Las Piedras no son mudas.
Ellas solamente
guardan el silencio.

—HUMBERTO AK'ABAL

1

THE FERAL FORESTS OF THE EASTERN PETÉN

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THE NEW DISCIPLINE of historical ecology recognizes that human culture and the environment mutually influence each other (Balée 1998), rather than following the conventional one-way paradigm in which humans are ever adapting to their environments. We examine the contemporary Maya forest of the eastern Petén from this realistic vantage point, suggesting that its species composition and phytosociology are human artifacts dating from the Late Classic period. Wiseman (1978) was the first to use the term *man-made* to describe the Maya forest. About the same time, Turner (1978) and Hammond (1978) wrote the epithet for the Maya swidden and milpa, suggesting instead a much more sophisticated and biologically diverse system of mixed farming and silviculture. In an evolving series of papers, Edwards (1986), Fedick (1996a, 1996b; Fedick and Ford 1990), Ford (1986, 1991, 1998; Ford and Wernecke 2002), and Gómez-Pompa (1987) suggested that the contemporary forests of the Yucatán Peninsula were largely anthropogenic due to the ancient Maya's manipulation of its species composition. Moreover, Gómez-Pompa, Flores, and Sosa (1987) provided a modern-day mechanism to explain this transformation—the Yucatec Maya forest garden, known as the *pet kot*—and they described how it was created and managed. Very simply, the Maya actively selected certain species in their gardens and discouraged others. Moreover, the boundary of pet kot and forest was not distinct. Each was derived from the other. Maya folk ecology reveals an intimate knowledge of myriad forest utilities (Atran 1993), and the Yucatecan Mayan language itself is evocative of the forest as garden: *kannan k'aax,* translated as "well-cared-for forest," implies a human curatorial relationship to the forest.

We agree that the contemporary forests of the southeastern Petén—that is, eastern Guatemala and western Belize—are anthropogenic, the result of the active enrichment, encouragement, and culling of various woody plant species by the Maya and of disturbance by periodic fires, whether intentional or unintentional, that swept the area beginning with the introduction of silviculture and agriculture in the Preclassic period. In other words, the contemporary Maya forest may be one huge feral forest garden, the origins of which date back to at least 4000 BP (Pohl et al. 1996).

We explore this historical ecological concept, however, from a vantage point different from history and archaeology alone: by using the analytical methods of phytosociology. Toward this end, we pose and test three hypotheses: (1) the alpha diversities of these forests are low compared to the alpha diversities of areas of similar latitude and climate that have not been submitted to such pervasive disturbance; (2) the beta diversity among widely spaced samples of these forests is small (in other words, the forests of the eastern Petén have a uniform species composition); and (3) the oligarchies of these forests are composed principally of species that were—and are—of economic value to the Maya.

RESEARCH BACKGROUND

We conducted botanical inventories of three forest sites in distinct settings within 30 kilometers of each other, located in the Cayo District of western Belize (the extreme eastern Petén): El Pilar, Terra Nova, and Ix Chel (figure 1.1). All three sites were abandoned around 1000 BP and have not been recolonized or slashed and burned in any substantive way since. Our forest inventories were initially conducted in support of the Belize Ethnobotany Project (Balick 1991; Balick and Mendelsohn 1992; Balick et al. 2000), designed to provide data as to the diversity, quantity, and patterns of distribution of as many economically valuable plants as possible in Cayo District. For this reason, we chose the sites for their edaphic heterogeneity in terms of inclination, terrain, and drainage. El Pilar, the site of a major Classic period Maya city, is in the undulating, well-drained uplands on an escarpment north of the Belize River valley. Terra Nova is in the nearly level, poorly drained lowlands north of the Belize River and is the site of the world's first ethnomedicinal plant reserve (Balick, Arvigo, and Romero 1994). Ix Chel is on a steep, rocky slope above the Macal River, the site of a medicinal plants trail (Arvigo 1992, 1994). The settlement densities of the Late Classic period on the sites reflect these patterns: El Pilar, Terra Nova, and Ix Chel represent a gradient of structure density during the Late Classic period of 200, 50, and 2 per square kilometer, respectively (Fedick and Ford 1990).

All woody stems (including lianas) greater than or equal to 1.5 centimeters DBH were sampled on each site (appendix 1.1). This criterion gave a far greater species number than the conventional 10 centimeters DBH threshold of inclusion (figure 1.3) used in the majority of phytosociological studies (Campbell 1989). We continued sampling until asymptote was approximated on a species-area curve,

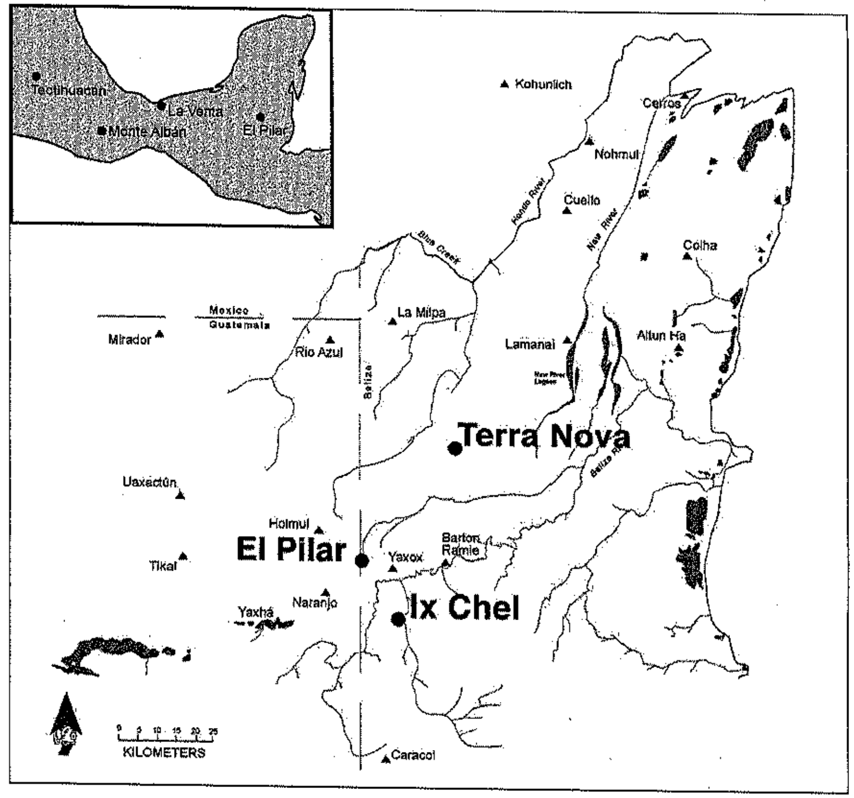

FIGURE 1.1 Three Maya forests.

giving us a reasonable certainty that we had sampled most of the species in the area (figure 1.2). We measured the DBH of each stem, from which we calculated its basal area (for individuals with multiple stems or lianas, the sum of the basal areas), and the relative dominance[1] for each taxon (table 1.3).

We collected voucher specimens for each individual plant until we were confident of our ability to recognize discrete species (or morphocategories) in the field. Representative voucher specimens of every taxon were identified by comparing them with reference specimens in the herbarium of the New York Botanical Garden. For various reasons (such as damage or loss), we were unable to identify 4 percent of the plants to either species or morphocategory, so we classified these plants as "unknown." We determined the Maya's ethnobotanical uses of the species in our samples from the literature (for all linguistic subgroups of the Maya, not just the Yucateca Maya), as well as from interviews with contemporary Yucatecan Maya in Cayo District (appendix 1.2).

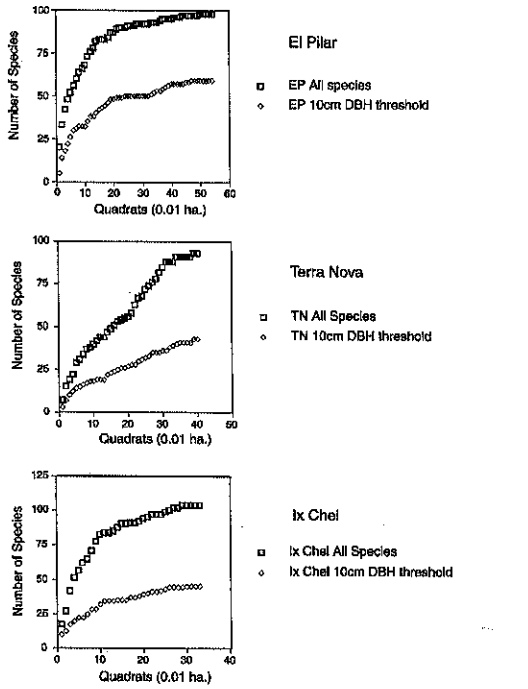

FIGURE 1.2 Species/area curves for three Maya forests.

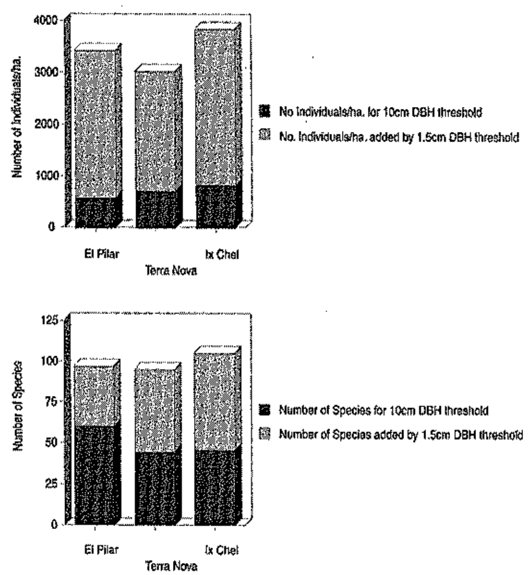

FIGURE 1.3 The attenuation of information using the 10-centimeter DBH threshold of inclusion versus the 1.5-centimeter DBH threshold.

Since first being applied to the phytosociology of tropical forests (Peters et al. 1989), the word *oligarchy* has undergone various definitions (Campbell 1994; Pitman et al. 2001). In a general sense, it means that a small number of species usurp a disproportionate share of the resources—in terms of space and light, for example—while the majority of species scrap for the remainder. For this chapter, we define *oligarchy* as the subsets of 10 (and 20) species in each sample with the highest relative dominances. Having identified the species that comprised our oligarchies, we tested the hypothesis that the oligarchies were anthropogenic. The test involved: (1) determining whether the mean relative dominance of the oligarchic species was significantly higher than that of nonoligarchic species or than that of the forest as a whole and (2) whether the percentage utilization of the oligarchic species was significantly higher than that of the nonoligarchic species or than that of the forest as a whole.

ANALYSIS OF A FERAL FOREST

We identified 179 species in the three inventories of the El Pilar, Terra Nova, and Ix Chel forests. (They and the number and relative dominance of each are listed in appendix 1.1.) Table 1.1 summarizes the general parameters of the inventories: the area of the sample, the number of stems, basal area (extrapolated to one hectare), number of species, Shannon's index of diversity, and Shannon's index of equitability.[2] The three sites showed a striking uniformity of species richness (93, 88, and 103 species, respectively) at approximate asymptote on the species/area curve. Each site also approached asymptote rapidly (figure 1.2), suggesting that a small sample—less than a hectare (and in the case of Ix Chel, a third of a hectare)—would be representative of the forest as a whole. Not surprisingly, therefore, the similarities (as measured by Sorenson's index)[3] among the various paired sites were also high, ranging from 0.46 to 0.61 for all species in the three forests (table 1.2).

Each site had a relatively low index of equitability (0.80, 0.77, and 0.90, respectively)—a hint of the presence of oligarchies described later, although the indices of similarity among the oligarchies of the three sites were more variable. Note that the oligarchy of Ix Chel appears to be the outlier among the three in terms of its species composition; we address this issue later in this chapter.

Among the 179 species found on the three sites, 76 (42 percent) were found to have been, or to be today, of economic value to the Maya (appendix 1.2). This value would appear to be low compared to the 80–90 percent utilization found in some other neotropical forests inhabited by Native Americans (Boom 1985); however, we did not count species that were used for no purpose other than "firewood" or "construction" in our analysis. When these species were added to our analyses, our sites had rates of utilization comparable to those of other neotropical forests.

TABLE 1.1 Summary of Three Maya Forests

EXTRAPOLATED

Site	Area	Minimum DBH	No. Stems ha^{-1}	Basal Area (m^2ha^{-1})	No. Spp.	H[a]	J[b]
El Pilar	0.54 ha.	≥1.5 cm	3,036	25.83	93	3.65	0.80
Terra Nova	0.40 ha.	≥1.5 cm	3,021	33.83	88	3.45	0.77
Ix Chel	0.33 ha.	≥1.5 cm	4,087	35.96	103	4.13	0.90

[a] Shannon diversity index, $(H) = -\Sigma P_i lnP_i$, where P_i = no. individuals of sp i/total no. individuals all spp. (Greig-Smith, 1983).

[b] Shannon equitability index, $(J) = H(lnS)^{-1}$, where S = total no. spp. (Greig-Smith 1983).

TABLE 1.2 Indices of Similarity of Three Maya Forests

SORENSON'S INDEX[a]

Site	All Spp.	20 Most Dominant Spp.	10 Most Dominant Spp.
El Pilar and Terra Nova	0.57	0.62	0.50
El Pilar and Ix Chel	0.46	0.40	0.30
Ix Chel and Terra Nova	0.61	0.35	0.30

[a] $H = 2a(2a + b + c)^{-1}$, where a = number of species common to both plots; b = number of species unique to area 1; c = number of species unique to area 2 (Greig-Smith 1983).

The species that composed the oligarchies (defined as both the top 10 and 20 species in terms of their relative dominances) of the three forests are listed in tables 1.3 through 1.5. Each of the three samples was highly oligarchic: the top 10 most dominant species in each forest usurped a minimum of 57 percent (and in the case of Terra Nova an astonishing 73 percent) of the forests' footprint in terms of basal area. Species that are of economic importance to the Maya (appendix 1.2) are in boldface type in tables 1.3 through 1.5. Note that they comprise a majority of the species in the oligarchies, leading to the principal question of this chapter: Are the oligarchies anthropogenic? One way to address this question is cultural. At all three sites, the percentage utilization of the oligarchic species was significantly greater ($P < 0.001$) than that of the nonoligarchic species (table 1.6).

Another way to address this question is ecological and structural, by comparing the mean relative dominance of species of economic value to the Maya with those of no value (table 1.7). Again, at all three sites, the differences were

TABLE 1.3 Twenty Most Dominant Tree Species ≥ 1.5-centimeter DBH at El Pilar

SPECIES	RELATIVE DOMINANCE[a]
Pouteria reticulata (Engl.) Eyma	9.57
Cryosophila stauracantha **(Heynh.) R. Evans**[b]	7.55
Sabal morrisiana **H. H. Bartlett & L. H. Bailey**	7.35
Alseis yucatanensis **Standl.**	6.00
Swietenia macrophylla **King**	5.89
Spondias radlkoferi **Donn. Sm.**	5.17
Licania platypus **(Hemsl.) Fritsch**	4.51
Tabebuia rosea **(Bertol.) DC**	4.11
Attalea cohune **Mart.**	3.76
Aspidosperma cruentum **Woodson**	2.96
Total Relative Dominance Top 10 Species	56.87
Simarouba glauca DC.	2.68
Pseudolmedia spuria **(Swartz) Griseb.**	2.68
Simira salvadorensis **(Standl.) Steyermark**	2.35
Pouteria campechiana **(HBK) Baehni**	2.19
Lonchocarpus castilloi **Standl.**	2.07
Bursera simaruba **(L.) Sarg.**	2.02
Protium copal **(Schltdl. & Cham.) Engl.**	1.79
Lippa myriocephala Schltdl. & Cham.	1.61
Croton guatemalensis Lotsy	1.54
Terminalia amazonia **(J. F. Gmel.) Exell**	1.48
Total Relative Dominance Top 20 Species	77.28
Total Relative Dominance Remaining 73 Species	22.72

[a] Relative dominance = total basal area for species A/total basal area for all species.

[b] **Bold face** indicates species that are of economic importance to the Maya.

statistically significant (ranging from $P < 0.05$ to $P < 0.001$). Moreover, a comparison of the mean relative dominance of those species not of utility to the Maya and the mean relative dominance of all of the species in each sample in every case proves not to be significant. These results imply that the oligarchy may indeed be the result of human selection. In other words, the species that have fared best in this forest over the past several thousand years have been those encouraged by the Maya.

TABLE 1.4 Twenty Most Dominant Tree Species ≥ 1.5-Centimeter DBH at Terra Nova

SPECIES	RELATIVE DOMINANCE
***Attalea cohune* Mart.**[a]	**19.27**
***Alseis yucatanensis* Standl.**	**14.44**
***Vitex gaumeri* Greenm.**	**9.30**
***Cryosophila stauracantha* (Heynh.) R. Evans**	**5.47**
Pouteria reticulata (Engl.) Eyma	5.18
***Sabal mauritiiformis* (H. Karst.) Griseb. & H. Wendl ex Griseb.**	**4.05**
***Pouteria campechiana* (H.B.K.) Baehni**	**3.94**
***Manilkara zapota* (L.) P. Royen**	**3.87**
Unknown TN 4	3.55
***Simira salvadorensis* (Standl.) Steyerm.**	**3.49**
Total Relative Dominance Top 10 Species	**72.56**
***Bursera simaruba* (L.) Sarg.**	**2.80**
***Bunchosia lindeniana* A. Juss.**	**2.27**
***Tabebuia rosea* (Bertol.) DC**	**2.13**
***Brosimum alicastrum* Sw.**	**1.94**
***Talisia oliviformis* (H.B.K.) Radlk.**	**1.46**
***Terminalia amazonia* (J. F. Gmel.) Exell**	**1.39**
***Guettarda combsii* Urban**	**1.25**
***Protium copal* (Schltdl. & Cham.) Engl.**	**1.10**
***Aspidosperma cruentum* R. E. Woodson**	**0.92**
***Dendropanax arboreus* (L.) Decne. & Planch.**	**0.76**
Total Relative Dominance Top 20 Species	88.58
Total Relative Dominance Remaining 68 Species	11.42

[a] **Bold face** indicates species that are of economic importance to the Maya.

TABLE 1.5 Twenty Most Dominant Tree Species ≥ 1.5-Centimeter DBH at Ix Chel

SPECIES	RELATIVE DOMINANCE
***Attalea cohune* Mart.**[a]	**29.12**
***Bursera simarouba* (L.) Sarg.**	**12.75**
***Vitex gaumeri* Greenm.**	**7.76**
***Cryosophila stauracantha* (Heynh.) R. Evans**	**5.86**
***Simira salvadorensis* Standl.**	**4.89**
Lonchocarpus castilloi (Standl.) Steyerm.	3.56
***Zuelania guidonia* (Sw.) Britton & Millsp.**	**2.00**
***Brosimum alicastrum* Sw.**	**1.76**
***Piscidia piscipula* (L.) Sarg.**	**1.65**
***Spondias radlkoferi* Donn. Sm.**	**1.63**
Total Relative Dominance Top 10 Species	70.98
***Protium copal* (Schltdl. & Cham.) Engl.**	**1.50**
Nectandra hihua (Ruiz & Pav) Rohmer	1.50
***Pouteria campechiana* (H.B.K.) Baehni**	**1.43**
***Thouinia canescens* v. paucidentata Radlk.**	**1.41**
***Simarouba glauca* DC.**	**1.39**
***Piper neesianum* C. DC.**	**1.34**
Hyperbaena mexicana Miers	1.27
***Swartzia cubensis* (Britton & P. Wilson) Standley**	**1.26**
Metopium brownei (Jacq.) Urb.	1.03
***Annona reticulata* L.**	**0.93**
Total Relative Dominance Top 10 Species	84.04
Total Relative Dominance Remaining 83 Species	**15.96**

[a] **Bold face** indicates species that are of economic importance to the Maya.

TABLE 1.6 Percentage Utilization by the Maya

SITE	EL PILAR	TERRA NOVA	IX CHEL	MAYA MTN. 1[2]	MAYA MTN. 2[2]
% Utilization of Oligarchic Spp.[1]	90	90	80	60	60
vs.					
% Utilization of Nonoligarchic Spp.[3]	35***	40***	42***	40 (NS)	48 (NS)

[1] Defined as the top 20 species in terms of relative dominance.
[2] Analysis did not include one morphocategory and six species not listed in Balick et al. 2000.
[3] Does not include unidentified species that could not be assigned to morphocategories.
*** $P < 0.001$ (Chi-square Test performed on actual numbers, not on percentages).

TABLE 1.7 Mean Relative Dominance of Species of Economic Value vs. No Economic Value

MEAN RELATIVE DOMINANCE	EL PILAR	TERRA NOVA	IX CHEL
Of Spp. of Economic Value to Maya	1.68 (2.12)	1.77 (3.68)	1.52 (4.22)
vs.			
Of Spp. Not of Economic Value to Maya[1]	0.43 (1.34)*	0.38 (0.94)**	0.19 (0.24)***

[1] Does not include unidentified species that could not be assigned to morphocategories.
* $P < 0.05$ (Mann-Whitney U Test).
** $P < 0.02$ (Mann-Whitney U Test).
*** $P < 0.001$ (Mann-Whitney U Test).

DISCUSSION

One might argue that the high rates of utility of the oligarchic species versus the rates of utility of the nonoligarchic species are simply a function of the Maya having experimented first (and most often) on the species that they would be most likely to encounter in the wild—in other words, in the oligarchy. This argument might be valid if the rare species were unnamed in Yucatecan Mayan. But the facts show the contrary: the contemporary Yucatecan Maya recognize and name most species in the samples—common as well as rare. The Maya forest is a well-understood biota, one of cognizance (Atran 1999).

The individual alpha diversities of the three samples of Maya forest, as well as the beta diversities[4] among them, are low. This is surprising given that we selected the three sites for their edaphic heterogeneity. Data sets from other seasonal subtropical New and Old World forests are rare, making it difficult to make rigorous comparisons. Consider, for example, inventories of seasonal lowland Amazonian forests (Campbell 1994; Campbell et al. 1986), which do not approach asymptote even after 3 hectares (using a threshold of inclusion of 10 centimeters DBH, no less). Inventories (using a comparable DBH to our Belizean studies) of seasonal subtopical forests in southern China, close to the same latitude as Belize, yield approximately two times as many species at asymptote (An et al. 1999; Wang et al. 1999), and surveys of the Atlantic coastal forests of Brazil, which have a comparable (but southern) latitude to that of Belize, have revealed some of the highest alpha and beta diversities ever measured (Mori et al. 1983; Thomas et al. 1998).

Likewise, the extreme oligarchies of these Maya forests are comparable to what one would expect in a naturally disturbed tropical forest, such as occurs on the *várzea* floodplains of Amazonia. In the *várzea*, there is a distinct positive correlation between the magnitude of disturbance and the magnitude of the oligarchy (Campbell 1994). Clearly, the large oligarchies of the three Maya forest sites indicate that the sites have been submitted to a pervasive disturbance regime. We submit that this disturbance is to a significant extent anthropogenic, consisting of enrichment with species of economic value to humans and, of course, culling by fire. However, it is important to note that the oligarchies of our three sites are not composed of fire-adapted or early-succession postswidden species (with the exception of *Attalea cohune*). Yet fire may nevertheless have been and may still be an important agent for the creation of these oligarchies. Throughout the eastern Petén, we have observed the Maya using stone walls and cleared breaks to protect desirable forest saplings or gardens from the wildfires that periodically range over the land. The fires do the culling, but the Maya do the selection.

These conclusions are supported by our affirmation that the oligarchic species of the three forests have a significantly greater rate of utilization than the nonoligarchic species and that the mean relative dominance of the oligarchic species is significantly greater than that of the nonoligarchic species. Our results suggest an explicit intentionality and human agency (see Erickson and Balée, chapter 7, this volume) in the creation of the contemporary Maya forest. The most parsimonious explanation for these patterns of impoverishment and concomitant high utility in our samples of the Maya forests is that they are the descendants of an ancient kannan k'aax that once covered vast areas of the greater Petén.

The Ix Chel forest is distinct from the others in terms of its oligarchic species composition—perhaps because it is located on steep, rocky terrain unsuitable for agriculture and, not surprisingly, had a low settlement density during the Classic period. For this reason, it simply may not have been as extensively manipulated over time as the other sites. For example, it abounds with poisonwood (*Metopium brownei*), by any measure an undesirable species (in the Anacardiaceae, a family infamous for its toxic principles) that is the first to be culled from contemporary Maya forest gardens and that, although present, is rare on the other two sites. Therefore, of the three sites, Ix Chel may most closely resemble the original pre-Maya forest. Regardless, in spite of its edaphic and oligarchic dissimilarity with the other sites, it is part of the same pervasive community as the two other sites, especially Terra Nova. We suspect that we may never be able to locate a pre-Maya (control) forest in Cayo District—one that would be representative of the Cayo forest before human perturbation—a frustrating concession. Certainly, access to such a forest would quickly validate or invalidate our hypotheses. However, it may simply be the circumstance that human perturbations and modifications of the Maya forest over the past 4,000 years have been so pervasive that a control forest in the lowland Maya forest does not exist.

Forested upland areas within 100 kilometers of our study sites are known, however, to have been sparsely occupied by the ancient Maya, and thus are areas where the forest may not be as anthropogenic. One is the southern foothills of the Maya Mountains, where Brewer and Webb (2002) conducted two 1-hectare inventories of all stems greater than or equal to 5.0 centimeters DBH on the Bladen Nature Reserve (BNR). It is a region of complex geology: a conjunction of granite, shale, and limestone (Wright et al. 1959), dissected by streams and concomitant alluvial deposits (Durham 1996). Although the settlement patterns of the region are not well studied, the evidence points to low settlement densities for most of the Maya occupation (Graham 1987; Hammond 1981). In the BNR region, there are sites of small-scale mineral extraction and, in the Late Classic period, a few raised terraces in pockets of alluvial soil.

Even at a hefty threshold of inclusion of 5.0 centimeters DBH, the two BNR forest plots, having 114 and 104 species, are more diverse than those of Cayo District. At one hectare, the BNR plots do not approach asymptote on a species-area curve. These high diversities are as one would expect in a region of limited human agency. Like the Cayo forests, the BNR forests are highly oligarchic. However, unlike Cayo forests, the BNR oligarchies are not significantly richer in species of economic value (utilities derived from the same references as given earlier) than the nonoligarchies (table 1.6). Moreover, there is no significant difference in the mean relative dominance of the species of economic importance versus those of no value (table 1.7). These results are opposite to what we found in Cayo District and precisely what one would expect from a forest that was not heavily manipulated by humans.

The Maya signature on the Cayo forests, last penned more than a millennium ago, is discernible not just in their phytosociologies, however. It is physical as well, illustrated by the inverse functions of total forest basal area and the density

of Maya structures. Where blocky limestone structures and rubble occupy much of the forest floor, there is less room for the establishment of massive tree trunks and roots. Liana frequency, by contrast, is a direct function of the structure density. In several parts of the Neotropics, high numbers of lianas have been correlated with human perturbation and, in Amazonia, with anthropogenic dark earth (Balée and Campbell 1990; Graham, chapter 2, and Neves and Peterson, chapter 9, this volume).

In conclusion, the contemporary Maya forests of Cayo District may be regarded from various perspectives. A preservationist would argue that they are the survivors of a much richer biotic community that was demolished by humans and that the forests we see today are the residue of that impoverishment. Remarkably, these forests, more than a millennium after the Maya civilization collapsed and abandoned them, still bear the scars of human perturbation, in both physical and phytosociological terms—casting an ominous perspective on the current rampant deforestation in the tropics and subtropics, including the Neotropics in general.

Anthropologists might be more optimistic. They might argue that the forests are a human-engineered wonder that once supported a large Maya population, yet still maintained a moderate biological diversity and forest cover. Certainly, the high degree of utility of these forests reveals the Maya's mastery of their biota and a concomitant knowledge of its virtues—a virtuosity that has been threatened since the European occupation of region.

A conservationist might employ a hybrid argument: that the patterns of Maya land use (both ancient and contemporary) may show us the path to a more rational way of making a living from the Maya forest without destroying it—certainly a better alternative to contemporary cattle ranching and agrarian monocultures.

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APPENDIX 1.1 Species in Three Maya Forests

FAMILY, GENUS, SPECIES	VULGAR NAME	NUMBER HA^{-1} (RELATIVE DOMINANCE)		
		EL PILAR	TERRA NOVA	IX CHEL
Acanthaceae				
Aphelandra scabra (Vahl) Sm.	anal; anal-chae			
	palo verde; wild ax canan			60(0.05)
Agavaceae				
Dracaena americana Donn. Sm.	wild isote	56(1.00)	33(0.10)	
Anacardiaceae				
Astronium graveolens Jacq.	jabin; jobillo	27(0.25)	3(0.21)	
Comocladia guatemalensis Donn. Sm.				7(0.01)
Metopium brownei (Jacq.) Urb.	che-chen;			
	black poisonwood	9(0.75)	13(0.66)	97(1.03)
Spondias radlkoferi Donn. Sm.	rum-p'ok; hog plum	63(5.17)	20(0.63)	47(1.63)
Annonaceae				
Annona glabra L.	cork wood	2(<0.005)		
A. reticulata L.	wild custard apple		23(0.23)	113(0.93)
Malmea depressa (Baill.) R. E. Fr.	sufrekaya	19(0.35)	23(0.10)	160(0.60)
Apocynaceae				
Aspidosperma cruentum Woodson	my lady	65(2.96)	28(0.92)	
Tabernaemontana arborea Rose	juevo de caballo	7(0.05)	8(0.30)	30(0.68)
Thevetia ahouai (L.) A. DC.	juevo de chucho	15(0.03)	3(<0.005)	27(0.03)
Araliaceae				
Dendropanax arboreus (L.) Decne. & Planch.	lion hand; lion heart; mano e león tree	13(0.34)	10(0.76)	10(0.07)

APPENDIX 1.1 *(continued)*

FAMILY, GENUS, SPECIES	VULGAR NAME	NUMBER HA^{-1} (RELATIVE DOMINANCE)		
		EL PILAR	TERRA NOVA	IX CHEL
Arecaceae				
Bactris mexicana Mart.	warrie cahoon	15(0.01)		
Chamaedorea TN1			3(<0.005)	
Cryosophila stauracantha (Heynh.) R. J. Evans	give-and-take	433(7.55)	558(5.47)	90(5.86)
Desmoncus orthacanthos Mart.	basket tietie			17(0.03)
Attalea cohune Mart.	corozo; cahoon	17(3.76)	110(19.27)	130(29.12)
Sabal mauritiiforme Griseb. & H. Wendl.	botán; bay leaf	63(7.35)	63(4.05)	
Schippia concolor Burret	silver thatch; silver palmetto			17(0.24)
Asteraceae				
Critonia morifolia (Mill.) R. M. King & H. Rob.	palo verde	202(0.80)		3(0.01)
Bignoniaceae				
Callichlamys latifolia (Rich.) K. Schum.	shna'corts; bejuco negro	30(0.14)		
Godmania aesculifolia (HBK.) Standl.				23(0.05)
Tabebuia rosea (Bertol.) DC.	roble	22(4.11)	33(2.13)	37(0.09)
Arrabidaea pubescens (L.) A. H. Gentry	allspice tie tie	44(0.20)	65(0.23)	
Bombacaceae				
Pachira aquatica Aubl.	uacut; provision tree			3(0.63)
Burseraceae				
Bursera simaruba (L.) Sarg.	cha-ca; gumbo limbo	13(2.02)	13(2.80)	230(12.75)
Protium copal (Schltdl. & Cham.) Engl.	pomte; copal	111(1.79)	35(1.10)	47(1.50)
Capparidaceae				
Unknown IX 1	fiddle wood			3(0.01)
Cecropiaceae				
Cecropia peltata L.	trumpet leaf	4(0.40)	3(0.09)	

APPENDIX 1.1 *(continued)*

FAMILY, GENUS, SPECIES	VULGAR NAME	NUMBER HA^{-1} (RELATIVE DOMINANCE)		
		EL PILAR	TERRA NOVA	IX CHEL
Pourouma bicolor Mart.	bahb; big leaf	7(0.13)		
Chrysobalanaceae				
Hirtella americana L.			8(0.11)	
Licania platypus (Hemsl.) Fritsch	succótz; monkey apple	41(4.51)		
Combretaceae				
Bucida buceras L.	puk te; bullet tree	13(0.78)		
Terminalia amazonia (J. F. Gmel.) Exell	nargusta	22(1.48)	18(1.39)	
Dioscoreaceae				
Dioscorea bartlettii C. V. Morton	ya-ya-chil cocomecca blanca; red China root	11(0.01)	8(<0.005)	7(<0.005)
Euphorbiaceae				
Croton guatemalensis Lotsy	black pepper; Sta. María	11(1.54)		70(0.46)
Sebastiania tuerckheimiana Pax & K. Hoffm.) Lundell	white poison wood		10(0.02)	40(0.69)
Flacourtiaceae				
Casearia sylvestris Sw.				13(0.10)
Laetia procera (Poepp.) Eichler	drunken bayman wood	24(0.59)		
L. thamnia L.	bullyhob			60(0.60)
Unknown IX 1			35(0.29)	3(<0.005)
Zuelania guidonia (Sw.) Britton & Millsp.	tamai		10(0.30)	107(2.00)
Lauraceae				
Licaria 1	tabaquillo		12(0.04)	7(0.01)
Licaria IX 1				50(0.55)
Licaria peckii (I. M. Johnston) Kosterm.	bahon		5(0.02)	10(0.04)
Nectandra hihua (Ruiz & Pav.) Rohwer	laurél	15(0.07)	5(0.15)	236(1.50)
N. nitida Mez	cot tree		3(0.16)	
Nectandra Unknown 1			18(0.15)	27(0.27)
Phoebe 1	granadillo		48(0.48)	3(0.03)
Lauraceae Unknown EP 1	rosewood	4(1.07)		

APPENDIX 1.1 *(continued)*

FAMILY, GENUS, SPECIES	VULGAR NAME	NUMBER HA^{-1} (RELATIVE DOMINANCE)		
		EL PILAR	TERRA NOVA	IX CHEL
Lauraceae Unknown EP 2	false rosewood	7(0.11)		
Lauraceae Unknown TN 1			28(0.41)	
Legum. Caesalpiniaceae				
Bauhinia calderonii (Rose) Lundell	bull hoof	20(0.49)	3(0.04)	27(0.09)
B. divaricata L.	bull hoof			7(0.02)
Legum. Fabaceae				
Erythrina EP 1	red seeds	2(0.70)		
Inga EP 1	inga	7(0.04)		
Lonchocarpus amarus Standl.	bitterwood; barbasco	15(0.49)		
L. castilloi Standl.	white/black cabbage bark	13(2.07)	8(0.07)	100(3.56)
Piscidia piscipula (L.) Sarg.	jabim; palo de gusano	4(0.03)	3(0.05)	110(1.65)
Swartzia cubensis (Britton & P. Wilson) Standl. (UNK EP 6)	llora sangre/blood vine	40(0.46)	10(0.01)	87(1.26)
Legum. Mimosaceae				
Acacia cornigera (L.) Willd.	white cockspur	43(0.58)	3(0.01)	
Acacia cf. *dolichostachya*	John Crow (unknown)			3(0.24)
Acacia gentlei Standl.	red cockspur		13(0.17)	176(0.81)
Acacia globulifera Saff.	white cockspur	9(0.05)		50(0.50)
Zygia 1	deerhorn		5(0.02)	97(0.48)
Mimosaceae IX 1				3(0.15)
Leguminosae				
Unknown EP 1	pole wood	7(0.21)		
Unknown IX 1				13(0.59)
Loganiaceae				
Strychnos panamensis Seem.	chicoloro	19(0.08)	18(0.07)	7(0.01)
Malphigiaceae				
Bunchosia swartziana Griseb.	mourín			3(0.027)
Bunchosia lindeniana A. Juss.	luín	37(1.22)	100(2.27)	20(0.029)

APPENDIX 1.1 (*continued*)

FAMILY, GENUS, SPECIES	VULGAR NAME	NUMBER HA^{-1} (RELATIVE DOMINANCE)		
		EL PILAR	TERRA NOVA	IX CHEL
Malvaceae				
Hampea trilobata Standl.	mahow; mahawa	7(0.65)		30(0.10)
Melastomataceae				
Miconia EP 1		31(0.44)		
Meliaceae				
Swietenia macrophylla King	mahogony	15(5.89)		
Trichilia havanensis Jacq.	spoon tree		5(0.03)	33(0.06)
T. hirta L.			3(<0.005)	
Trichilia cf. *pallida* Sw.	brown berries		10(0.02)	27(0.40)
Menispermaceae				
Hyperbaena mexicana Miers				50(1.27)
Monimiaceae				
Mollinedia guatemalensis Perkins	wild coffee	9(0.04)	38(0.15)	
Moraceae				
Brosimum alicastrum Sw.	ramon	20(1.27)	23(1.94)	7(1.76)
Ficus radula Willd.	higo de la montaña	9(0.64)		
F. schippii Standl.	mata palo	13(0.82)	13(0.61)	
Pseudolmedia spuria Griseb.	wild cherry	154(2.68)	85(0.63)	3(0.02)
Myrtaceae				
Eugenia cf. *axillaris* (sw.) Willd.	little green berries		3(<0.005)	23(0.03)
E. buxifolia (Sw.) Willd.	semillón; guaya-billo; bastard gumbo limbo	137(1.12)	5(0.11)	
E. oerstediana O. Berg	little green berries			3(0.03)
Myrcianthes fragrans (Sw.) McVaugh	little green berries		5(0.15)	90(0.25)
Pimenta dioica (L.) Merr.	allspice	4(0.50)	3(0.02)	37(0.15)
Nyctaginaceae				
Neea psychotrioides Donn. Sm.			5(0.01)	37(0.25)
Pisonia aculeata L.	una de gato vine	13(0.19)	5(0.03)	7(0.05)

APPENDIX 1.1 (*continued*)

FAMILY, GENUS, SPECIES	VULGAR NAME	NUMBER HA^{-1} (RELATIVE DOMINANCE)		
		EL PILAR	TERRA NOVA	IX CHEL
Ochnaceae				
Ouratea nitida (Swartz) Engl.			10(0.01)	3(<0.005)
Opiliaceae				
Agonandra EP 1	man vine	9(0.04)		
Piperaceae				
Piper amalgo L.	red cordonsillo	92(0.42)	163(0.23)	33(0.05)
Piper neesianum C. DC.	black cordoncillo	18(0.20)	18(0.03)	193(1.34)
Polygonaceae				
Coccoloba hondurensis Lundell	wild grape		10(0.71)	
Coccoloba schiedeana Lindau	wild grape	2(<0.005)		10(0.33)
Rhamnaceae				
Krugiodendron ferreum Urb.	ax master	9(0.04)	3(0.03)	20(0.38)
Rubiaceae				
Alseis yucatanensis Standl.	lión; dzón	124(6.00)	275(14.44)	13(0.58)
Chiococca alba (L.) Hitchc.	kibish			3(0.01)
Chiococca 1	skunk vine	2(0.01)	13(0.05)	7(0.03)
Guettarda combsii Urb.	verde lucero; xtez-tab; glassy wood; casacb	9(0.18)	78(1.25)	20(0.10)
Guettarda IX 1	wild grape			10(0.23)
Psychotria chiapensis Standl.			3(<0.005)	
P. nervosa Swartz	wild ix canon		5(0.02)	13(0.01)
Psychotria EP 1	bastard wild coffee	216(0.86)		
Psychotria IX 1				10(0.01)
Randia cf. *pleiomeris* Standl.	wild okra		3(0.01)	17(0.10)
Randia xalapensis M. Martens & Galeotti	wild okra			7(0.01)
Simira salvadorensis (Standl.) Steyerm.	redwood; John Crow	50(2.35)	88(3.49)	120(4.89)
Rutaceae				
Zanthoxylum riedelianum Engl.	prickly yellow tree	55(0.14)		

APPENDIX 1.1 *(continued)*

FAMILY, GENUS, SPECIES	VULGAR NAME	NUMBER HA^{-1} (RELATIVE DOMINANCE)		
		EL PILAR	TERRA NOVA	IX CHEL
Z. juniperinum Poepp	sinan ché; lemoncillo	6(0.4)	8(0.25)	
Sapindaceae				
Allophylus cominia (L.) Sw.	tabaquillo		3(0.03)	
Cupania belizensis Standl.	grande Betty	52(0.87)	45(0.45)	153(0.10)
Sapindus saponaria L.	kinep (guinep)			40(0.17)
Talisia olivaeformis (H.B.K.) Radlk.			13(1.46)	77(0.22)
Thouinia paucidentata Radlk.	trifolia	56(0.28)		120(1.41)
Sapotaceae				
Chrysophyllum cf. *mexicanum* Brandegee ex Standl.				3(0.01)
Dipholis salicifolia A. DC.	sapote			3(<0.005)
Manilkara zapota (L.) P. Royen	chico sapote; chic ibúl	13(0.16)	3(3.87)	30(0.26)
Mastichodendron foetidissimum (Jacq.) Cronquist	mastic		10(0.09)	
Pouteria IX 1				7(0.10)
Pouteria campechiana (H.B.K.) Baehni	sapotillo rojo	56(2.19)	148(3.94)	47(1.43)
Pouteria reticulata (Engl.) Eyma	sapotillo blanco	111(9.57)	243(5.18)	3(<0.005)
Sapotaceae Unknown TN 1	mamay		3(0.28)	
Sapotaceae Unknown IX 1				3(0.05)
Simaroubaceae				
Simarouba glauca DC.	negrito; dysentery bark	41(2.68)	13(0.04)	83(1.39)
Smilacaceae				
Smilax 1	red China root vine	2(0.01)	6(0.01)	
Solanaceae				
Solanum EP 1	lava plato vine	24(0.09)		
Solanum EP 2	velvet leaf	2(<0.005)		

APPENDIX 1.1 *(continued)*

FAMILY, GENUS, SPECIES	VULGAR NAME	NUMBER HA^{-1} (RELATIVE DOMINANCE)		
		EL PILAR	TERRA NOVA	IX CHEL
Theophrastaceae				
Jacquinia aurantiaca Ait.			3(0.01)	
Deherainia smaragdina Decne.				10(0.02)
Unknown				
Unknown 2	yax coch; red ramon	6(0.20)		
Unknown 16	waco/ wild ocro vine	4(0.01)	3(<0.005)	
Unknown EP 1	(white latex)	2(0.02)		
Unknown EP 5 (EP 3)		2(0.07)		
Unknown EP 7	wairú	2(0.01)		
Unknown EP 8	Wild star apple; caimito	2(0.06)		
Unknown EP 9	conch root vine	2(0.01)		
Unknown EP 10	cuello de sapo	2(0.52)		
Unknown EP 11	fluffy flowers/sm. lvs.	22(0.28)		
Unknown EP 13	fuzzy stem	2(<0.005)		
Unknown EP 14	habanero vine	13(0.03)		
Unknown EP 17	false grande Betty	2(<0.005)		
Unknown EP 18		2(<0.005)		
Unknown EP 19		2(0.37)		
Unknown EP 20	bejuco blanco	80(0.07)		
Unknown TN 1	kibish		5(0.02)	
Unknown TN 2	(vine)		3(0.01)	
Unknown TN 3	(vine)		3(0.02)	
Unknown TN 4			10(3.55)	
Unknown TN 5	guinego		3(0.01)	
Unknown TN 6	puntero		3(0.01)	
Unknown IX 1				3(0.02)
Unknown IX 4	trifolia			27(0.38)
Unknown IX 5	kinep			3(0.01)
Unknown IX 6				3(0.04)
Unknown IX 7				27(0.30)

APPENDIX 1.1 *(continued)*

FAMILY, GENUS, SPECIES	VULGAR NAME	NUMBER HA^{-1} (RELATIVE DOMINANCE)		
		EL PILAR	TERRA NOVA	IX CHEL
Unknown IX 8	jobillo			3(0.03)
Unknown IX 9				3(0.14)
Unknown IX 10				10(0.24)
Unknown IX 11	guinego			13(0.04)
Unknown IX 12	yellow manchich			3(0.01)
Unknown IX 13	bohuna			3(<0.005)
Unknown IX 14	jobillo			3(<0.005)
Unknown IX 15	kibish			3(0.01)
Unknown vines		24(0.08)	70(0.35)	53(0.18)
No Voucher		9(0.16)	10(1.38)	57(0.30)
Verbenaceae				
Lippia myriocephala Schltdl. & Cham.	sakuché	24(1.61)		17(0.43)
Vitex gaumeri Greenm.	fiddle wood; yax-nik	63(0.43)	53(9.30)	63(7.76)
Violaceae				
Rinorea 1	bahon		100(0.40)	3(0.05)
Vitaceae				
Vitis tilliaefolia Humb. & Bonpl.	bejuco de agua	9(0.02)	5(0.02)	
Total		3,230(100.45)[1]	3,056(100.98)	3,889(98.16)
Total Species 179		93	88	103

Source: Vouchers were identified using specimens at the New York Botanical Garden, and in Balick, Nee, and Atha 2000; Nash and Dieterle 1976; Nash and Williams 1976; Standley and Record 1936; Standley and Steyermark 1946a, 1946b, 1949a, 1949b, 1952; Standley and Williams 1961, 1962, 1963, 1967, 1970, 1973, 1975; Standley, Williams, and Gibson 1974; Swallen 1955.

APPENDIX 1.2 Maya Ethnobotany

SPECIES (FAMILY)	MAYA USE (REFERENCES)
Acacia cornigera (Mimosaceae)	*home garden* (Allison 1983:29) *medicinal* (Arvigo 1992:24; Arvigo and Balick 1993:47; Roys 1931:312)
A. dolichostachya	*construction* (Atran 1993:656; Mutchnick and McCarthy 1997:176) *medicinal* (Mutchnick and McCarthy 1997:176)
A. globulifera	*medicinal* (Roys 1931:312)
Allophylus cominia (Sapindaceae)	*food* (Standley and Steyermark 1949b:237)
Alseis yucatanensis (Rubiaceae)	*construction* (178, Atran 1993:667; Mutchnick and McCarthy 1997) *brooms* (Romero 1997–2001:1)
Annona reticulata (Annonaceae)	*fiber* (Atran 1993:647) *food* (Arvigo 1992:46; Atran 1993:647; Roys 1931:272; Standley and Steyermark 1946a:279) *medicinal* (Arvigo 1992:46; Arvigo and Balick 1993:187; Comerford 1996:332; Rico-Grey, Cheams, and Mandujano 1991:152; Roys 1931:272) dye (Arvigo 1992:46; Standley and Steyermark 1946a:279) *plant remains at Colha: charcoal, seeds* (Caldwell 1980:264)
Attalea cohune (Arecaceae)	*construction* (Arvigo 1992:6; Standley and Steyermark 1949a:276) *food* (Arvigo 1992:6; Mutchnick and McCarthy 1997:174; Romero 1997–2001:1; Standley and Steyermark 1949a:276) *medicinal* (Arvigo 1992:6; Romero 1997–2001:1)
Bauhinia divaricata (Caesalpiniaceae)	*construction* (Rico-Grey, Cheams, and Mandujano 1991:152) *fiber* (Rico-Grey, Cheams, and Mandujano 1991:152; Standley and Steyermark 1946b:91) *fodder* (Rico-Grey, Cheams, and Mandujano 1991:152) *medicinal* (Arvigo 1992:48; Comerford 1996:333; Rico-Grey, Cheams, and Mandujano 1991:152; Roys 1931:308, 315)

SPECIES (FAMILY)	MAYA USE (REFERENCES)
Brosimum alicastrum (Moraceae)	*construction* (Standley and Steyermark 1946a:13; Atran 1993:663) *fodder* (Arvigo 1992:56; Atran 1993:663; Rico-Grey, Cheams, and Mandujano 1991:152; Roys 1931:272; Standley and Steyermark 1946a:13) *food* (Arvigo 1992:56; Atran 1993:663; Mutchnick and McCarthy 1997:178; Rico-Grey, Cheams, and Mandujano 1991:152; Romero 1997–2001:1; Roys 1931:272; Standley and Steyermark 1946a:13) *home garden* (Allison 1983) *magico-religious* (Roys 1931:272) *medicinal* (Orellana 1987:184; Rico-Grey, Cheams, and Mandujano 1991:152; Roys 19316:272) *plant remains at Colha: charcoal, seeds, phytoliths* (Caldwell 1980:266) *tools* (Atran 1993:663 Rico-Grey, Cheams, and Mandujano 1991:152)
Bucida buceras (Combretaceae)	*plant remains at Colha: charcoal, seeds, pollen, phytoliths* (Caldwell 1980:265) *seeds at Cerros* (Dunham, Jamison, and Leventhal 1989:309)
Bunchosia lindeniana (Malpighiaceae)	*medicinal* (Romero 1997–2001:8)
B. swartziana	*construction* (Rico-Grey, Cheams, and Mandujano 1991:152) *magico-religious* (Rico-Grey, Cheams, and Mandujano 1991:152) medicinal (Rico-Grey, Cheams, and Mandujano 1991:152)
Bursera simaruba (Burseraceae)	*construction* (Mutchnick and McCarthy 1997:174; Rico-Grey, Cheams, and Mandujano 1991:152) *fodder* (Rico-Grey, Cheams, and Mandujano 1991:152) *food* (Mutchnick and McCarthy 1997:174; Rico-Grey, Cheams, and Mandujano 1991:152) *home garden* (Allison 1983:28) *living Fences* (Arvigo 1992:40, Roys 1931:228; Standley and Steyermark 1946b:440) *magico-religious* (Arnason et al. 1980:359; Rico-Grey, Cheams, and Mandujano 1991:152; Standley and Steyermark 1946b:440)

SPECIES (FAMILY)	MAYA USE (REFERENCES)
	medicinal (Allison 1983, Arnason et al. 1980:347, 348, 355; Arvigo 1992:40; Arvigo and Balick 1993:89; Atran1993:653; Comerford 1996:333; Mutchnick and McCarthy 1997:174; Orellana 1987:184; Rico-Grey, Cheams, and Mandujano 1991:152; Romero 1997–2001:3; Roys 1931:228; Standley and Steyermark 1946b:440) *plant remains at Colha: charcoal, seeds, pollen, phytoliths* (Caldwell 1980:264) *tools* (Rico-Grey, Cheams, and Mandujano 1991:152)
Casearia sylvestris (Flacourtiaceae)	*fuel* (Alcorn 1984:582) *medicinal* (Alcorn 1984:582)
Chiococca alba (Rubiaceae)	*medicinal* (Arvigo 1992:22; Arvigo and Balick 1993:16; Comerford 1996:334; Roys 1931:223)
Cryosophila stauracantha (Arecaceae)	*construction* (Arvigo 1992:30; Mutchnick and McCarthy 1997:174) *food* (Arvigo 1992:30) *medicinal* (Arvigo 1992:30; Arvigo and Balick 1993:79; Romero 1997–2001:2) *tools* (Arvigo 1992:30; Arvigo and Balick 1993:79; Romero 1997–2001:2)
Chrysophyllum mexicanum (Sapotaceae)	*construction* (Mutchnick and McCarthy 1997:180) *food* (Mutchnick and McCarthy 1997:180) *fuel* (Atran 1993:670) *tools* (Standley and Williams 1967:219)
Chrysophyllum sp.	*pollen at Cerros* (Dunham, Jamison, and Leventhal 1989:311)
Coccoloba acapulcensis (Polygonaceae)	*artisanal, making bastones* (Ortiz 1994:16) *construction* (Rico-Grey, Cheams, and Mandujano 1991:153) *fodder* (Rico-Grey, Cheams, and Mandujano 1991:153) *food* (Rico-Grey, Cheams, and Mandujano 1991:153)
Critonia morifolia (Asteraceae)	*medicinal* (Romero 1997–2001:4 and 5)
Croton guatemalensis (Euphorbiaceae)	*medicinal* (Arvigo and Balick 1993:151; Standley and Steyermark 1949b:72)
Cupania belizensis (Sapindaceae)	*fuel* (Arvigo 1992:54; Arvigo and Balick 1993:83) *medicinal* (Arvigo 1992:54; Arvigo and Balick 1993:83)

SPECIES (FAMILY)	MAYA USE (REFERENCES)
Dendropanax arboreus (Araliaceae)	*construction* (Atran 1993:649; Mutchnick and McCarthy 1997:174) *medicinal* (Atran 1993:649)
Desmoncus orthacanthos (Arecaceae)	*fiber* (Arvigo 1992:10; Standley and Steyermark 1949a:258)
Dioscorea bartlettii (Dioscoreaceae)	*food* (Nations and Nigh 1980:16) medicinal (Arvigo 1992:58; Romero 1997–2001:15)
Diphysa carthagenensis (Fabaceae)	*fodder* (Rico-Grey, Cheams, and Mandujano 1991:154) *medicinal* (Arnason et al. 1980:355, 358; Rico-Grey, Cheams, and Mandujano 1991:154; Roys 1931:316)
Dracaena americana (Liliaceae)	*fiber* (Rico-Grey, Cheams, and Mandujano 1991:154) *ornamental* (Rico-Grey, Cheams, and Mandujano 1991:154)
Eugenia axillaris (Myrtaceae)	*medicinal* (Roys 1931:248)
Eugenia oestediana (Myrtaceae)	*food* (Alcorn 1984:643) *medicinal* (Alcorn 1984:643)
Eupatorium morifolium (Asteraceae)	*construction* (Nash and Williams 1976:82) *medicinal* (Arvigo and Balick 1993:85)
Ficus maxima and ***F. schippi*** (Moraceae)	*bark paper* (Standley and Steyermark 1946a:31) *construction* (Standley and Steyermark 1946a:31) *fodder* (Standley and Steyermark 1946a:31) *magico-religious* (Standley and Steyermark 1946a:31)
Guazuma ulmifolia (Sterculiaceae)	*construction* (Rico-Grey, Cheams, and Mandujano 1991:155; Roys 1931:276) *fiber* (Atran 1993:671; Roys 1931:276; Standley and Steyermark 1949b:412) *fodder* (Arvigo 1992:16, Standley and Steyermark 1949b:411) *food* (Arvigo 1992:16; Arvigo and Balick 1993:25; Atran 1993:671; Rico-Grey, Cheams, and Mandujano 1991:155; Standley and Steyermark 1949b:411) *home gardens* (Allison 1980:64) *medicinal* (Allison 1980:70; Arvigo 1992:16; Arvigo and Balick 1993:25; Atran 1993:671; Comerford 1996:335; Mutchnick and McCarthy 1997:180; Rico-Grey, Cheams, and Mandujano 1991:155; Roys 1931:276; Standley and Steyermark 1949b:412)

SPECIES (FAMILY)	MAYA USE (REFERENCES)
	tools (Rico-Grey, Cheams, and Mandujano 1991:155; Standley and Steyermark 1949b:412)
Guettarda combsii (Rubiaceae)	*construction* (Atran 1993:667; Mutchnick and McCarthy 1997:178)
Hampea trilobata (Malvaceae)	*fiber* (Atran 1993:651; Rico-Grey, Cheams, and Mandujano 1991:155; Standley and Steyermark 1949b:396) *home garden* (Allison 1983:29)[1]
Hirtella americana (Chrysobalanaceae)	*food* (Lundell 1938:46)
Jacquinia aurantiaca (Theophrastaceae)	*barbasco* (Roys 1931:267; Standley and Williams 1967:132) *medicinal* (Standley and Williams 1967:132; Roys 1931:267) *ornamental* (Standley and Williams 1967:132 *plant remains at Colha: charcoal, phytoliths* (Caldwell 1980:268)
Laetia thamnia (Flacourtiaceae)	*construction* (Atran 1993:659) *medicinal* (Comerford 1996:333)
Licania platypus (Chrysobalanaceae)	*food* (Lundell 1938:46; Mutchnik and McCarthy 1997:176–177)
Licaria **sp.** (Lauraceae)	*construction* (Atran 1993:659) *tools* (Atran1993:659)
Lonchocarpus castilloi (Fabaceae)	*alcoholic beverage* (Atran1993:666) *construction* (Arvigo 1992:44; Mutchnick and McCarthy 1997:176) *medicinal* (Mutchnick and McCarthy 1997:176) *tools* (Mutchnick and McCarthy 1997:176)
Malmea depressa (Annonaceae)	*construction* (Mutchnick and McCarthy 1997:174; Rico-Grey, Cheams, and Mandujano 1991:156) *food* (Rico-Grey, Cheams, and Mandujano 1991:156; Standley and Steyermark 4:288) *medicinal* (Comerford 1996:332; Rico-Grey, Cheams, and Mandujano 1991:156) *tools* (Mutchnick and McCarthy 1997:174)
Manilkara zapota (Sapotaceae)	*chicle* (Arvigo 1992:62; Atran1993:669; Rico-Grey, Cheams, and Mandujano 1991:156; Roys 1931:297; Standley and Williams 1967:224) *construction* (Arvigo 1992:62; Atran1993:669; Rico-Grey, Cheams, and Mandujano 1991:156) *food* (Arvigo 1992:62; Rico-Grey, Cheams, and Mandujano 1991:156; Roys 1931:297; Standley and Williams 1967:224) *medicinal* (Arnason et al. 1980:357; Rico-Grey, Cheams, and Mandujano 1991:156)

SPECIES (FAMILY)	MAYA USE (REFERENCES)
	plant remains at Colha: seeds (Caldwell 1980:267) *Manilkara* sp. *pollen at Cerros* (Dunham, Jamison, and Leventhal 1989:311)
Neea psychotrioides (Nyctaginaceae)	*ink* (Rico-Grey, Cheams, and Mandujano 1991:156)
Pachira aquatica (Bombacaceae)	*food* (Mutchnick and McCarthy 1997:174) *medicinal* (Arnason et al. 1980:351; Arvigo and Balick 1993:137; Atran1993:651; Mutchnick and McCarthy 1997:174; Orellana 1987:224) *plant remains at Colha: charcoal, seeds, pollen, phytoliths* (Caldwell 1980:264)
Pimenta dioica (Myrtaceae)	*construction* (Atran1993:664; Mutchnick and McCarthy 1997:178) *embalming* (Arvigo 1992:26; McVaugh 1963:385) *home garden* (Allison 1983) *medicinal* (Arnason et al. 1980:357; Arvigo 1992:26; Arvigo and Balick 1993:3; Atran1993:664; Comerford 1996:334; McVaugh 1963:385; Mutchnick and McCarthy 1997:178; Orellana 1987:227; Romero 1997–2001:5) *plant remains at Colha: charcoal, pollen, phytoliths* (Caldwell 1980:267) *Spice* (Arvigo 1992:26; McVayh 1963:385; Romero 1997–2001:4) *tools* (Mutchnick and McCarthy 1997:178)
Piper amalago (Piperaceae)	*medicinal* (Arnason et al. 1980:347, 356; Arvigo 1992:38; Arvigo and Balick 1993:31; Comerford 1996:334; Romero 1997–2001:13–14)
P. neesianum	*medicinal* (Comerford 1996:334)
Piscidia piscipula (Fabaceae)	*barbasco* (Rico-Grey, Cheams, and Mandujano 1991:156; Standley and Steyermark 1946b:337) *construction* (Atran1993:665; Mutchnick and McCarthy 1997:176; Rico-Grey, Cheams, and Mandujano 1991:156; Standley and Steyermark 1946b:337) *handcrafts* (Rico-Grey, Cheams, and Mandujano 1991:156) *medicinal* (Arvigo and Balick 1993:97; Atran1993:665; Orellana 1987:228; Rico-Grey, Cheams, and Mandujano 1991:156; Standley and Steyermark 1946b:337) *timber* (Rico-Grey, Cheams, and Mandujano 1991:156)
Pisonia aculeate (Nyctaginaceae)	*medicinal* (Rico-Grey, Cheams, and Mandujano 1991:156; Roys 1931:217) *seeds at Cerros* (Dunham, Jamison, and Leventhal 1989:309)

SPECIES (FAMILY)	MAYA USE (REFERENCES)
Pouteria campechiana (Sapotaceae)	*chicle adulterant* (Standley and Williams 1967:236) construction (Standley ad Williams 1967:236) food (Standley and Williams 1967:236)
Protium copal (Burseraceae)	*fencing* (Atran1993:653) *magico-religious* (Arnason et al. 1980:358; Arvigo 1992:36; Arvigo and Balick 1993:57; Atran1993:653; Romero 1997–2001:7; Roys 1931:277; Standley and Steyermark 1946b:442) *medicinal* (Arnason et al. 1980:347; Arvigo 1992:36; Arvigo and Balick 1993:57; Atran1993:653; Comerford 1996:333; Romero 1997–2001:7; Roys 1931:278) *varnish* (Arvigo 1992:36; Standley and Steyermark 1946b:442; Romero 1997–2001:7) *resin at Cerros* (Dunham, Jamison, and Leventhal 1989:309)
Pseudolmedia oxyphyllaria (Moraceae)	*construction* (Atran1993:663; Mutchnick and McCarthy 1997:178) *food* (Atran1993:663; Mutchnick and McCarthy 1997:178; Romero 1997–2001:14) *medicinal* (Atran1993:663, Romero 1997–2001:14)
Pseudolmedia spuria (Moraceae)	*food* (Standley and Steyermark 1946a:55) *medicinal* (Mutchnick and McCarthy 1997:178)
Psychotria nervosa (Rubiaceae)	*magico-religious* (Alcorn 1984:768) *medicinal* (Alcorn 1984:768)
Sabal mauritiiforme (Arecaceae)	*construction* (Mutchnick and McCarthy 1997:174, Romero 1997–2001:3 and 15; Standley and Steyermark 1949a:289) *food* (Mutchnick and McCarthy 1997:174, Romero 1997–2001:3) *medicinal* (Romero 1997–2001:3) *seeds at Cerros* (Dunham, Jamison, and Leventhal 1989:309)
Sapindus saponaria (Sapindaceae)	*barbasco* (Standley and Steyermark 1949b:256) *construction* (Rico-Grey, Cheams, and Mandujano 1991:157) *home garden* (Allison 1983) *magico-religious* (Roys 1931:309, Standley and Steyermark 1949b:256) *soap* (Roys 1931:309, Standley and Steyermark 1949b:256) *tanning* (Rico-Grey, Cheams, and Mandujano 1991:157)
Sebastiana tuerckheimiana (Euphorbiaceae)	*barbasco* (Atran1993:646)

SPECIES (FAMILY)	MAYA USE (REFERENCES)
	construction (Mutchnick and McCarthy 1997:176) *fuel* (Mutchnick and McCarthy 1997:176) *medicinal* (Mutchnick and McCarthy 1997:176)
Sideroxylon foetidissimum (Sapotaceae)	*chicle adulterant* (Atran1993:669; Standley and Williams 1967:221) *construction* (Atran1993:669; Standley and Williams 1967:221)
Simarouba glauca (Simaroubaceae)	*construction* (Arvigo and Balick 1993:121; Atran1993:670; Mutchnick and McCarthy 1997:180) *food* (Atran1993:670; Standley and Steyermark 1946b:433) *medicinal* (Arnason et al. 1980:357; Arvigo 1992:28; Arvigo and Balick 1993:121; Comerford 1996:335; Mutchnick and McCarthy 1997:180, Standley and Steyermark 1946b:434; Romero 1997–2001:11) *tools* (Arvigo and Balick 1993:121; Mutchnick and McCarthy 1997:180)
Simira salvadorensis (Rubiaceae)	*dye* (Standley and Williams 1975:199)
Spondias mombin (Anacardiaceae)	*construction* (Mutchnick and McCarthy 1997:174) *food* (Arvigo 1992:8; Atran1993:647; Cano et al. 2000:33; Mutchnick and McCarthy 1997:174; Romero 1997–2001:7) *medicinal* (Arvigo 1992:8, Romero 1997–2001:7, Orellana 1987:243) *tools* (Mutchnick and McCarthy 1997:174) *plant remains at Colha: charcoal, seeds, pollen, phytoliths* (Caldwell 1980:264) *remnant of forest garden* (Kelley 1988:149)
Spondias radlkoferi (Anacardiaceae)	*medicinal* (Arvigo and Balick 1993:95)
Swartzia cubensis (Fabaceae)	*construction* (Atran1993:654)
Swietenia macrophylla (Meliaceae)	*home gardens* (Allison 1980:64)
Tabebuia rosea (Bignoniaceae)	*home gardens* (Allison 1980:64)
Tabernaemontana alba (Apocynaceae)	*glue* (Alcorn 1984:803) *medicinal* (Alcorn 1984:803)
Tabernaemontana arborea (Apocynaceae)	*latex for "rubber" balls* (Romero 1997–2001:5)
Talisia olivaeformis (Sapindaceae)	*fodder* (Rico-Grey, Cheams, and Mandujano 1991:157) *food* (Atran1993:669; Mutchnick and McCarthy 1997:180; Rico-Grey, Cheams, and Mandujano 1991:157; Standley and Steyermark 1946b:269)

SPECIES (FAMILY)	MAYA USE (REFERENCES)
	medicinal (Rico-Grey, Cheams, and Mandujano 1991:157) *tools* (Mutchnick and McCarthy 1997:180)
Terminalia amazonia (Combretaceae)	*construction* (Mutchnick and McCarthy 1997:176, Atran1993:656)
Thouinia paucidentata (Sapindaceae)	*construction* (Atran1993:669, Rico-Grey, Cheams, and Mandujano 1991:157) *fuel* (Atran1993:669) *medicinal* (Rico-Grey, Cheams, and Mandujano 1991:157)
Trichilia havanensis (Meliaceae)	*medicinal* (Standley and Steyermark 1946b:463; Orellana 1987:249) *tools* (Standley and Steyermark 1946b:463; Romero 1997–2001:5)
Trichilia hirta (Meliaceae)	*cosmetic* (Standley and Steyermark 1946b:464)
Vitex gaumeri (Verbenaceae)	*construction* (Arvigo 1992:50; Arvigo and Balick 1993:73; Atran1993:671; Mutchnick and McCarthy 1997;180; Rico-Grey, Cheams, and Mandujano 1991:158) *medicinal* (Arnason et al. 1980:348; Arvigo 1992:50; Arvigo and Balick 1993:73; Atran1993:671; Mutchnick and McCarthy 1997:180; Rico-Grey, Cheams, and Mandujano 1991:158; Romero 1997–2001:15; Roys 1931:300) *tools* (Atran1993:671; Mutchnick and McCarthy 1997:180; Rico-Grey, Cheams, and Mandujano 1991:158) *fodder* (Rico-Grey, Cheams, and Mandujano 1991:158) *musical instruments* (Arvigo 1992:50; Arvigo and Balick 1993:73; Romero 1997–2001:15)
Vitis tiliafolia (Vitaceae)	*fiber* (Standley and Steyermark 1949b:302) *medicinal* (Orellana 1987:252) *water source* (Nations and Nigh 1980:22; Standley and Steyermark 1949b:302)
Zuelania guidonia (Flacourtiaceae)	*construction* (Rico-Grey, Cheams, and Mandujano 1991:158) *medicinal* (Rico-Grey, Cheams, and Mandujano 1991:158)

Note: The ethnobotanical uses of "construction" and "firewood" were considered insufficient for inclusion in this appendix. However, "construction" was listed as a use if the species was already represented as being utilized in another manner.

NOTES

1. *Relative dominance* is defined in table 1.3.
2. Shannon's index of diversity is a numerical measurement of species richness and the spatial distribution of those species (equitability) based on information theory. The index of equitability is one of the components of Shannon's index. Both indexes are defined mathematically in table 1.1.
3. Sorenson's index is a numerical measure of the similarity of species compositions between two sites, ranging from 0.0 (no species in common) to 1.0 (complete similarity). Sorenson's index is defined mathematically in table 1.2.
4. *Alpha diversity* is a measure of species richness in one sample, in one place. *Beta diversity* is the turnover in species compositions among one or more samples that occur in different places. Therefore, the inverse of Sorenson's index of similarity is a good numerical measurement of beta diversity.

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