.5	11.3	14.6
Euphorbiaceae	<i>Hevea guianensis</i>	10.0	1.3	18.8
Fabaceae	<i>Macrolobium microcalyx</i>	9.5	0	19.8
Annonaceae	<i>Diclinanona tessmannii</i>	7.5	0	15.6
Euphorbiaceae	<i>Micranda elata</i>	7.5	0	15.6
Euphorbiaceae	<i>Senefeldera skutchiana</i>	7.5	17.5	1.0
Apocynaceae	<i>Aspidosperma excelsum</i>	7.0	1.3	12.5
Palmae	<i>Astrocaryum macrocalyx</i>	7.0	16.3	1.0
Top 10 species		121.0	82.8	175.9
All species		638.5	637	640
B. The 10 families with the highest density of stems $\geq$ 10 cm diameter per hectare.				
Family	Stem density			
Fabaceae:	115.5			
Caesalpinjiaceae	53.0			
Mimosaceae	23.5			
Papilionaceae	36.5			
Indet. Fabaceae	2.5			
Palmae	61.5			
Myristicaceae	59.0			
Euphorbiaceae	56.5			
Sapotaceae	33.0			
Moraceae	30.5			
Annonaceae	27.0			
Lauraceae	26.5			
Burseraceae	21.5			
Lecythidaceae	16.0			
Top 10 families	420.0			
All families	638.5			
C. The 10 families with the highest number of species $\geq$ 10 cm diameter sampled throughout our 2-ha sampled area. The values given are for the minimum and most likely (underlined) number of species per family.				
Family	Total species inventoried			
Fabaceae:	82/89			
Caesalpinjiaceae	27/29			
Mimosaceae	25/28			
Papilionaceae	28/29			
Indet. Fabaceae	2/3			
Moraceae	31/31			
Lauraceae	29/29			
Annonaceae	27/27			
Burseraceae	23/24			
Euphorbiaceae	23/23			
Sapotaceae	22/23			
Myristicaceae	21/21			
Lecythidaceae	14/14			
Myrtaceae	10/12			
Top 10 families	262/273			
All families	433/444			

Table 3. Edaphic specialists in the Allpahuayo plots. For all species with five or more individuals, a binomial test was conducted to test the null hypothesis of random distribution with respect to soil type. The hypothesis was rejected for half the 56 species tested (* ($P < 0.05$); ** ($P < 0.01$); *** ($P < 0.001$)). See text for further details.

A. Specialists on white sand (“Varillal” soils).

Family	Taxon	Total stems	Shapaja stems	Varillal stems	Probability of random distribution
Annonaceae	<i>Diclinanona tessmannii</i>	15	0	15	***
Apocynaceae	<i>Aspidosperma excelsum</i>	14	1	12	**
Bignoniaceae	<i>Jacaranda macrocarpa</i>	5	0	5	*
Euphorbiaceae	<i>Hevea guianensis</i>	20	1	18	***
Euphorbiaceae	<i>Micranda elata</i>	15	0	15	***
Fabaceae (Caes.)	<i>Macrolobium bifolium</i>	8	0	8	**
Fabaceae (Caes.)	<i>Macrolobium microcalyx</i>	19	0	19	***
Fabaceae (Caes.)	<i>Sclerolobium bracteosum</i>	5	0	5	*
Fabaceae (Caes.)	<i>Tachigali ptychophysca</i>	10	0	10	***
Fabaceae (Caes.)	<i>Tachigali tesmannii</i> cf.	13	0	13	***
Fabaceae (Pap.)	<i>Swartzia racemosa</i> var. <i>klugii</i>	11	1	10	**
Icacinaceae	<i>Emmotum floribundum</i>	5	0	5	*
Lauraceae	<i>Ocotea aciphylla</i>	8	0	8	**
Malpighiaceae	<i>Byrsonima stipulina</i>	8	0	8	**
Myristicaceae	<i>Iryanthera ulei</i>	29	7	20	*
Nyctaginaceae	<i>Neea floribunda</i>	8	1	7	*
Palmae	<i>Oenocarpus bataua</i> subsp. <i>bataua</i>	78	21	53	***
Rosaceae	<i>Prunus detrita</i> vel sp. aff.	5	0	5	*
Rubiaceae	<i>Ferdinandusa chlorantha</i>	5	0	5	*
Sapotaceae	<i>Chrysophyllum bombycinum</i>	9	0	9	**

B. Specialists on clay (“Shapaja” soils).

Euphorbiaceae	<i>Conceveiba rhytidocarpa</i>	7	6	1	*
Euphorbiaceae	<i>Nealchornea yapurensis</i>	9	8	1	**
Euphorbiaceae	<i>Senefeldera skutchiana</i>	15	14	1	***
Flacourtiaceae	<i>Lindackeria paludosa</i>	6	5	0	*
Monimiaceae	<i>Siparuna decipiens</i>	5	5	0	*
Palmae	<i>Astrocaryum macrocalyx</i>	14	13	1	***
Palmae	<i>Iriartea deltoidea</i>	13	12	1	***
Violaceae	<i>Leonia glycyarpa</i> var. <i>glycyarpa</i>	8	6	0	*

Table 4. Stem density and basal area of some lowland Amazonian forests, for stems ≥ 10 cm diameter per ha. Data are from this study (Allpahuayo, 1990 census) or other sources (Mishana, Tambopata, Yanamono: Gentry, 1988b; Añangu, Jatun Sacha, Belém, San Carlos de Río Negro: Phillips et al., 1994; Cusco Amazónico: Phillips et al., unpublished data). Stem density values are per ha. Basal area values are m² per ha.

Site	Tree stem density	Liana and strangler stem density	Tree basal area	Liana and strangler basal area
Belém, Brazil	572		27.7	
Jatun Sacha, Ecuador	724		30.5	
Añangu, Ecuador	734		23.1	
Allpahuayo Plot 1, Peru	616	27	26.77	0.42
Allpahuayo Plot 2, Peru	608	26	27.33	0.27
Cusco Amazonico Plot 1, Peru	489	45	25.9	
Mishana, Peru	842	16	28.7	
Tambopata Plot 1, Peru	585	17	26.9	
Yanamono, Peru	580	26	32.7	
San Carlos de Río Negro, Venezuela	744		23.0	

Table 5. Annual rates of natural stem and basal area mortality, recruitment, and increment, for stems ≥ 10 cm diameter, between 1990 and 1996. All results are based on 0.84 ha (plot 1) and 0.96 ha (plot 2).

A. Stem dynamics.

	Annual mortality	Annual recruitment	Annual turnover (mean of loss and gain)
Plot 1: Tree stems	1.89%	1.57%	1.73%
Plot 2: Tree stems	1.84%	2.04%	1.94%
Plot 1: Liana and strangler stems	4.41%	1.89%	3.15%
Plot 2: Liana and strangler stems	4.87%	8.02%	6.44%

B. Basal area dynamics. Note that the annual gain in basal area is the sum of new recruitment into the 10 cm diameter size-class, plus the growth of pre-existing stems ≥ 10 cm diameter, and annual turnover is the mean of mortality and gain rates.

	Annual mortality	Annual recruitment	Annual gain	Annual turnover
Plot 1: Tree basal area	1.76%	0.48%	2.08%	1.92%
Plot 2: Tree basal area	2.21%	0.57%	2.32%	2.26%
Plot 1: Liana and strangler basal area	5.69%	1.03%	5.72%	5.71%
Plot 2: Liana and strangler basal area	8.29%	7.24%	8.57%	8.43%

data for liana basal area (lianas are rarely systematically censused in ecological plots, and liana basal area is even more rarely reported), so it is not possible to compare Allpahuayo with other forests in this respect. Elsewhere (Phillips et al., 1998) we reported that tree basal area values have been increasing in the majority of Amazonian plots censused since the mid-1970s, which we interpreted as being a possible effect of long-term fertilization by rising atmospheric concentrations of carbon dioxide. In this context it is interesting to note that by 1996, both plots at Allpahuayo had experienced small net increases in basal area (by 0.1% and 1.9%) over the 1990 values shown in Table 4, in spite of some illegal felling of palm trees within a few of the sub-plots. Clearly a longer census interval will be needed to confirm whether the small change in forest structure is part of a long-term trend at Allpahuayo, or simply part of a pattern of random fluctuation around a long-term stable state.

To estimate annual natural mortality and growth rates we excluded the sub-plots where palm trees were cut (Table 5). Stem turnover and basal area turnover functions measure slightly different attributes of the stand dynamics—stem turnover is concerned with population dynamics (i.e., the mean of population mortality and recruitment rates), while basal area turnover is concerned with basal area dynamics (i.e., the mean of basal area mortality and recruitment plus growth of existing trees). Over the long-term an old-growth forest would be expected to have similar values of each, and at Allpahuayo the turnover rates of tree stems and basal area both

averaged close to 2% per year in the first half of the 1990s. This rate is not unusual by the standards of western Amazonian forests, but it is higher than the average turnover rate for other tropical moist forests ($\approx 1.5\%$ per year based on studies at 40 different sites; Phillips, 1996). Based on our small sample of lianas and stranglers, large climbing plants appear to turn over notably faster than trees, about 5% a year, which indicates that these organisms may have shorter canopy residence times than most trees. Whether this pattern is repeated elsewhere remains to be seen, but if faster turnover of lianas and stranglers is a general property of Amazon forests it would have implications for plot studies, most of which still ignore climbers. We may be overlooking a component of the forest that is more significant ecologically than has been appreciated.

CONCLUSIONS

Our floristic and ecological results at Allpahuayo well demonstrate the ecological and systematic benefits that can result when we concentrate our joint efforts on inventories in fixed plots. For the ecologist the benefits are clear—without the collaboration of botanists in the field and the herbarium it is impossible to characterize patterns of diversity and floristic composition in most tropical forests, let alone explore the factors that determine these. As forests become more vulnerable to widespread environmental stresses such as fragmentation and climate change (Laurance et al., 1997; Phillips,

1997), plots are also needed to monitor these impacts on biodiversity. Systematists at botanical gardens therefore offer essential expertise for understanding the biological effects of global change.

For the systematist or floristic monographer, establishing permanent sample plots can help in understanding the local flora. The precise rigor of ecological sampling forces researchers to look equally at every plant that meets pre-determined criteria. In contrast, peripatetic botanizing may catalog the weedy, common, obvious, and accessible species, while missing rarer or larger plants, especially canopy trees, lianas, and epiphytes. Rigorous plot inventories can therefore reduce the spatial, taxonomic, life-form, and even seasonal biases prevalent in herbaria (e.g., Nelson et al., 1990), especially when integrated into a larger intensive collecting effort. Thus, a comparison of taxa in Vásquez (1997) with those listed in Brako and Zarucchi (1993) shows that the intensive collecting effort in permanent plots and surrounding forest at several Iquitos sites has yielded nearly 250 taxa new to Peru. At Allpahuayo, new tree taxa have been recognized in Annonaceae (2 species; Chatrou, 1998) and in Lauraceae (3 species including a new genus; van der Werff, 1993, 1997), while the repetition of plot visits has also allowed us to collect fertile material confirming new herb and shrub taxa (e.g., Kallunki, 1994; Vásquez, 1997).

Literature Cited

- Brako, L. & J. L. Zarucchi. 1993. Catalogue of the Flowering Plants and Gymnosperms of Peru. Monogr. Syst. Bot. Missouri Bot. Gard. 45.
- Chatrou, L. W. 1998. Changing genera: Systematic studies in Neotropical and West African Annonaceae. Herbarium Division, Utrecht University.
- Clinebell, R. C., II, O. L. Phillips, A. H. Gentry, N. Stark & H. Zuurig. 1995. Prediction of neotropical tree and liana species richness from soil and climatic data. *Biodiversity and Conservation* 4: 56–90.
- Condit, R., R. B. Foster, S. P. Hubbell, R. Sukumar, E. G. Leigh, N. Manokaran, S. Loo de Lao, J. V. LaFrankie & P. S. Ashton. 1998. Assessing forest diversity on small plots: Calibration using species-individual curves from 50-ha plots. Pp. 247–267 in F. Dallmeier & J. Comiskey (editors), *Long-Term Monitoring of Biological Diversity in Tropical Forest Areas*. UNESCO, Paris.
- Dallmeier, F. & J. Comiskey (editors). 1998a. *Forest Biodiversity Research, Monitoring, and Modeling: Conceptual Background and Old World Case Studies*. MAB Series Vol. 20. UNESCO, Paris.
- & — (Editors). 1998b. *Forest Biodiversity in North, Central and South America, and the Caribbean: Research and Monitoring*. MAB Series Vol. 21. UNESCO, Paris.
- Duivenvoorden, J. F. & H. Lipps. 1995. A land-ecological study of soils, vegetation, and plant diversity in Colombian Amazonia. *Tropenbos Series* 12: 1–438.
- Gentry, A. H. 1988a. Changes in plant community diversity and floristic composition on environmental and geographical gradients. *Ann. Missouri Bot. Gard.* 75: 1–34.
- . 1988b. Tree species richness of upper Amazonian forests. *Proc. Natl. Acad. Sci. U.S.A.* 85: 156–159.
- . 1992. Diversity and floristic composition of Andean forests of Peru and adjacent countries: Implications for their conservation. *Mem. Mus. Hist. Nat. (Lima)* 21: 11–19.
- Kalliola, R., K. Ruokolainen, H. Tuomisto, A. Linna & S. Maki. 1998. Mapa geocológico de la zona de Iquitos y variación ambiental. Pp. 443–457 in R. Kalliola & S. Flores Paitán (editors), *Geoecología y Desarrollo Amazónico*. Turku, Finland.
- Kallunki, J. A. 1994. Revision of *Raputia* Aubl. (Cuspariinae, Rutaceae). *Brittonia*, 46: 279–295.
- Laurance, W. F., S. F. Laurance, L. V. Ferreira, J. M. Rankin de Merona, C. Gascon & T. E. Lovejoy. 1997. Biomass collapse in Amazonian forest fragments. *Science* 278: 1117–1118.
- Lowry, P. P., II, G. E. Schatz & P. B. Phillipson. 1997. The classification of natural and anthropogenic vegetation in Madagascar. Pp. 93–123 in S. M. Goodman & B. D. Patterson (editors), *Natural Change and Human Impact in Madagascar*. Smithsonian Institution Press, Washington, D.C.
- Marengo, J. 1998. Climatología de la zona de Iquitos, Perú. Pp. 35–57 in R. Kalliola & S. Flores Paitán (editors), *Geoecología y Desarrollo Amazónico*. Turku, Finland.
- McNeely, J. A., K. R. Miller, W. V. Reid, R. A. Mittermeier & T. B. Werner. 1990. *Conserving the World's Biodiversity*. IUCN, Gland, Switzerland, and Island Press, Covelo, California.
- National Research Council. 1992. *Conserving Biodiversity: A Research Agenda for Development Agencies*. National Academy of Sciences Press, Washington, D.C.
- National Science Board. 1990. *Loss of Biological Diversity: A Global Crisis Requiring International Solutions*. National Science Board, Washington, D.C.
- Nelson, B. W., C. A. C. Ferreira, M. F. da Silva & M. L. Kawasaki. 1990. Endemism centres, refugia and botanical collecting density in Brazilian Amazonia. *Nature* 345: 714–716.
- Phillips, O. L. 1996. Long-term environmental change in tropical forests: Increasing tree turnover. *Environm. Conservation* 23: 235–248.
- . 1997. The changing ecology of tropical forests. *Biodiversity and Conservation* 6: 291–311.
- & A. H. Gentry. 1994. Increasing turnover through time in tropical forests. *Science* 263: 954–958.
- & J. S. Miller. In prep. *Global Patterns of Forest Diversity: The dataset of Alwyn Gentry*. Monogr. Syst. Bot. Missouri Bot. Gard.
- & P. H. Raven. 1996. A strategy for sampling neotropical forests. Pp. 141–165 in A. C. Gibson (editor), *Neotropical Biodiversity and Conservation*. Occas. Publ. Mildred E. Mathias Botanical Garden 1. Mildred E. Mathias Botanical Garden, Los Angeles.
- , P. Hall, A. H. Gentry, S. A. Sawyer & R. Vásquez. 1994. Dynamics and species richness of tropical rain forests. *Proc. Natl. Acad. Sci. U.S.A.* 91: 2805–2809.
- , Y. Malhi, N. Higuchi, W. F. Laurance, P. Nuñez V., R. Vásquez M., S. G. Laurance, L. V. Ferreira, M. Stern, S. Brown & J. Grace. 1998. Changes in the carbon balance of tropical forest: Evidence from long-term plots. *Science* 282: 439–442.

- Rakotomalaza, P. J. & N. Messmer. 1999. Structure and floristic composition of the vegetation in the Réserve Naturelle Intégrale d'Andohahela, Madagascar. *Fiediana: Zoology*, n.s., 94: 51–96.
- Rudas L., A. 1996. Estudio Florístico y de la Vegetación del Parque Nacional Natural Amacayacu Amazonas-Colombia. M.Sc. Thesis, Universidad Nacional de Colombia, Bogotá.
- Swaine, M. D & D. Lieberman. 1987. Note on the calculation of mortality rates. *J. Tropical Ecol.* 3: ii–iii.
- Tuomisto, H., K. Ruokolainen, R. Kalliola, A. Linna, W. Danjoy & Z. Rodriguez. 1995. Dissecting Amazonian biodiversity. *Science* 269: 63–66.
- Valencia, R., H. Balslev & G. Paz y Miño. 1994. High tree alpha-diversity in Amazonian Ecuador. *Biodiversity and Conservation* 3: 21–28.
- Vásquez M., R. 1997. Flórula de las Reservas Biológicas de Iquitos. *Monogr. Syst. Bot. Missouri Bot. Gard.* 63.
- Vormisto, J., O. L. Phillips, K. Ruokolainen, H. Tuomisto & R. Vásquez M. 2000. A comparison of small-scale distribution patterns of four plant groups in an Amazonian rainforest. *Ecography* 23: 349–359.
- Werff, H., van der. 1993. A revision of the genus *Pleurothyrium* (Lauraceae). *Ann. Missouri Bot. Gard.* 80: 39–118.
- . 1997. *Sextonia*, a new genus of Lauraceae from South America. *Novon* 7: 436–439.

Appendix 1. Woody plant taxa ≥ 10 cm DBH recorded from two 1-ha plots at Allpahuayo. All taxa are trees unless indicated as *** (liana). When a voucher is fertile, we indicate its status by the following code: bd (buds), fl (flowers), fr (fruits). See text for further discussion.

Family	Taxon and authority	No. plants in 2-ha	Vásquez collections (only the first six are listed per taxon)		
Anacardiaceae	<i>Tapirira peckoltiana</i> Engl.	2	14,608	14,614 bd	
	<i>Tapirira retusa</i> Ducke	1	15,185		
	<i>Tapirira</i> sp.	1	15,794		
Annonaceae	<i>Anaxagorea brevipes</i> Benth.	1	14,815 fl		
	<i>Anaxagorea phaeocarpa</i> Mart.	2	14,655 bd	14,757	
	<i>Annona duckei</i> Diels	1	15,614		
	<i>Annona montana</i> Macfad.	2	14,788	15,332	
	<i>Annona poeppigii</i> (Mart.) Maas & Westra	1	14,695		
	<i>Bocageopsis mattogrossensis</i> (R. E. Fr.) R. E. Fr.	1	15,324		
	<i>Diclinanona tessmannii</i> Diels	15	14,819	14,840	14,919
	<i>Duguetia cauliflora</i> R. E. Fr.	1	15,035 fr		14,928
	<i>Duguetia</i> sp.	1	15,770		
	<i>Fusaea longifolia</i> (Aubl.) Saf.	2	14,764 bd	15,788 fl	
	<i>Fusaea</i> sp.	1	15,730		
	<i>Guatteria elata</i> R. E. Fr.	1	15,566		
	<i>Guatteria megalophylla</i> Diels	1	15,039		
	<i>Guatteria olinacea</i> R. E. Fr.	2	14,773	14,797 fr	
	<i>Guatteria rugosa</i> R. E. Fr.	1	14,943		
	<i>Guatteria schomburgkiana</i> Mart.	2	14,770	14,812 fl	
	<i>Guatteria sessilis</i> Fries	2	14,844	15,204	
	<i>Oxandra xylopioides</i> Diels	2	15,489 fl	15,802	
	<i>Rollinia cuspidata</i> Mart.	1	14,877		
	<i>Rollinia peruviana</i> Diels	4	14,776 fl	14,869	15,203 fl 15,671
	<i>Rollinia pittieri</i> Saff.	1	14,643 fl		
	<i>Unonopsis floribunda</i> Diels	2	14,793	15,042	
	<i>Unonopsis spectabilis</i> Diels	1	15,569		
	<i>Xylopia barbata</i> Mart.	2	15,259	15,268	
	<i>Xylopia benhamii</i> R. E. Fr.	1	15,622 ft		
	<i>Xylopia excellens</i> R. E. Fr.	1	14,897		
	<i>Xylopia nitida</i> Dunal	1	15,536 bd		
	<i>Xylopia sericea</i> A. St.-Hil.	1	15,799 ft		

Appendix 1. Continued.

Family	Taxon and authority	No. plants in 2-ha	Vásquez collections (only the first six are listed per taxon)		
Apocynaceae	<i>Ambelania occidentalis</i> Zarucchi	2	15,107 ft		
	<i>Aspidosperma desmanthum</i> Benth. ex Müll. Arg.	2	15,251	15,425	14,852
	<i>Aspidosperma excelsum</i> Benth.	14	14,823	14,825	14,839
	<i>Aspidosperma spruceanum</i> Benth. ex Müll. Arg.	1	14,818		
	<i>Aspidosperma schultesii</i> Woodson	1	15,341		
	<i>Couma macrocarpa</i> Barb. Rodr.	1	15,017		
	<i>Himatanthus succuba</i> (Spruce ex Müll. Arg.) Woodson	1	15,676		
	<i>Malouettia killipii</i> Woodson	2	14,601	14,622	
	<i>Malouettia tamaquirina</i> var. <i>tamaquirina</i> (Aubl.) A. DC.***	1	14,882		
	<i>Odontadenia puncticulosa</i> (Richard) Pulle***	2	15,407	15,504	
Aquifoliaceae	<i>Parahancornia peruviana</i> Monachin	3	14,985	15,478	15,762
	<i>Ilex andarenensis</i> vel sp. aff. Loes.	4	14,941	15,256 fl	15,435
	<i>Dendropanax umbellatus</i> (Ruiz & Pav.) Decne.	2	14,908	15,440	
	<i>Schefflera morototoni</i> (Aubl.) Maguire, Steyerl. & Frodin	1	14,858	15,009	
Bignoniaceae	<i>Jacaranda macrocarpa</i> Bureau & K. Schum.	5	14,862	14,878	15,019
	<i>Jacaranda obtusifolia</i> subsp. <i>obtusifolia</i> Humb. & Bonpl.	1	15,015		15,434
	<i>Memora cladotricha</i> Sandwith	1	15,485		
	<i>Eriotheca macrophylla</i> subsp. <i>sclerophylla</i> (Ducke) Robyns	2	15,514		
Bombacaceae	<i>Matisia bracteolosa</i> Ducke	2	15,620	15,662	
	<i>Matisia hirta</i> Cuatrec.	1	15,060		
	<i>Matisia malacocalyx</i> (A. Robyns & S. Nilsson) W. S. Alverson	2	15,199	15,499	
	<i>Matisia soegengii</i> Cuatrec.	1	15,733		
	<i>Pachira insignis</i> (Sw.) Sw. ex Savigny	5	14,881	15,113	15,598
	<i>Phragmotheca mammosa</i> subsp. <i>amazonica</i> W. S. Alverson	1	15,513	15,182	15,702

Appendix 1. Continued.

Family	Taxon and authority	No. plants in 2-ha	Vásquez collections (only the first six are listed per taxon)	
Boraginaceae	<i>Cordia mexicana</i> I. M. Johnst.	1	15,135	
	<i>Cordia nodosa</i> Lam.	2	14,624	15,660
Bursaceae	<i>Crepidospermum goudotianum</i> (Tul.) Triana & Planch.	2	15,607	15,653
	<i>Crepidospermum prancei</i> Daly	1	15,771	
	<i>Dacryodes peruviana</i> (Loes.) J. F. Macbr.	1	15,766	
	<i>Protium aracouchini</i> (Aubl.) Marchand	1	15,500	
	<i>Protium crassipetalum</i> Cuatrec.	1	15,822	
	<i>Protium divaricatum</i> Engl.	1	15,785	
	<i>Protium ferrugineum</i> (Engl.) Engl.	1	15,045	
	<i>Protium fimbriatum</i> Swart	3	15,176	15,172
	<i>Protium gallosum</i> Daly	1	14,744	
	<i>Protium grandifolium</i> Engl.	6	15,179	15,308
	<i>Protium hebetatum</i> Daly	5	14,634	14,895 fl
	<i>Protium macrophylla</i> (HBK) Engl.	1	15,642	
	<i>Protium nitidifolium</i> Daly	2	14,787	15,760
	<i>Protium nodulosum</i> Swart	1	15,650	
	<i>Protium opacum</i> Swart subsp. <i>opacum</i>	2	14,599	14,612
	<i>Protium opacum</i> vel sp. aff. Swart	2	15,521	15,797
	<i>Protium subserratum</i> (Engl.) A. DC. & C. DC.	1	14,975	
	<i>Protium tenuifolium</i> vel sp. aff. (Engl.) Engl.	1	15,720	
	<i>Protium trifoliatum</i> Engl.	1	14,724	
	<i>Protium</i> sp. aff. <i>robustum</i>	1	15,764	
	<i>Protium</i> sp.	4	15,074	15,094
	<i>Tetragastris panamensis</i> (Engl.) Kuntze	1	15,136	15,125
	<i>Trattinickia peruviana</i> Diels	2	14,775	15,442
Cappariaceae	<i>Capparis schunkei</i> J. F. Macbr.	1	15,806 fl	
Caryocaraceae	<i>Anthodiscus klugii</i> Standl. ex Prance	1	15,525	
	<i>Anthodiscus pilosus</i> Ducke	1	15,395	
	<i>Caryocar glabrum</i> (Aubl.) Pers.	1	15,801	
	<i>Caryocar harlingii</i> Prance & Encarn.	2	14,802	15,201
Celastraceae	<i>Maytenus amazonica</i> Mart.	1	14,843	

Appendix 1. Continued.

Family	Taxon and authority	No. plants in 2-ha	Vásquez collections (only the first six are listed per taxon)
Chrysobalanaceae	<i>Couepia dolichopoda</i> Prance	1	15,284
	<i>Couepia guianensis</i> Aubl. subsp. <i>guianensis</i>	1	14,659
	<i>Couepia racemosa</i> Benth. ex Hook. f.	1	14,783
	<i>Licania arachnoidea</i> Fauschawe	1	14,777
	<i>Licania blackii</i> Prance	1	15,080
	<i>Licania canescens</i> Benoist	1	15,079
	<i>Licania heteromorpha</i> var. <i>heteromorpha</i> Benth.	2	14,979
	<i>Parinari klugii</i> Prance	1	15,206
	<i>Parinari parilis</i> J. F. Macbr.	1	15,606
Clusiaceae	<i>Caracaia punctulata</i> Ducke	2	14,731
	<i>Chrysochlamys weberbaueri</i> Engl.	1	15,488 ft
	<i>Clusia laxiflora</i> (Poepp.) D. Dietr.	1	15,625
	<i>Moronobea coccinea</i> Aubl.	1	15,198
	<i>Symphonia globulifera</i> L. f.	1	15,800
	<i>Tovomita speciosa</i> Ducke	3	14,732
	<i>Tovomita stigmatica</i> Planch. & Triana	4	14,656
	<i>Buchenavia amazonica</i> Alwan & Stace	2	15,243
	<i>Dicranostyles scandens</i> Benth.**	1	15,093
Convolvulaceae	<i>Tapura amazonica</i> Poepp.	1	14,673
	<i>Tapura coriacea</i> J. F. Macbr.	1	15,084
Dilleniaceae	<i>Doliciarpus amazonicus</i> Sleumer subsp. <i>amazonicus</i> ***	2	15,063
	<i>Doliciarpus novogranatensis</i> Kubitzki***	1	14,763
	<i>Pinzona coriacea</i> Mart. & Zuccagni***	1	14,680
Ebenaceae	<i>Diospyros subrotata</i> Hiern	1	15,561 fl
	<i>Lissocarpa stenocarpa</i> Steyerf.	2	15,447

Appendix 1. Continued.

Family	Taxon and authority	No. plants in 2-ha	Vásquez collections (only the first six are listed per taxon)		
Elaeocarpaceae	<i>Sloanea durissima</i> Spruce ex Benth.	3	14,609	15,078	15,152
	<i>Sloanea floribunda</i> Spruce ex Benth.	3	14,920	15,083	15,306
	<i>Sloanea guianensis</i> (Aubl.) Benth.	2	14,888	15,631	
	<i>Sloanea latifolia</i> (Rich.) K. Schum.	1	15,753		
	<i>Sloanea laxiflora</i> Spruce ex Benth.	1	14,894 fl		
	<i>Sloanea robusta</i> Uittien	5	14,632	14,721	15,147
	<i>Sloanea sinemariensis</i> Aubl.	1	15,307		15,748
	<i>Sloanea tuerckheimii</i> Donn. Sm.	1	15,803		
	<i>Sloanea</i> sp.	1	15,304		
	genus	1	14,880		
	<i>Alchornea schomburgkii</i> Klotzsch	1	15,593		
	<i>Alchornea triplinervia</i> (Spreng.) Muell. Arg.	3	14,729	14,771 ft	15,011
Euphorbiaceae	<i>Alchorneopsis floribunda</i> (Benth.) Muell. Arg.	1	15,302		
	<i>Conceveiba martiana</i> Baill.	1	15,741		
	<i>Conceveiba rhytidocarpa</i> Muell. Arg.	7	14,611	14,630	14,738
	<i>Conceveiba</i> sp. nov.	3	15,633 fl	15,690	15,757
	<i>Dodecostigma amazonicum</i> Ducke	1	14,700		
	<i>Glycidendron amazonicum</i> Ducke	1	15,048		
	<i>Hevea guianensis</i> Aubl.	20	14,704	14,817	14,821
	<i>Hevea pauciflora</i> (Spruce ex Benth.) Muell. Arg.	6	14,667 ft	14,887 ft	15,004
	<i>Hyeronima alchorneoides</i> Allemao	3	14,613 bd	14,616 bd	14,681
	<i>Hyeronima oblonga</i> Cuatrec.	7	14,642	14,683	14,684
	<i>Mabea maynensis</i> Muell. Arg.	3	15,071	15,480	15,334
	<i>Micranda elata</i> Muell Arg.	15	15,250 ft	15,271	15,273
	<i>Micranda spruceana</i> (Baill.) R. E. Schult.	11	15,005	15,026	15,047
	<i>Nealchornea yapurenensis</i> Huber	9	14,794	15,575	15,592
	<i>Pera benensis</i> Rusby	1	15,274		
	<i>Pera bicolor</i> (Klotzsch) Muell. Arg.	1	15,424		
	<i>Pera leandri</i> vel sp. aff. Baill.	1	15,647		
	<i>Plukenetia polyadenia</i> Muell. Arg.***	1	15,651		
	<i>Richeria grandis</i> Vahl	3	14,678	14,913	15,501
	<i>Senefeldera stutchiana</i> Croizat	15	14,596	14,646	14,657
				14,660 ft	14,662
					14,663

Appendix 1. Continued.

Family	Taxon and authority	No. plants in 2-ha	Vásquez collections (only the first six are listed per taxon)		
Fabaceae	genus	1	15,825		
	genus	1	15,681		
	genus	1	15,515		
	genus	1	15,538		
	genus	1	15,624		
Fabaceae: Caesalpinaceae	<i>Bauhinia guianensis</i> Aubl. subsp. <i>guianensis</i> ***	4	14,710	15,594	14,728
	<i>Bauhinia guianensis</i> subsp. <i>kaunthiana</i> (Vogel)***	3	14,918	14,933	15,002
	<i>Cynometra bauhiniifolia</i> Benth.	4	15,551	15,700 ft	15,745
	<i>Cynometra spruceana</i> var. <i>spruceana</i> (Hayne) J. F. Macbr.	5	14,708	15,123	15,156
	<i>Dialium guianense</i> (Aubl.) Sandwith	4	14,730	15,103A ft	15,486
	<i>Dimorphanthera macrostachya</i> Benth.	1	14,845		
	<i>Hymenaea oblongifolia</i> Huber	3	14,718	15,162	15,602
	<i>Macrolobium acacifolium</i> (Benth.) Benth.	1	14,931		
	<i>Macrolobium angustifolium</i> (Benth.) R. S. Cowan	2	14,689	14,837	
	<i>Macrolobium arenarium</i> Ducke	1	15,197		
	<i>Macrolobium bifolium</i> (Aubl.) Pers.	8	14,860	14,963	15,252
	<i>Macrolobium limbatum</i> Spruce ex Benth. var. <i>limbatum</i>	3	15,608	15,680	15,299
	<i>Macrolobium limbatum</i> var. <i>propinquum</i> R. S. Cowan	1	15,299		
	<i>Macrolobium microcalyx</i> Ducke	19	15,244 ft	15,254	15,345
	<i>Macrolobium</i> sp.	1	15,301		
	<i>Macrolobium</i> sp.	1	15,339		
	<i>Sclerolobium bracteosum</i> Harms	5	15,305	15,310	15,363
	<i>Sclerolobium micropetalum</i> Ducke	1	15,773		
	<i>Sclerolobium vasquezii</i> Pipoly	1	15,634		
	<i>Senna</i> sp.	1	15,564		
	<i>Tachigali cavipes</i> (Spruce ex Benth.) J. F. Macbr.	1	15,338 fl		

Appendix 1. Continued.

Family	Taxon and authority	No. plants in 2-ha	Vásquez collections (only the first six are listed per taxon)			
Fabaceae: Caesalpinaceae	<i>Tachigali chrysophylla</i> (Poep.) Zarucchi & Herend.	1	14,799			
	<i>Tachigali paniculata</i> Aubl.	1	15,717			
	<i>Tachigali poeppigiana</i> Tul.	1	14,804			
	<i>Tachigali ptychophysca</i> Spruce ex Benth.	10	15,246	15,354	15,362	15,373
	<i>Tachigali rusbyi</i> Harms	1	15,611			15,377
	<i>Tachigali tessmannii</i> cf. Harms	13	14,917	14,921	14,942	15,346
	<i>Tachigali</i> sp.	1	14,996			15,349
	<i>Tachigali</i> sp.	1	15,030			
	<i>Tachigali</i> sp.	1	14,953			
	<i>Tachigali</i> sp.	1	14,957			
	<i>Tachigali</i> sp.	1	14,965			
	<i>Tachigali</i> sp.	1	14,961			
	<i>Tachigali</i> sp.	1	14,966			
	<i>Tachigali</i> sp.	1	14,856			
	<i>Tachigali</i> sp.	1	14,859			
	<i>Tachigali</i> sp.	1	14,871			
	<i>Tachigali</i> sp.	1	14,872			
Fabaceae: Mimosaceae	<i>Albizia</i> sp.	1	15,664			
	<i>Enterolobium barnebyanum</i> Mesquita & M. F. Silva	1	15,562			
	<i>Inga acrocephala</i> Steud.	1	15,558			
	<i>Inga bourgonii</i> (Aubl.) DC.	1	15,619			
	<i>Inga capitata</i> Desv.	1	15,109			
	<i>Inga cortuscan</i> Humb. & Bonpl. ex Willd.	1	14,604			
	<i>Inga densiflora</i> Benth.	1	14,772			
	<i>Inga laurina</i> (Sw.) Willd.	2	15,311	15,312		
	<i>Inga multijuga</i> Benth.	1	15,719			
	<i>Inga oerstediana</i> Benth.	1	15,559			
	<i>Inga peziifera</i> Benth.	2	14,810	15,493		

Appendix 1. Continued.

Family	Taxon and authority	No. plants in 2-ha	Vásquez collections (only the first six are listed per taxon)
Fabaceae: Mimosaceae	<i>Inga poeppigiana</i> Benth.	1	15,811
	<i>Inga semialata</i> (Vell.) Mart.	1	15,537
	<i>Inga spectabilis</i> var. <i>schimpffii</i> (Harms) Little	1	15,545
	<i>Inga velutina</i> Willd.	1	15,698
	<i>Inga</i> sp.	1	15,755
	<i>Inga</i> sp.	1	15,523
	<i>Inga</i> sp.	1	not collected
	<i>Inga</i> sp.	1	14,598
	<i>Marmaroxylon basijugum</i> (Ducke) L. Rico	4	15,024
	<i>Parkia igneiflora</i> Ducke	3	14,991
	<i>Parkia multijuga</i> Benth.	2	14,970
	<i>Parkia nitida</i> Miq.	5	14,605
	<i>Parkia panurensis</i> Benth. ex H. C. Hopkins	1	voucher lost
	<i>Parkia velutina</i> Benoist	2	15,260
	<i>Pithecellobium</i> sp.	1	14,595
	<i>Pithecellobium</i> sp.	1	14,650
	<i>Pithecellobium</i> sp.	1	14,651
	<i>Pithecellobium</i> sp.	1	14,692
	<i>Pithecellobium</i> sp.	1	15,131
	<i>Pithecellobium</i> sp.	1	15,502
Fabaceae: Papilionaceae	<i>Pithecellobium</i> sp.	1	14,652
	<i>Stryphnodendron polystachyum</i> (Miq.) Kleinhoonte	2	14,972
	<i>Zygia latifolia</i> (L.) Fawcett	1	14,626
	<i>Andira macrothyrsa</i> Ducke	2	15,548
	<i>Batesia floribunda</i> Spruce ex Benth.	2	15,044
	<i>Dalbergia monetaria</i> var. <i>monetaria</i> L. f.***	5	14,676A
	<i>Dalbergia riedelii</i> (Benth.) Sandwith***	1	15,761
	<i>Dalbergia</i> sp.***	1	15,064
	<i>Diplotropis purpurea</i> var. <i>leptophylla</i> (Rich.) Amshoff	3	14,654
	<i>Dipteryx micrantha</i> Harms	2	14,762
	<i>Hymenolobium nitidum</i> Benth.	3	14,967
	<i>Lonchocarpus spiciflorus</i> C. Mart. ex Benth.	1	15,375
	<i>Machaerium</i> sp. cf. <i>multifoliatum</i> ***	1	15,498
	<i>Machaerium cuspidatum</i> Kuhl. & Hoehne***	1	15,657
			15,776
			15,792
			15,804
			15,138
			15,604
			14,610
			14,832
			15,247
			15,476
			15,335
			15,568
			15,627
			15,705
			14,756A
			15,401
			15,402
			15,813
			15,399
			15,166
			14,989
			15,322

Appendix 1. Continued.

Family	Taxon and authority	No. plants in 2-ha	Vásquez collections (only the first six are listed per taxon)			
Fabaceae: Papilionaceae	<i>Machaerium floribundum</i> var. <i>parviflorum</i> Benth.***	1	14,627			
	<i>Machaerium begelli</i> Meisn.***	1	15,810			
	<i>Machaerium multifoliatum</i> Ducke***	3	14,600	15,294	14,988	
	<i>Machaerium</i> sp.***	1	15,073			
	<i>Machaerium</i> sp.***	1	15,025			
	<i>Machaerium</i> sp.***	1	15,095			
	<i>Ormosia arborea</i> (Vell.) Harms	1	14,937			
	<i>Pterocarpus amazonum</i> (C. Mart. ex Benth.) Amshoff	1	14,929			
	<i>Pterocarpus rohrii</i> M. Vahl.	1	15,013			
	<i>Swartzia benthamiana</i> Miq. var. <i>benthamiana</i>	8	14,768	15,032	15,261 fl	15,292
	<i>Swartzia brachyrachis</i> var. <i>peruviana</i> R. S. Cowan	1	15,722			
	<i>Swartzia cardiosperma</i> Spruce ex Benth.	4	14,784	15,151	15,257 fl	15,347
	<i>Swartzia laevicarpa</i> Amshoff	1	15,116			
	<i>Swartzia polyphylla</i> DC.	2	15,281	15,713		
	<i>Swartzia racemosa</i> var. <i>klugii</i> R. S. Cowan	11	14,765 bd	14,834	14,841	14,993
	<i>Swartzia tessmannii</i> Harms	4	14,670	14,707	14,774	15,285
	<i>Swartzia</i> sp.	1	15,061			
	<i>Swartzia</i> sp.	1	14,875			
	<i>Taralea oppositifolia</i> Aubl.	3	14,874	14,940	14,977	
	<i>Vantanea parviflora</i> Lam.	3	15,772	15,789	15,824	
Flacourtiaceae	<i>Casearia acuminata</i> DC.	1	15,177			
	<i>Casearia combaymensis</i> Tul.	1	14,751			
	<i>Casearia fasciculata</i> (Ruiz & Pav.) Sleumer	4	14,769	15,540 ft	15,552	15,686
	<i>Casearia javitensis</i> Kunth	1	14,699 ft			
	<i>Casearia sylvestris</i> Sw. var. <i>syvestris</i>	1	15,508 ft			
	<i>Casearia ulmifolia</i> M. Vahl ex Vent.	1	15,645			
	<i>Lindachertia paludosa</i> (Benth.) Gilg.	6	14,691	14,693 ft	15,104	15,694
	<i>Mayna grandifolia</i> (H. Karst.) Warb.	1	15,056			
	<i>Tetracylum macrophyllum</i> Poepp.	1	15,509			
	<i>Tetrastylidium peruvianum</i> Sleumer	7	14,798	14,827	15,150 ft	15,528
	<i>Salacia</i> sp.***	1	15,629			
Hippocrateaceae	<i>Tontelea ovalifolia</i> subsp. <i>richardii</i> (Miers) A. C. Sm.***	1	14,676			
						15,738
						15,605

Appendix 1. Continued.

Family	Taxon and authority	No. plants in 2-ha	Vásquez collections (only the first six are listed per taxon)		
Humiriaceae	<i>Sacoglottis ceratocarpa</i> Ducke	1	14,615		
	<i>Sacoglottis</i> sp.	1	15,511		
Icacinaeae	<i>Dendrobangia boliviana</i> Rusby	1	15,145		
	<i>Discophora guianensis</i> Miers	1	15,422		
	<i>Emmotum floribundum</i> Howard	5	14,950	14,951	15,348 15,437
	<i>Lacistema aggregatum</i> (Bergius) Rusby	4	14,594 ft	14,597	15,736 ft
Lauraceae	genus	1	15,547		
	genus	1	15,663		
	genus	1	15,674		
	genus	1	15,643		
	<i>Anaueria brasiliensis</i> Kosterm.	2	14,742	14,786	
	<i>Aniba perutilis</i> Hemsl.	4	14,959	15,253	15,454
	<i>Aniba taubertiana</i> Mez	1	15,139 ft		
	<i>Endlicheria citriodora</i> van der Werff	2	14,922	14,949	
	<i>Licaria brasiliensis</i> (Nees) Kosterm.	1	15,496		
	<i>Licaria canella</i> (Meisn.) Kosterm.	2	14,838	15,768	
	<i>Licaria</i> sp. cf. <i>dolichantha</i> Kurz	1	15,280		
	<i>Licaria</i> sp. cf. <i>rodriguesii</i> Kurz	1	15,570		
	<i>Mez Laurus opaca</i> Kubitzki & van der Werff	2	15,746	15,759 ft	
	<i>Nectandra acuminata</i> (Nees) J. F. Macbr.	1	15,621		
	<i>Nectandra globosa</i> (Aubl.) Mez	2	15,099	15,313	
	<i>Nectandra pearcei</i> Mez	1	15,731		
	<i>Ocotea aciphylla</i> (Nees) Mez	8	15,245	15,290	15,416 15,432 15,436
	<i>Ocotea argyrophylla</i> Ducke	4	14,932	14,925	14,939
	<i>Ocotea bofo</i> Kunth	4	15,059	15,117	15,729 15,815
	<i>Ocotea bracteosa</i> (Meisn.) Mez	1	15,455		
	<i>Ocotea leucoxydon</i> (Sw.) Laness.	1	15,418		
	<i>Ocotea longifolia</i> Kunth	1	15,632 ft		
	<i>Ocotea myriantha</i> (Meisn.) Mez	2	14,833	15,325	
	<i>Ocotea puberula</i> (Rich.) Nees	2	15,370	15,361	
	<i>Ocotea whitlei</i> Woodson	1	15,140		
	<i>Ocotea</i> sp.	1	15,821		

Appendix 1. Continued.

Family	Taxon and authority	No. plants in 2-ha	Vásquez collections (only the first six are listed per taxon)			
Lauraceae	<i>Ocotea</i> sp.	1	15,751			
	<i>Persea</i> sp. cf. <i>boliniensis</i>	1	15,467			
	<i>Pleurothyrium vásquezii</i> van der Werff	1	15,649			
Lecythidaceae	<i>Cariniana</i> sp. cf. <i>multiflora</i> Ducke	1	14,753			
	<i>Eschweilera chartaceifolia</i> S. A. Mori	3	14,750	14,906	15,112	15,703
	<i>Eschweilera coriacea</i> (DC.) S. A. Mori	7	14,641	15,057	15,062	15,679
	<i>Eschweilera gigantea</i> (Knuth) J. F. Macbr.	1	15,721		15,517	
	<i>Eschweilera micrantha</i> (Berg) Miers	1	15,724			
	<i>Eschweilera rufifolia</i> S. A. Mori	9	14,761	14,690	15,089	15,128
	<i>Eschweilera tessmannii</i> Knuth	2	15,102	15,134	15,110	
	<i>Eschweilera</i> sp.	1	14,638			
	<i>Eschweilera</i> sp.	1	14,661			
	<i>Gustavia hexapetala</i> (Aubl.) Sm.	1	15,160			
	<i>Gustavia longifolia</i> Poepp. ex Berg	2	14,625	14,628		
	<i>Lecythis pisonis</i> aff. <i>Cambess.</i>	1	15,097			
	<i>Lecythis</i> sp. cf. <i>chartacea</i> Berg	1	15,066			
Lepidobotryaceae	<i>Rupiliocarpon</i> sp.	3	14,820	15,543	15,740	
Linaceae	<i>Hebepetalum humirifolium</i> (Planch.) Benth.	1	15,018	15,126		
	<i>Raucheria punctata</i> (Ducke) Ducke	1	15,791 ft			
Loganiaceae	<i>Strychnos ramentifera</i> Ducke***	1	15,054			
	<i>Strychnos sandwithiana</i> Krukoff & Barneby***	1	15,775			
Malpighiaceae	<i>Byrsonima cowanii</i> W. R. Anderson	1	15,714			
	<i>Byrsonima poeppigiana</i> A. Juss.	2	14,809	15,001		
	<i>Byrsonima stipulina</i> A. Juss.	8	14,902	14,927	15,431 fl	15,448 bd
	<i>Dicella julianii</i> (J. F. Macbr.) W. R. Anderson***	1	15,549	15,031	15,049	
	<i>Tetrapteryx mucronata</i> Cav.***	1	15,669			
Marcgraviaceae	<i>Norantea guianensis</i> subsp. <i>japurensis</i> Aubl.***	1	14,892 fl			
Melastomataceae	<i>Miconia tetragona</i> Cogn.	1	14,969			

Appendix 1. Continued.

Family	Taxon and authority	No. plants in 2-ha	Vásquez collections (only the first six are listed per taxon)					
			14,629	14,647	14,653	14,679	14,863	14,891
Meliaceae	<i>Carapa procera</i> DC.	6	14,629	14,647	14,653	14,679	14,863	14,891
	<i>Guarea silvatica</i> DC.	1	15,790					
	<i>Guarea</i> sp.	1	14,759					
	<i>Guarea</i> sp.	1	14,645					
	<i>Trichilia</i> sp. cf. <i>micrantha</i> Benth.	3	14,780	14,813	14,893			
Menispermaceae	<i>Abuta grandifolia</i> (Mart.) Sandwith	3	15,518	15,623	15,654			
	<i>Abuta</i> sp.***	1	15,264					
	<i>Abuta</i> sp. cf. <i>imene</i> ***	1	15,058					
	<i>Curarea tecunarium</i> Barneby & Krukoff***	1	15,101					
	<i>Telitoxicum kruckii</i> Moldenke***	1	15,277					
	<i>Telitoxicum minutifolium</i> (Diels) Moldenke***	1	15,466					
	<i>Telitoxicum peruvianum</i> Moldenke***	1	15,282					
	<i>Siparuna cristata</i> (Peopp. & Endl.) A. DC.	1	15,527					
	<i>Siparuna cuspidata</i> (Tul.) A. DC.	1	15,781					
	<i>Siparuna decipiens</i> (Tul.) A. DC.	5	14,674 bd	14,766 bd	15,505	15,565	15,597 ft	
Moraceae	<i>Siparuna guianensis</i> Aubl.	3	14,709	14,723	14,782			
	genus cf. <i>Castilla</i>	1	15,203A					
	<i>Brosimum acutifolium</i> subsp. <i>obovatum</i> (Ducke) C. C. Berg	1	15,289					
	<i>Brosimum guianense</i> (Aubl.) Huber	3	15,487	15,616	15,709 bd			
	<i>Borsimum lactescens</i> (S. Moore) C. C. Berg	1	15,630					
	<i>Brosimum potabile</i> Ducke	1	14,741					
	<i>Brosimum rubescens</i> Taub.	3	14,854	14,964	15,127			
	<i>Brosimum utile</i> subsp. <i>ovatifolium</i> (Kunth) Pittier	5	14,836	15,165 ft	15,184	15,554	15,571	
	<i>Castilla ullei</i> Warb.	1	15,652					
	<i>Cecropia distachya</i> Huber	3	14,725 fl	15,021	15,288			
	<i>Cecropia engleriana</i> Smetl.	2	15,707 fl	15,708				
	<i>Cecropia sciadophylla</i> Mart.	1	15,615 fl					
	<i>Ficus amazonica</i> (Miq.) Miq.	1	15,163					
	<i>Ficus subapiculata</i> (Miq.) Miq.	1	15,626					
	<i>Helicostylis tomentosa</i> (Poepp. & Endl.) Rusby	4	14,637	14,778	15,130	15,191		
	<i>Maquira calophylla</i> (Poepp. & Endl.) C. C. Berg	3	14,705	15,609	15,695			

Appendix 1. Continued.

Family	Taxon and authority	No. plants in 2-ha	Vásquez collections (only the first six are listed per taxon)		
Moraceae	<i>Naucleopsis imitans</i> (Ducke) C. C. Berg	1	15,798		
	<i>Naucleopsis mello-barretoi</i> (Standl.) C. C. Berg	1	15,668		
	<i>Naucleopsis ternstroemiiflora</i> (Mildbr.) C. C. Berg	1	15,376		
	<i>Naucleopsis ulei</i> (Warb.) Ducke	1	15,716		
	<i>Perebea glabrifolia</i> C. C. Berg	2	14,791		
	<i>Perebea guianensis</i> Aubl. subsp. <i>guianensis</i>	4	14,733	15,170	15,735
	<i>Pourouma bicolor</i> Mart. subsp. <i>bicolor</i>	1	15,189	14,735	
	<i>Pourouma bicolor</i> subsp. <i>scobina</i> (Benoist) C. C. Berg	1	15,068	15,189	
	<i>Pourouma ferruginea</i> Standl.	1	15,683		
	<i>Pourouma guianensis</i> Aubl. subsp. <i>guianensis</i>	2	14,805	15,726	
	<i>Pourouma herrerensis</i> C. C. Berg	1	15,085		
	<i>Pourouma minor</i> Benoist	1	15,532		
	<i>Pourouma</i> sp.	1	14,631		
	<i>Pseudolmedia laevis</i> (Ruiz & Pav.) J. F. Macbr.	3	14,602	14,685	
	<i>Pseudolmedia laevigata</i> Trécul	6	14,842	14,903 bd	15,481
	<i>Trymatococcus amazonicus</i> Poepp. & Endl.	2	14,698 ft	15,699	
	<i>Campsonera capitellata</i> (A. DC.) Warb.	1	15,809	15,082	15,808
Myristicaceae	<i>Iryanthera crassifolia</i> A. C. Sm.	4	15,070		
	<i>Iryanthera elliptica</i> Ducke	1	15,146		
	<i>Iryanthera jiruensis</i> Warb.	13	14,618	14,640	15,503
	<i>Iryanthera laevis</i> Markgr.	3	14,745	14,978	15,546
	<i>Iryanthera lancifolia</i> Ducke	4	14,639	14,803	15,040
	<i>Iryanthera macrophylla</i> (Benth.) Warb.	7	14,706	14,760	15,786
	<i>Iryanthera paradoxa</i> (Schwacke) Warb.	9	14,739	14,846	15,752
	<i>Iryanthera paraensis</i> Huber	3	14,668	14,853	14,890
	<i>Iryanthera polynaura</i> Ducke	2	14,855	15,067	14,901
	<i>Iryanthera ulei</i> Warb.	29	14,603	14,722	15,510 ft
				14,743	15,287 ft
				15,291 ft	
				15,481	

Appendix 1. Continued.

Family	Taxon and authority	No. plants in 2-ha	Vásquez collections (only the first six are listed per taxon)		
Myristicaceae	<i>Iryanthera</i> sp.	1	15,262		
	<i>Iryanthera</i> sp.	1	15,519		
	<i>Osteophloeum platyspermum</i> (A. DC.) Warb.	4	14,701	15,561	15,750
	<i>Otoba glyticarpa</i> W. Rodr.	2	15,560		
	<i>Virola calophylla</i> Warb.	4	15,050	15,419 bd	15,465 ft
	<i>Virola divergens</i> Ducke	1	15,823		
	<i>Virola duckei</i> A. C. Sm.	1	15,591		
	<i>Virola elongata</i> (Benth.) Warb.	2	14,767 ft		
	<i>Virola mollissima</i> (A. DC.) Warb.	1	15,725		
	<i>Virola multinervia</i> Ducke	3	14,795	15,174	15,644
	<i>Virola pavanis</i> (A. DC.) A. C. Smith	23	14,619	14,669	14,789
	<i>Cybianthus peruvianus</i> Miq.	1	15,016		15,272 ft
Myrtaceae	genus	1	15,675		
	genus	1	15,687		
	genus	1	15,390		
	genus	1	15,769		
	genus	1	14,715		
	genus	1	14,816		
	genus	1	14,857		
	genus	1	14,995		
	genus	1	15,033		
	genus	2	15,408	15,410	
	genus	1	15,400		
	genus	1	15,471		
	genus	1	voucher lost		
	<i>Calyptranthes crebra</i> McVaugh	1	14,956		
	<i>Calyptranthes cuspidata</i> DC.	1	14,971		
	<i>Calyptranthes simulata</i> McVaugh	1	14,954		
	<i>Eugenia patrisii</i> Vahl	1	15,534		
	<i>Marliera caudata</i> McVaugh	3	15,266	15,343	15,443
	<i>Marliera imperfecta</i> McVaugh	1	14,955		

Appendix 1. Continued.

Family	Taxon and authority	No. plants in 2-ha	Vásquez collections (only the first six are listed per taxon)			
Nyctaginaceae	genus	1	15,194 ft			
	genus	1	15,557			
	genus	1	14,696			
	genus	1	voucher lost			
	<i>Neea divaricata</i> Poepp. & Endl.	2	14,671	15,820		
	<i>Neea floribunda</i> Poepp. & Endl.	8	15,383	15,387	15,412	15,430
	<i>Neea parviflora</i> Poepp. & Endl.	1	15,795			15,439
	<i>Neea spruceana</i> Heimerl	3	15,655	15,710		
	<i>Neea verticillata</i> Ruiz & Pav.	1	14,737		15,711	
	<i>Neea</i> sp. cf. <i>macrophylla</i> Poepp. & Endl.	1	15,403			
Ochnaceae	<i>Cespedesia spathulata</i> (Ruiz & Pav.) Planch.	1	14,911	14,912		
	<i>Ouratea</i> sp.	1	15,248			
Olacaceae	<i>Aptandra tubicina</i> (Poepp.) Benth. ex Miers	1	15,087 ft			
	<i>Cathedra acuminata</i> (Benth.) Miers	2	14,909 bd	15,192		
	<i>Minquartia guianensis</i> Aubl.	4	14,811	15,670	15,712	15,763
	<i>Schoepfia lucida</i> Pulle	1	15,603			
	<i>Agonandra brasiliensis</i> Benth.	1	15,737			
Opiliaceae	<i>Agonandra silvatica</i> Ducke	1	15,530			
	<i>Agonandra</i> sp.	1	15,807			
Palmae	<i>Astrocaryum chambira</i> Burret	6	14,801 fl			
	<i>Astrocaryum macrocalyx</i> Burret	14	14,592			
	<i>Euterpe precatoria</i> Mart.	7	14,623	14,828 ft		
	<i>Iriartea deltoidea</i> Ruiz & Pav.	13	14,593 fl			
	<i>Oenocarpus bataua</i> Mart.	78	14,633	15,020		
	<i>Scheelea moorei</i> Glassman	3	no voucher			
	<i>Socratea exorrhiza</i> (Mart.) H. Wendl.	2	14,617 ft			
	<i>Coccoloba</i> sp.***	1	14,960	15,613		
Polygonaceae	<i>Coccoloba</i> sp.	1	15,613			
	<i>Moutabea</i> sp.***	1	15,550			
Quinaceae	<i>Lacunaria jennmanii</i> (Oliver) Ducke	1	14,864			
	<i>Quina obovata</i> Tul.	3	14,687	15,142		15,167
	<i>Quina</i> sp.	1	15,749			

Appendix 1. Continued.

Family	Taxon and authority	No. plants in 2-ha	Vásquez collections (only the first six are listed per taxon)			
Rhizophoraceae	<i>Cassipourea peruviana</i> Alston	1	15,601			
Rosaceae	<i>Prunus detrita</i> vel sp. aff. <i>J. F. Macbr.</i>	5	14,958	15,367	15,397	15,446 15,451
Rubiaceae	<i>Aleis microarpa</i> Standl. & Steyerh.	1	15,661			
	<i>Boroja claniifora</i> (K. Schum.) Cuatrec.	2	15,180	15,636		
	<i>Ferdinandusa chlorantha</i> (Wedd.) Standl.	5	15,242	15,344	15,372	15,452
	<i>Kochubaea sericantha</i> Standl.	2	14,999	15,743		
	<i>Pogamea coriacea</i> Spruce ex Benth.	1	15,423			
	<i>Rudgea fissistipula</i> Muell. Arg.	1	14,915 ft			
Rutaceae	<i>Zanthoxylum huberi</i> Waterman	1	15,090			
Sabiaceae	<i>Meliosma herbertii</i> Rolfe	2	15,283 ft	15,286		
	<i>Ophiocaryon heterophyllum</i> (Benth.) Urb.	2	15,497	15,541		
	<i>Ophiocaryon klugii</i> Barneby	3	15,610	15,646	15,696	
	<i>Ophiocaryon manausense</i> (W. A. Rodrigues) Barneby	1	14,978			
Sapindaceae	<i>Cupania diphylla</i> Vahl	1	15,111			
	<i>Cupania</i> sp.	1	14,697			
	<i>Matayba arborescens</i> (Aubl.) Radlk.	1	15,029 ft			
	<i>Matayba guianensis</i> Aubl.	1	15,828			
	<i>Matayba</i> sp.	3	14,935	15,000	15,023	
	<i>Talisia japurensis</i> Radlk.	1	15,175			
	<i>Talisia</i> sp.	1	15,132			
Sapotaceae	Genus cf. <i>Ecclinusa</i>	1	21,365			
	<i>Chrysophyllum amazonicum</i> T. D. Penn.	3	15,118	15,520	15,596	
	<i>Chrysophyllum bombicinum</i> T. D. Penn.	9	14,866	14,930	14,976	15,072 15,249
	<i>Chrysophyllum cuneifolium</i> (Rudge) A. DC.	2	15,137	15,202		
	<i>Chrysophyllum sanguinolentum</i> (Pierre) Baehni	4	14,814	14,848	14,997	15,053
	<i>Ecclinusa lanceolata</i> (Mart. & Eichler) Pierre	4	14,807	15,012	15,326	15,328
	<i>Ecclinusa ramiflora</i> Mart.	1	14,884			
	<i>Micropholis acutangula</i> (Ducke) Eyma	1	14,713			
	<i>Micropholis casiquiarensis</i> Aubrev.	4	14,675 ft	14,806	15,096	15,524
	<i>Micropholis egenis</i> (A. DC.) Pierre	3	14,835 bd	14,883	15,133	

Appendix 1. Continued.

Family	Taxon and authority	No. plants in 2-ha	Vásquez collections (only the first six are listed per taxon)		
Simaroubaceae	<i>Micropholis guyanensis</i> subsp. <i>ducheana</i> (A. DC.) Pierre	4	14,938	14,986	15,409 15,590
	<i>Micropholis guyanensis</i> (A. DC.) Pierre subsp. <i>guyanensis</i>	2	15,092	15,369	
	<i>Micropholis venulosa</i> (Mart. & Eichler) Pierre	1	15,052		
	<i>Pouteria bangii</i> (Rusby) T. D. Penn.	5	14,849	15,037	15,129 15,187
	<i>Pouteria cainito</i> (Ruiz & Pav.) Radlk.	4	14,755	15,100	15,535 15,697
	<i>Pouteria cuspidata</i> (A. DC.) Baehni	5	15,276	15,359	15,396 15,475 15,572
	<i>Pouteria eugeniifolia</i> vel. sp. aff. (Pierre) Baehni	1	15,119		
	<i>Pouteria multiflora</i> vel sp. aff. (A. DC.) Eyma	2	14,727	15,086	
	<i>Pouteria reticulata</i> (Engl.) Eyma subsp. <i>reticulata</i>	1	15,723		
	<i>Pouteria rostrata</i> (Huber) Baehni	1	14,702		
	<i>Pouteria subrotata</i> Cronquist	1	14,781		
	<i>Pouteria torta</i> subsp. <i>glabra</i> T. D. Penn.	3	15,153	15,154	15,779
	<i>Pouteria torta</i> subsp. <i>tuberculata</i> (Sleumer) T. D. Penn.	2	14,720 fl		
	<i>Pouteria</i> sp.	1	14,790		
	<i>Pouteria</i> sp.	1	14,717	14,746 fl	
	<i>Simaba guianensis</i> Aubl.	1	14,607		
	<i>Simaba polyphylla</i> (Cavalc.) W. Thomas	1	15,688		
	<i>Simarouba amara</i> Aubl.	6	14,606	14,952	15,178 15,495 15,576 15,677
Sterculiaceae	<i>Sterculia apetibophylla</i> Ducke	1	15,639		
	<i>Sterculia pruriens</i> (Aubl.) K. Schum.	3	14,686	15,172	15,529
	<i>Sterculia tessmannii</i> Mildbraed	2	15,186	15,507	
	<i>Sterculia</i> sp.	1	15,144		
	<i>Sterculia</i> sp.	1	15,539		
	<i>Theobroma glaucum</i> H. Karst.	1	15,734		
	<i>Theobroma obovatum</i> Klotzsch ex Bernoulli	1	15,556		
	<i>Theobroma subincanum</i> Mart.	10	14,635	14,716 14,792	15,008 15,051 15,114

Appendix 1. Continued.

Family	Taxon and authority	No. plants in 2-ha	Vásquez collections (only the first six are listed per taxon)		
Tiliaceae	<i>Apeiba aspera</i> Aubl.	3	15,014 bd	14,752 bd	15,672 fl
	<i>Luehea</i> sp.	1	14,714 fl		
	<i>Luehea</i> sp.	1	14,648		
	<i>Luehea</i> sp.	1	14,658		
	<i>Luehea</i> sp.	1	15,685		
	<i>Luehea</i> sp.	1	15,754		
Violaceae	<i>Leonia glycyocarpa</i> Ruiz & Pav. var. <i>glycyocarpa</i>	8	14,644	14,672	14,796
	<i>Paypayrola</i> sp.	1	15,205		
	<i>Rinorea flavescens</i> (Aubl.) Kuntze	1	15,190		
	<i>Rinorea racemosa</i> (Mart.) Kuntze	9	14,711	14,754	15,105
	<i>Rinorea</i> sp.	1	15,796		
	<i>Rinorea</i> sp.	1	15,718 ft		
Vochysiaceae	<i>Rinorea</i> sp.	1	15,706		
	<i>Qualea paraensis</i> Ducke	2	15,784	15,829	
	<i>Vochysia densifolia</i> Spruce	1	14,666		