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DOMINANT PLANTS OF THE MAYA FOREST AND GARDENS OF EL PILAR: IMPLICATIONS FOR PALEOENVIRONMENTAL RECONSTRUCTIONS

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ABSTRACT.—The ancient Maya have been accused of destroying their forests yet the Maya forest today is replete with economic value, and contemporary traditional Maya forest gardeners manage and maintain the dominant plants of the forest for their economic values. Paleoenvironmental reconstructions of the Maya area have relied on the distribution of primarily wind borne pollen in ancient soil deposits, but the majority of these plants are pollinated biotically. An examination of the pollen syndromes of the dominant species of the Maya forest and the forest gardens demonstrates that only one of the dominant plants of the forest today appears in the pollen record of paleoenvironmental soil cores. In contrast, all the herbs and grasses of the high performance milpa, although dominated by maize, are in the pollen record. Rather than deforested, I suggest that the ancient Maya created a mosaic of field to forest, very little of which can be effectively defined in the palynological record.

Key words: environmental reconstruction, pollination, economic botany, ancient Maya, forest management.

RESUMEN.—Los antiguos Mayas han sido acusados de destruir la selva aunque hoy la selva Maya tiene un gran valor económico. Hoy, los tradicionales jardineros forestales maya, manegan y mantienen las especies dominantes de la selva por sus valores economicos. Reconstrucciones paleo-ambientales de la área Maya han enfocado sus interpretaciones en el polen llevado por el viento. Sin embargo, la mayoría de las plantas de la selva tropical son polinizados por animales. Un examen de los síndromes de polinización de las especies dominantes de la selva Maya y los jardines forestales demuestra que solamente una especie aparece en las muestras de polen depositado en los núcleos de los lagos locales. Además la milpa productiva, dominada por el maíz, sostiene las hierbas y pastos reconocidos en los núcleos de polen. Mas que deforestación, pienso que los antiguos Mayas crearon un mosaico desde campo hasta selva. El hecho de que los jardines Maya tradicionales estén compuestos en gran parte de especies de la selva Maya y que contienen las mismas especies dominantes que están en la selva sugiere que el paisaje era dinámico y variado. En este ensayo se argumenta que hoy la selva Maya es un jardín y los jardines tradicionales que comparten especies nativas representan una inversión significativa en la selva que ha tenido una larga historia.

RÉSUMÉ.—Les anciens Mayas ont été accusés de détruire la forêt et pourtant elle a aujourd'hui une grande valeur économique et les jardiniers traditionnels de la forêt Maya administrent et entretiennent les espèces dominantes. Des reconstructions paleo environnementales de la zone Maya se sont concentrées sur le pollen transporté par le vent et déposés dans les sols, bien que la majorité des plantes de la forêt tropicale soient pollinisées par des animaux. Un examen des syndromes de pollinisation des espèces dominantes de la forêt démontre que seule une espèce apparaît dans les registres de pollen déposé au fond des lacs locaux. Au contraire, toutes les herbes et les pâturages ayant une croissance (milpa) élevée et dominées par le maïs, s'apparentent au pollen. Donc, plus que la déforestation, je pense que les anciens Mayas ont créé une mosaïque allant du champ à la forêt qu'il est difficile de caractériser dans les enregistrements palynologicaux. Le fait que les jardins Mayas traditionnels soient composés en grande partie d'espèces de la forêt Maya et qu'ils contiennent les mêmes espèces dominantes que la forêt suggère que le paysage était dynamique et varié. On pourrait donc dire qu'aujourd'hui, la forêt est un jardin, et que les jardins traditionnels qui partagent des espèces d'origine avec la forêt ont une très longue histoire.

INTRODUCTION

The contiguous Maya forest of Belize, Guatemala, and Mexico is the northernmost tropical forest in the New World and is known for its distinctive biodiversity featuring an abundance of important economic plants (The Nature Conservancy 2007). Forming the heart of the Yucatan Peninsula, the Caribbean coast of Mexico and Belize and the greater Petén of Guatemala, the Maya forest is presently considered a conservation risk as its biodiversity is impacted by the expansion of pasture, plough, and population (Conservation International 2007). This was, however, once home to the ancient Maya civilization that, in the Classic period (AD 250–900), supported a burgeoning agrarian society based on centuries of local sustainable development and resource management (Figure 1).

Paleoenvironmental and archaeological evidence has traditionally been used to suggest that the end of the Classic period was one of social and political failure caused by environmental devastation (see Brenner et al. 2002). The question often asked is: Why did the Maya destroy their environment and provoke their collapse? Perhaps the question is not phrased correctly: maybe they did not destroy their environment. This paper explores the possibility that paleoenvironmental interpretations based on pollen data are flawed and instead that modern Maya forest gardens provide important evidence for ancient Maya environmental sustainability.

Mounting botanical studies demonstrate the important economic qualities of the Maya forest itself. Today, many commercially valued plants grow both in the forest and the garden, vanilla (*Vanilla planifolia* B.D.Jackson) and cacao (*Theobroma cacao* L.) for example. Commercially, the forest value has been measured in the hard currency of the world economy with dyewood, lumber, and chewing gum, all which were major economic facets of the eighteenth to the early twentieth centuries (Schwartz 1990). However, the majority of the dominant plants of the modern Maya forest are economically important to the Maya themselves. In the managed household forest gardens, forest plants appear for

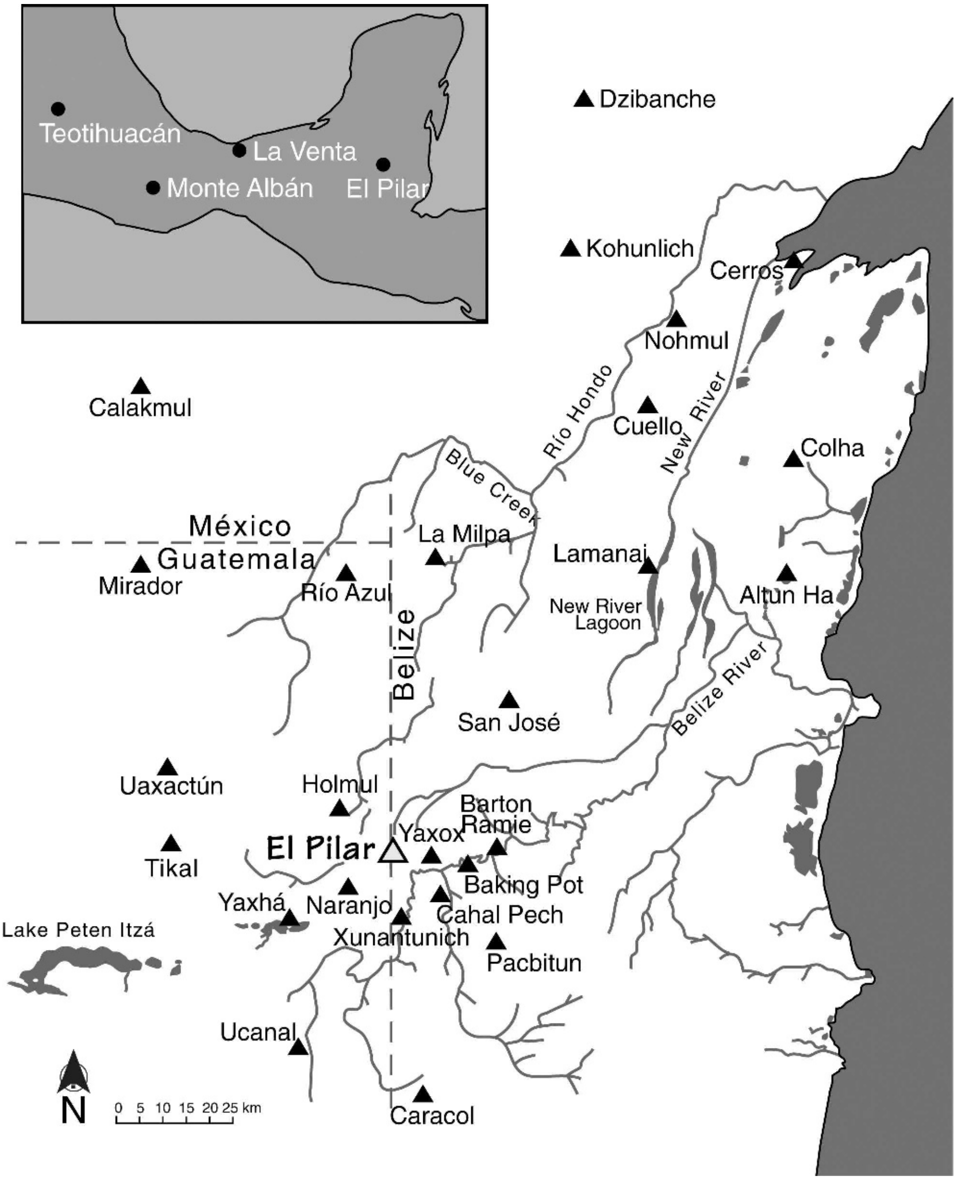

FIGURE 1.—Central Maya Lowlands with El Pilar and other Maya Centers (map created by BRASS/El Pilar).

such diverse uses as food, medicine, construction, utensils, spice, and ritual. Curiously, the forest, while biodiverse, shows relative homogeneity, unlike the Amazon, and various researchers have linked this to human interaction and management (Campbell et al. 2006; Plotkin and Famolare 1992:115). These data suggests that the Maya have long managed their forest to emphasize economically useful species.

While information on the economic value of the Maya forest is not readily accessible or even recognized in the archaeological literature on the Maya, it is commonly known among traditional farmers of the region as shown in this paper. Not surprisingly, the dominant plants of the protected forests of the region are found managed by traditional agriculturalists. These traditional managed forests areas are called forest gardens.

What is the relationship of these dominant plants of the forest and those of the traditional forest gardens to the data presented in the paleoenvironmental reconstructions? How might contemporary knowledge and land use relate to the past? The careful management of economically valued species in household and forest garden argues strenuously against the current interpretation of Maya mismanagement of the tropical forests, suggesting the need for a reassessment of paleoenvironmental reconstructions.

Understanding the pollination syndromes, the way pollen is dispersed, is critical to environmental reconstructions. Examining the pollination syndromes of the dominant plants of the forest and forest gardens provides a basis for assessing the reconstructions of past environments. Paleoenvironmental reconstructions are founded on lake core sediments and are based predominantly on wind pollen (Bradley 1999:363–64), while it is commonly understood among botanists that wind pollination is represented by less than 2% of the tropical forest species (Turner 2001:130).

This paper considers the Maya forest of the Central Maya Lowlands as a starting point in understanding the development of the Maya forest as a garden. The study describes the plants of a local cadre of twenty-three modern Maya forest gardeners within the vicinity of the ancient Maya archaeological center of El Pilar in Belize and Guatemala (Figure 2). With a general description of the nature of the plants they use, I focus on twenty dominant forest plants identified by Campbell and others (2006), all which are found in the gardens. Based on open-ended interviews, the general qualities of traditional Maya forest gardens and their management of the dominant species of the Maya forest are discussed. These dominant plants are examined for their pollination syndrome and compared with the paleoenvironmental record for a match. This study shows that because the current paleoenvironmental data rely on wind borne pollen recovered from lake core sediments, they are limited in their scope (cf. Jones 1994). Over 98% of tropical forest plants are pollinated by fauna, that is insects, birds, and bats (Turner 2001:130); the Maya forest is no exception.

THE CENTRAL LOWLAND MAYA AREA OF EL PILAR

Today, the hills and ridges of the Central Maya lowland area support the broadleaf forest dominated by palms such as corozo (*Attalea cohune*), guano (*Sabal morrisiana*) and escoba (*Chriysophilia stauracantha*), hardwoods, such as mahogany (*Swietenia macrophylia*) and malerio (*Aspidosperma cruentum*), as well as fruits such as mamey (*Alseis yucatanensis*), hogplum (*Spondias radlkofleri*), chicle (*Manilkara zapota*) and ramón (*Brosimum alicastrum*). See tables for family and authorities for these and all other plant names. The plant communities of the hills and ridges rely on a thin blanket of soil that forms directly on the limestone, known as

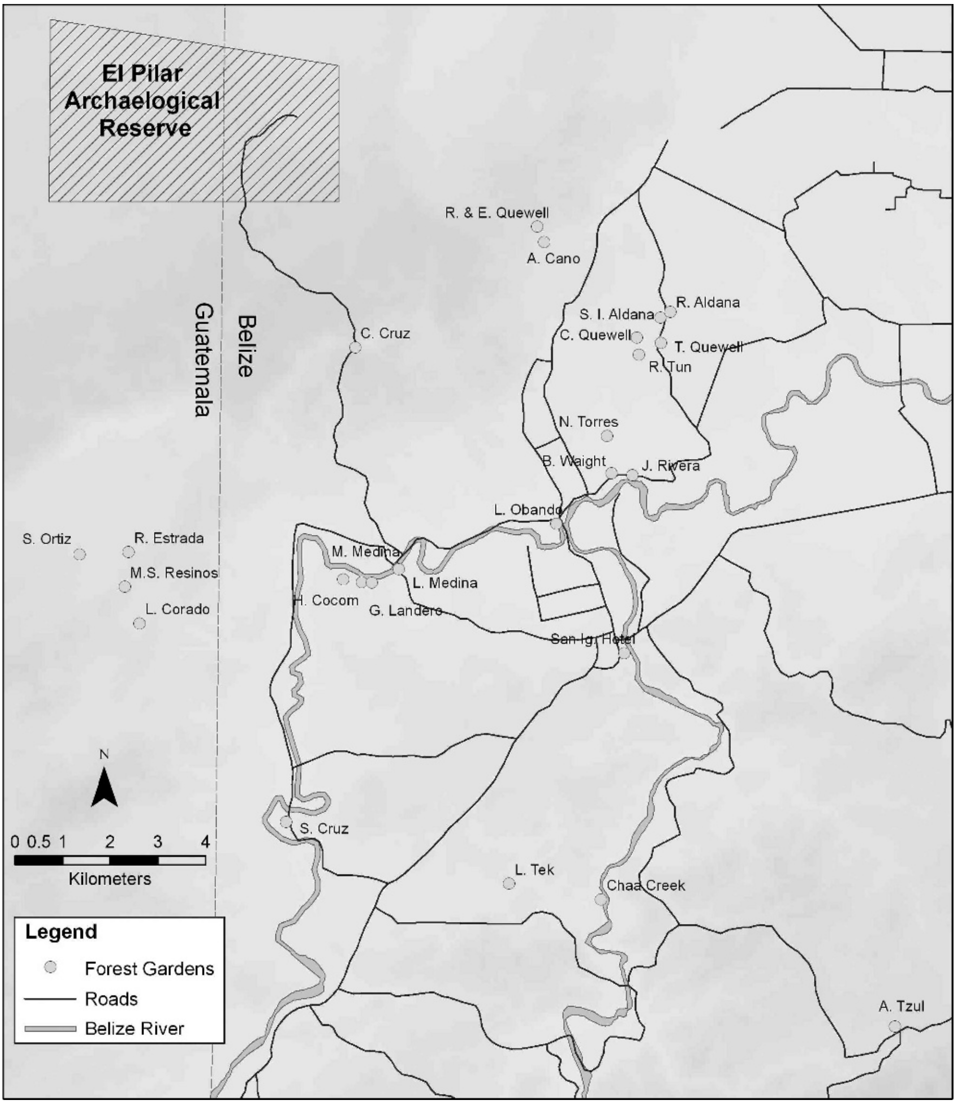

FIGURE 2.—The El Pilar Forest Garden Network (map created by BRASS/El Pilar).

molisols or rendzinas. Molisols are rich, friable, and fertile, but dependent on the continual introduction of organics from decomposed leaf litter for maintenance. These ridges and hills are precisely the same locations that were preferred by the farming settlements of the ancient Maya (Fedick and Ford 1990).

The El Pilar Archaeological Reserve for Maya Flora and Fauna, and the major Maya center it embraces, is situated at the eastern margin and ecotone at the edge of the interior ridge and hill area, with its notable absence of surface water, and the riverine area of the Belize River watershed, with significant presence of surface water (Figure 2). In ancient Maya times, El Pilar represented a vital civic center, the largest in the local area and only 50 km from Tikal. While building and maintenance of El Pilar spanned 1800 years (Ford 2004) and the civic buildings were abandoned after the Terminal Classic period c. AD 1000, there is no clear evidence that the landscape was equally abandoned. The small numbers of European forays into the Central Maya Lowlands after contact suggest that settlements existed throughout the area; however, no major centers as in the Classic period were encountered (see Jones 1998; Thompson 1988). The importance of the landscape for subsistence farmers was retained into the historic period (Mazzarelli 1977), and place names around El Pilar were known destinations by the Maya refugees of the Caste Wars (Dumond 1997). In colonial times these scattered communities were undetected and their residents lived an essentially subsistence existence.

Historically, the El Pilar area embraced dispersed settlements such as Yaloch, Chorro, and San José. The Maya maintained scattered settlements in the forest, hidden from the growing British settlements of the river valleys (Mazzarelli 1967). These settlements were ephemeral and leave little trace today (Yeager et al. 2005). In the nineteenth century, these settlements also incorporated Maya refugees of the Caste War of the Yucatan (Dumond 1997). Once discovered in the early twentieth century, settlements were forcibly relocated into the Belize River Valley (Sullivan 1978). Today, Maya descendants are found in the riverside villages, many of whom are still dedicated to the traditional agricultural practice of forest gardening. These are the cadre of traditional farmers that are the focus of this paper.

METHODS

Research at El Pilar has included community participation in studies of traditional home and forest gardens since the inception of work at the site (CONAP 2004; Ford 1990, 1998, 2004; Ford and Fedick 1992; IoA 2006). Collective work by the El Pilar communities, the El Pilar archaeological project, Amigos de El Pilar (AdEP) and Help for Progress (HfP) developed the network and the description of the traditional forest gardens of the El Pilar area. From the meetings, interviews, and visits, we have assembled an understanding of the direct and tangible values provided by community forest gardeners (MesoAmerican Research Center 2007) and resulted in a compilation of the general qualities of the forest gardens.

From 2004 to 2006, based on the foundation work of HfP in identifying the local traditional farmers with meetings and visits, the El Pilar project team followed with field visits to twenty-three traditional Maya forest gardeners in the El Pilar area. These traditional forest gardeners provided our team with an appreciation of their practice and philosophy of work. The team was able to plot the locations of their home gardens and their forest reserves (Figure 2). Data were collected and organized by student leader Kelly Moore with student participants from the El Pilar project team. Forest garden sites were located with a Global Positioning System device and plotted in the context of the Maya Forest Geographic Information System (ADL 2007; Ford and Clarke 2004).

All gardens were visited with the owners and, in open-ended interviews, the individual forest gardeners discussed their plots, identified plants, and responded to specific questions. The forest gardeners each were fully aware of the economic investment they were making, the contribution made to their households, as well as their role in conservation. Plants utilized at the time of the interviews were self-identified and recorded. The El Pilar project team's objectives were to gather data pertinent to the overall complexity of the forest gardens, to document the diversity of plants that were managed, and to itemize the plant species the traditional farmers said they maintained in the gardens. The team was particularly interested in native species and documented the presence of twenty recognized dominant forest species in the gardens. Within the context of these activities, the team gathered broad information on the categories of plant habit (grass, herb, shrub, tree, vine, etc.), their uses, general origin, and the evidence of the dominant plants of the Maya forest. With data on the variety of plants in the forest gardens, we used the literature to identify the pollen syndromes for the dominant plants of the forest and the forest gardens. This provided a basis for understanding the pollen data from the lake cores.

RESULTS

Composition of Forest Gardens.—Based on the visits and interviews with 23 forest gardeners, we were able to compile comparable data for 18 of the forest gardens (www.mayaforestgardeners.org). The results presented here are based on the 18 gardens. Agricultural activities of the forest gardens were located in the zones of recognized soil properties by the farmers as well as by soil scientists (Jenkin et al. 1976). Furthermore, they were the same zones that the ancient Maya utilized in the past (Fedick and Ford 1990).

The self-enumerated plant identifications by the gardeners in their individual gardens demonstrate a wide variety of species and habits. They represent diverse polycultivation plots that supply food, fiber and fruit, as well as fortification for soil. While many studies have focused on the maize fields and their productivity in terms of grain (Whitmore and Turner 2002), every micro-environment of an individual plot was part of the mosaic that yielded plant and animal resources for the household (see Kintz 1990:6; Wilken 1987). Ecological variations within a field or plot were generally acknowledged as advantageous rather than limiting; plants that required moist soil were encouraged in the low areas while plants that preferred drainage were nurtured in the uplands. The forest gardeners' intimate knowledge of their own landscape and the importance of the variety of habitats was part of this practice (Tzul 2001). Insects that pollinate, birds and bats that spread seed, and forage for four-legged animals are also recognized and encouraged within the context of the plot, as, of course, are animals that provide protein (see Atran 1999).

Forest gardeners of El Pilar identified a diversity of over 350 plants that they were using in the dry season (Table 1). The forest gardeners recognize nearly twenty general uses for the plants they manage (Figure 3). They are used to promote income, construction, fruit, medicine, and decor. There are plants that are used directly – food, spice, medicine; that are components of end products – soap, baskets, fans; that are enjoyed for their beauty – flowers, shade trees, foliage; and that are recognized to attract animals – birds, bees, deer. Many plants

TABLE 1.—Plant Groups of the Forest Garden.

Plant Group	Number	Percent
Grasses	8	2%
Ferns	2	1%
Lianas/Vines	37	10%
Herbs	64	18%
Shrubs	81	23%
Palms	15	4%
Trees	150	42%
Total	357	100%

have multiple uses. The medicinal category incorporated 54% of all the plants of the forest. Food for humans accounted for 43% and was differentiated from food for animals, such as forage (10%). Raw materials for production accounted for 27% and included items destined for soap, utensils, toys, fish bait, and

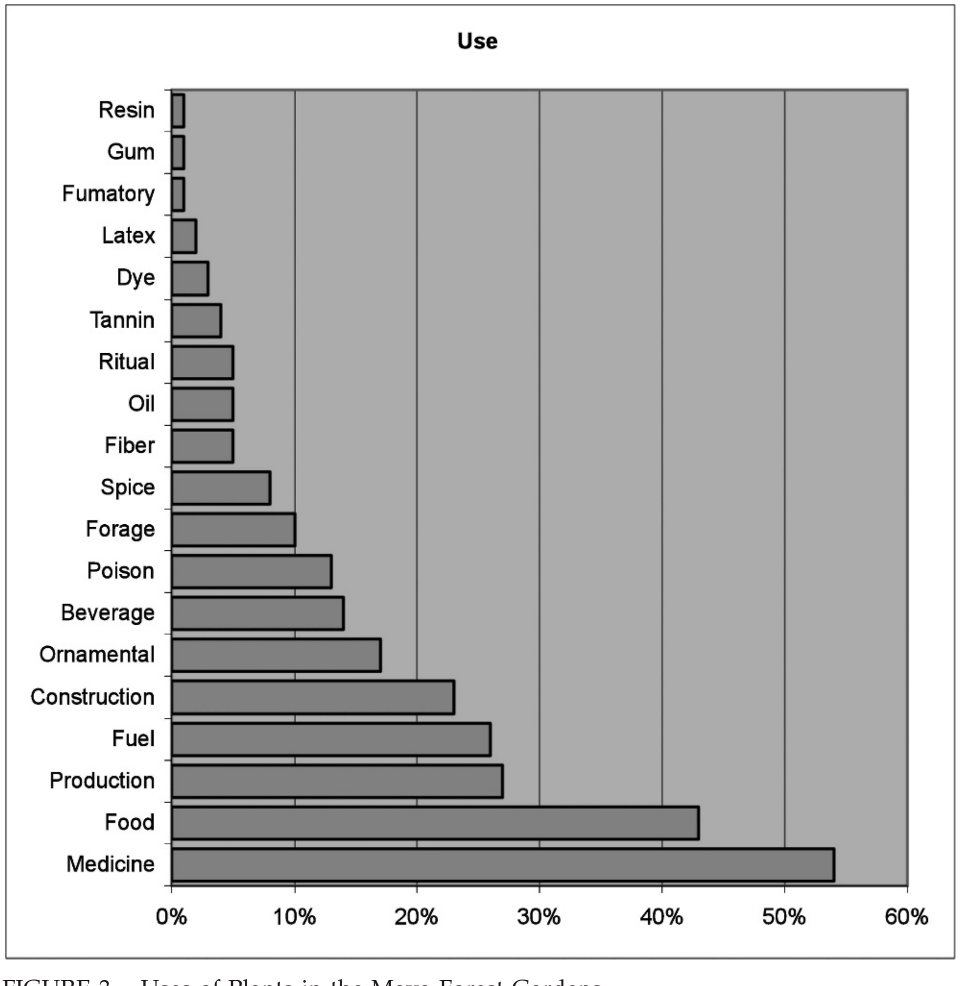

FIGURE 3.—Uses of Plants in the Maya Forest Gardens.

TABLE 2.—Origins of Plants in the Forest Gardens.

Origin	Amount	Percent
Native	192	53%
Exotic	81	22%
Unidentified	74	20%
Naturalized	9	3%
Unknown	4	2%
Total	361	100%

ingredients for household implements. Plants for diverse culinary needs included beverages (14%), spices (8%), and oil (5%). Nearly every household need is met by the resources of these forest gardens.

With 500 years of plant exchange after the Spanish conquest, it is no revelation that plants from the tropics worldwide are represented in the contemporary Maya forest garden. The forest gardens of the El Pilar area today may have banana from Southeast Asia, mango from South Asia, citrus from Asia, and coffee from Africa together with the bounty of plants native to the Maya forest. Nevertheless, the majority (53%) of the plants are indigenous to the Maya forest and Mesoamerica in general (Table 2).

Among the native plants of the forest gardens are representatives of the dominant plants of the forest (Table 3). This shows an important connection between the forest and the gardens and demonstrates the investment in the native species by the traditional farmer today. Among the most widely represented is ramón, self-identified in 77% of the compared gardens.

The household management of the dominant forest species is important in the conservation of the Maya forest. That the forest species occur in these gardens is demonstration that people are a crucial component in the maintenance and ultimately the regeneration of the Maya forest.

The managed forest gardens themselves have a different suite of dominant species emphasizing their use in the contemporary household (Table 4). It is noteworthy that native plants of the Maya forest are important and make up over half the species. Importantly, 35% of the dominant species of the garden are from the dominant species of the forest, including ramón, corozo, chicle, and gumbolimbo. As the consistent stress is on useful plants, the gardens have incorporated an array of plants drawing from native species (Table 4). Among other native species that make up more than half the garden species are found avocado, allspice, bullet tree, guava, pixoy, and guanacaste all contributing to the support of native species of the forest.

These forest gardens are integrated polycultivation plots where all major plant types are represented in layers and tiers from open sun to closed shade (Figure 4, see Table 1). They provide space for plant nurseries under the productive trees, fields for the Mesoamerican trilogy of maize-beans-squash as well as dozens of other annual herbs destined for home use that traditionally are grown in concert in the maize fields. A number of other crops are regularly found in the milpa: watermelon, jicama, sweet potato, makal, cucumber, chaya, chile, tomato, and a variety of legumes (see Bye and Qualset 1999).

TABLE 3.—Twenty Dominant Species Found in the Garden.

Family	Scientific Name	Common Name	Number of Gardens	Pollinator
ANACARDIACEAE	*Spondias mombin* L.	Hogplum, Jobo	8	insects
APOCYNACEAE	*Aspidosperma cruentum* Woodson	Mylady, Malerio	3	insects
ARECACEAE	*Attalea cohune* C. Mart.	Cohune, Corozo	12	insects
ARECACEAE	*Cryosophila stauracantha* (Heynh.) R. Evans	Give-and-take, Escoba	7	beetles
ARECACEAE	*Sabal morrisian* Bartlett	Bay leaf, Guano	14	insects
BIGNONIACEAE	*Tabebuia rosea* (Bertol.) DC.	Mayflower, Maculiz	3	bees
BURSERACEAE	*Bursera simarouba* (L.)	Gumbolimbo, Chaca	10	bees
CHRYSOBALANACEAE	*Licania platypus* (Hemsley) Fritsch	Monkey apple, Succotz	7	moths
FABACEAE: Papilionoideae	*Lonchocarpus castilloi* Standley	Cabbage Bark, Manchich	6	insects
FABACEAE: Papilionoideae	*Piscidia piscipula* (L.) Sarg.	jabin	8	bees
FLACOURTIACEAE	*Zuelania guidonia* Britton & Millsp.	Tamay, Paragua	4	bees
MELIACEAE	*Swietenia macrophylla* King	Mahogany, Caoba	2	insects
MORACEAE	*Brosimum alicastrum* Sw*	Ramon, Yaxox	14	wind
RUBIACEAE	*Alseis yucatanensis* Standley	wild mamey	5	moths
RUBIACEAE	*Simira salvadorensis* (Standl.)*	Redwood, puntero	9	moths
SAPINDACEAE	*Talisia oliviformis* Radlk.*	Kinep, Guaya	12	bees
SAPOTACEAE	*Pouteria reticulata* (Engl.)	zapote negro	1	insects
SAPOTACEAE	*Pouteria campechiana* (Kunth) Baehni	zapotillo	3	insects
SAPOTACEAE	*Manilkara zapota* (L.) van Royen*	Chicle, Chico Zapote	11	bats
VERBENACEAE	*Vitex gaumeri* Greenman	Fiddlewood, Yaxnik	4	bats

* dominant in the gardens ** After Campbell et al. 2006.

As common in other Maya communities, the traditional forest gardeners of El Pilar recognize the importance of their gardens in the contribution to biodiversity (Gómez-Pompa 1992; Gómez-Pompa and Bainbridge 1989; Gómez-Pompa et al. 1991) as well as environmental interactions (Atran 1993, 1999; Atran et al. 2000; Gómez-Pompa and Kaus 1990). They are acutely aware of the importance of managing surface water on a limestone base and work with shade and water purposely. They understand ecological services: conservation of moisture, replenishment of soil, the maintenance of the air, and the detention of erosion. Their practice includes a constant vigilance of their plots. They know where the beehives are, they acknowledge the importance of animals, and they are conscientious about potential disease, recognizing and addressing changes

TABLE 4.—Dominant plants of the forest Gardens.

Family	Species	Common Name	Pollinator
ANACARDIACEAE	*Mangifera indica* L.	mango	insects
ANNONACEAE	*Annona muricata* L.	guanabanaˆ	insects*
ARECACEAE	*Cocos nucifera* L.	coconut	insects, wind
ARECACEAE	*Sabal morrisian* Bartlett	bay leaf palmˆ	insects*
ARECACEAE	*Attalea cohune* C.	corozoˆ	insects, wind*
BOMBACACEAE	*Ceiba pentandra* L.	ceibaˆ	phyllostomid bat
BROMELIACEAE	*Ananas comosus* (L.) Merr.	pineapple	humming birds
BURSERACEAE	*Bursera simarouba* (L.)	gumbo limboˆ	bees
CACTACEAE	*Opuntia cochenillifera* (L.) P. Mill	nopalˆ	insects
CAESALPINIACEAE	*Pachyrhizus erosus* (L.)	jicamaˆ	insects
CARICACEAE	*Carica papaya* L.	papayaˆ	insects, wind
CECROPIACEAE	*Cecropia peltata* L.	trumpet treeˆ	wind*
CLUSIACEAE	*Calophyllum brasiliense* Cambess	Santa Mariaˆ	halictid bees
COMBRETACEAE	*Bucida buceras* L.	pukteˆ	insects
CUCURBITACEAE	*Cucurbita pepo* L.	cucumber	bees
CUCURBITACEAE	*Momordica charantia* L.	sorosi	insects
DIOSCOREACEAE	*Dioscorea bartlettii* C.V.Morton	red china root	bees
EUPHORBIACEAE	*Cnidoscolus chayamansa* McVaugh	chayaˆ	insects
EUPHORBIACEAE	*Manihot esculenta* Crantz	cassava	insects
FABACEAE: Mimosoideae	*Acacia cornigera* (L.) Wild	black cockspurˆ	insects, birds
FABACEAE: Mimosoideae	*Enterolobium cyclocarpum* (Jacq.) Griseb.	guanacasteˆ	insects
FAGACEAE	*Quercus oleoides* Schltdl. & Cham.	encinoˆ	wind
LAURACEAE	*Persea Americana* P. Mill	avocadoˆ	honey bees
MALPIGHIACEAE	*Byrsonima crassifolia* (L.) Kunth	crabooˆ	insects*
MELIACEAE	*Guarea glabra* Vahl	cedrillo	insects*
MORACEAE	*Brosimum alicastrum* Sw.	ramonˆ	wind
MUSACEAE	*Musa paradisiacal* L. (pro sp.)	banana	bats, birds
MYRTACEAE	*Pimenta dioica* (L.) Merr.	allspiceˆ	insects, birds
MYRTACEAE	*Psidium guajava* L.	guavaˆ	insects
POACEAE/ GRAMINAE	*Saccharum officinarum* L.	sugar cane	wind
POACEAE/ GRAMINAE	*Cymbopogon citratus* (DC. Ex Nees) Stapf	lemon grass	wind
RUBIACEAE	*Hamelia patens* Jacq.	ixcananˆ	insects*
RUBIACEAE	*Simira salvadorensis* (Standl.)	john crow redwoodˆ	moth
SAPINDACEAE	*Talisia oliviformis* Radlk.	kinepˆ	bees*
SAPOTACEAE	*Manilkara zapota* (L.) van Royen	chicleˆ	bats
SAPOTACEAE	*Pouteria sapota* (Jacq.) H>E> Moore & Stearn	zac-xa-nalˆ	bats*
STERCULIACEAE	*Guazuma ulmifolia* Lam.	bay cedarˆ	bees

ˆ species native to Mesoamerica and the Maya forest.
* pollinator was found for a plant with same genus but different species.

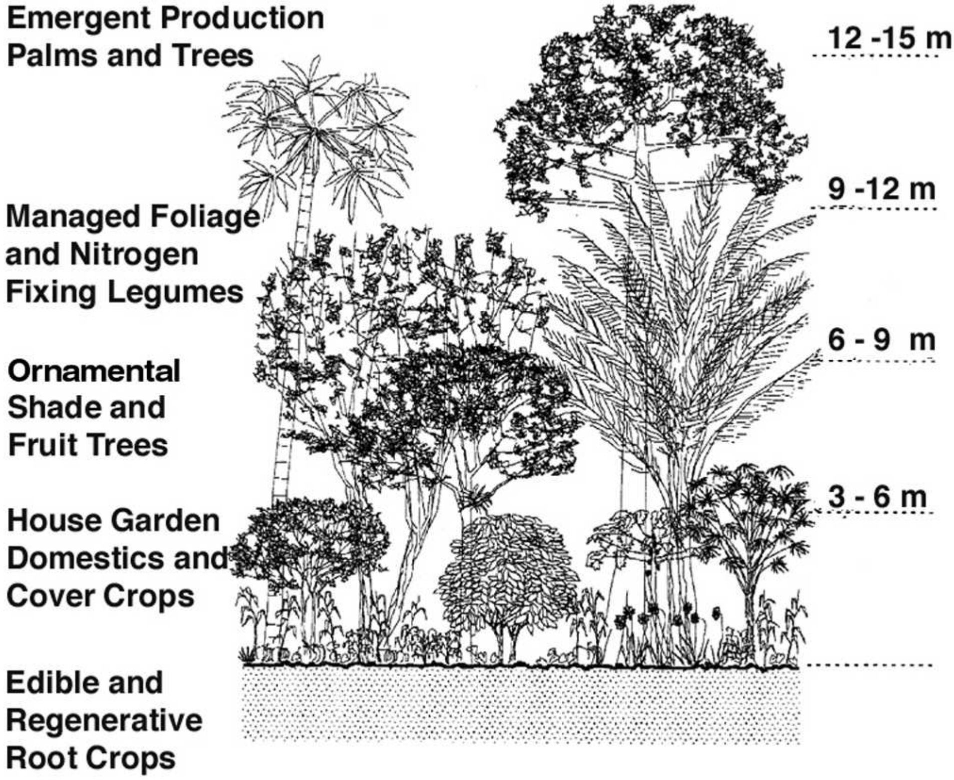

FIGURE 4.—The Structure of the Maya Forest Garden (illustration produced by BRASS/El Pilar).

immediately. They have no specific word for weed, but rather use the compound term ''good and bad herb,'' distinguishing the habit of the plant. Depending on the surroundings, in one context plants may be good while in another bad (see Gleissman 1978, 1981). Ever alert to modifications and growth, they will happily keep a volunteer herb or tree when they determine it makes for good competition, but later it may crowd out preferred trees, as with an example of allspice, and be removed. This is where values shift, such that in one setting a particular growth is desirable while in another it is detrimental. The forest gardeners of El Pilar demonstrate a vital understanding of their environment and the consequences of their interactions with the environment, something that has also been seen as part of their language (Atran 1993, 1999).

Pollen Syndromes of the Forest and Forest Gardens.—Turning to the composition of the forest and the forest garden, I now consider the issue of pollination. Taking a look at the trees that make up the majority of the Maya forest (Campbell et al. 2006), what is remarkable is how they are pollinated (see Table 3). Nearly all of the plants are pollinated by various kinds of animals (Anderson et al. 1991; Brooklyn Botanic Garden 2007; Chazdon et al. 2003; Crane and Balerdi 2007a,b; Hequet 2007; Novick et al. 2003; Peters 1983; Tomlinson 1990; Turner 2001; Tzul

2007). Only one plant, the ramón, is wind pollinated (Peters 1983). Considering the composition of the dominant plants of the contemporary forest gardens, there too, wind pollination is the exception (see Table 4). The majority (84%) of the plants from the gardens are animal pollinated (Afik et al. 2006; Anderson et al. 1991; Carr 2006; Chazdon et al. 2003; Collins 1960; Daehler 2005a,b,c,d,e; Fischer and Santos 2001; Frankie et al. 2004; Hamrick 2007; Hequet 2007; Lenzi et al. 2005; Nepi and Pacini 1993; Parfitt and Pickett 1980; Plants for a Future 2007; Roubik et al. 2005; Sather 1999; Tomlinson 1990; Tudge 2006; Turner 2001; Tzul 2007; Whitlock et al. 2001). This is consistent with the assessment of tropical forest environments worldwide where at least 98% of the plants are pollinated by animals (Turner 2001: 130) and where winds below the canopy are so slight that even small grains of pollen are too heavy to spread effectively in and outside the forest (Faegri and Pijl 1979:39).

DISCUSSION

The pollen data from lake core sediments of the Petén and their interpretations have sustained the view that the Maya civilization, with its population growth and concomitant environmental impacts, destroyed the forest and caused the collapse of the civilization (see Diamond 2005; Webster 2002 but compare Gómez -Pompa and Kaus 1999). The source of this position has been the fluctuation of the family Moraceae, and the specific tree *Brosimum alicastrum*, also known as ramón (Binford et al. 1987; Brenner 2002; Islebe 1996; Leyden 2002). It has been consistently noted that with the rise in the proportion of Moraceae, and therefore *Brosimum alicastrum*, there is a lower proportion of grasses and herbaceous species. Conversely, with the rise of grasses and herbaceous species, there is a drop in Moraceae, and by inference *Brosimum alicastrum*. This is particularly noteworthy for the contrast from Classic to the Postclassic periods where it is argued that the rise of Moraceae reflects the recovery of the forest, yet it is implied for the Preclassic into the Classic periods as well, when Moraceae drops with the rise of the Classic Maya civilization (Binford et al. 1987; Brenner 2002; Islebe 1996; Leyden 2002).

The signal of Moraceae, and presumably *Brosimum alicastrum* as well, is an important one in the interpretation of the ancient Maya landscape, but what does it really mean? It has been unilaterally accepted that this signal is the reflection of the forest's contraction and expansion. Ramón, however, is both a pioneer as well as a high canopy species. While it occupies an important niche in the top twenty dominant species of the forest and is an important canopy species today, it also is among the early succession plants particularly in the areas of exposed limestone (Lambert and Arnason 1982), noted in Maya pastures (Campbell this volume), and traditionally has played a role in the Maya forest garden (Culhane 2002; Vohman 2007).

Given the diversity found within the traditional forest gardens, and the role of ramón in the forest and the forest gardens, alternative explanations must be entertained before the current equation of ramón and forest may be accepted. Among them should be 1) the justification of why ramón is used as the forest indicator rather than simply one signal of change, 2) the reflection on a diversified economic forest that would restrict the spread of ramón pollen, 3) the consideration of the drop of ramón in the Classic period as a result of ramón suppression in favor of other important fruit and hardwood trees that do not contribute to the pollen assay, and 4) the interpretation of the rise of ramón in Postclassic as a consequence of the rich pioneering opportunity offered by the lack of maintenance of the Classic period public constructions.

Turning to a consideration of the grasses and herbaceous species, these have been taken as an indicator of open cleared forests. Yet all these species are common and cohabit the traditional high performance milpa (Wilken 1987). Many of these herbs are integral to local diet and nutrition. Examples abound and include amaranths and chenopods, used for edible greens and seeds (Bye and Calvin 1999). In addition, many of the woody herbs and grasses that immediately follow in the stages of succession, when maize was no longer sown, provide important food sources as well (Brubacher 1989) as they also play a role in the fostering of regeneration (Lambert and Arnason 1986). This regeneration is orchestrated to include numerous fruit and hardwood trees that later provide necessities for the household. In fact, the major herbaceous pollen identified in the cores is from plants in managed milpa settings (Bye and Calvin 1999; Birol and Villalba 2006). In other words, the signal of ramón and herbs in the pollen record are simply recording the presence of the Maya on the landscape, not the destruction of the forest.

In this new scenario, the presence of herbs and grasses are a signal of human habitation and land management, not the absence of forest (see Jones 1994; VanDenwarker 2006). It is well known that herbs and grasses are wind pollinated and will contribute robust quantities of wind borne pollen across the landscape and into the sediment records of lakes (Bradley 1999). The issue is not that there is disturbance, for there certainly must have been as settlements are recorded in all the well drained zones (Ford 1986; Ford 1990; Puleston 1973; Rice 1976), but whether the forest was displaced because of these disturbances. An alternative hypothesis is that the changes wrought with the expansion of populations and civic centers altered the environment to a more varied mosaic of fields, orchestrated succession plots, and managed forests, leaving no area untouched (Gómez-Pompa and Kaus 1990; Peters 1983), but like the forest gardeners of El Pilar, the mosaic was managed under the framework of tropical diversity to maintain soil quality, conserve moisture, manage surface water, and provide for the population.

Reflecting on the contemporary forest gardens, it is evident that they are integrated plots aimed to fulfill basic household needs. All major plant habits are represented with layers and tiers of trees, bushes, and ground plants that range from sun and shade (see Figure 4). Complex and dynamic, the ever-changing plots that are maintained by the forest gardeners reflect the changing seasons, the importance of household needs, and the gathering knowledge of the manager. The plots have trees that produce pollen for animal distribution as well as plants that are contributors to wind pollen distribution (Table 4). Plant cover is a part of every stage of succession. An open field at one stage will be an orchard at another representing the dynamic investment in the landscape.

The dynamic quality of the tropical environment introduces variety from one forest garden to the next and depends on the agricultural and residential cycle. Further, with the diversity of the mosaic produced at the landscape level, one can well imagine that at the time of the Classic period with the greatest population levels, pollen formed by the disturbance herbs and grasses that produce copious wind pollen could easily overshadow the forest species unrepresented by wind pollination, but not underrepresented across the area.

The Classic period residential structures themselves, distributed at c. 200 per sq km in the well-drained uplands and marginally present outside swamps in all areas at lower densities (Fedick and Ford 1990; Ford 1986; Ford and Clarke 2004, Ford et. al. in press), would be expected to release a signal of disturbance. But disturbance need not mean at the expense of the forest. Since the forest pollen signal would be underrepresented, we cannot expect to have the full story captured in the evidence of the ancient lake core sediments (Gómez -Pompa and Kaus 1999:3). We need to infer the whole from an understanding of the agricultural system.

The Maya forest gardens represent cycles of growth, maturation, and demise with a continuum of annual open high performance milpa fields to closed orchards of diverse fruits and hardwoods trees. Each household supports plots in phases from field to forest. This continuum of fields, gardens, and forests together meet the needs of household subsistence. As the Maya forest and gardens of today share in common the maintenance of twenty dominant trees known from the forest, it is reasonable to suggest that this relationship has a long past. Hints that link to the past may be found in the promise of identifying phytoliths in archaeological soil deposits (Bryant 2003) to add to the data from the growing pollen record.

The pollination syndrome of the tropics parsimoniously explains the lack of other tree pollen in the lake core sediments of the Central Maya lowlands. Since ramón is but one of the dominant species of the forest, it stands as a potential indicator for the forest. Yet, the fact that it is the only species on the list of dominant trees that is pollinated by wind, it does not justify the reliance on ramón pollen as the key indicator of forest. It could be as likely that all twenty species now recognized as dominant species were part of the composite diversity of the Maya forest of the past. The fluctuations of ramón pollen are suggestive of another hypothesis: ramón is naturally present in the unmanaged forest, yet when humans are actively managing the forest, as must have been the case for the Classic period Maya as it is today with the contemporary Maya forest gardeners, they favor a greater diversity of tree species to meet their household needs. These are precisely the trees that will not appear in the lake pollen record and thus would have a significant impact on the reconstruction of the landscape.

CONCLUSION

In sum, contemporary forest garden plots are complex and cycled differently for each household to match its needs. These traditional gardens all share the dominant plants of the forest providing a backdrop for the regeneration of the forest architecture. In addition, these same gardens harbour many native species that are found in the forest itself. These species, too, are nurtured and help to maintain the biodiversity of the forest. Far from destroying the environment, the forest gardeners are supporting the forest, nurturing the economic plants that sustain their life and contribute to the maintenance of the Maya forest as a whole. These remarkable farmers are not only maintaining their time honoured traditions, but in their practice they are the real heroes of the conservation efforts in the region. Without them there likely will be no forest at all.

The contemporary traditional Maya forest gardener of the El Pilar area focuses on a diversity of plants that they recognize as useful, including plants that are used directly, are components of end products, are enjoyed for their beauty or to attract animals. The vast majority of the forest and garden plants rely on animals for pollination and consequently would not be conspicuously represented in the pollen captured in lake cores from the area. The data of the pollen record is a vital signature of the past environment, and needs to be critically interpreted. The lack of most of the forest trees in this paleoenvironmental record does not imply their absence from the landscape, just that their pollen is not easily carried by wind to the lakes. Indeed, their absence is consistent with expectations of palynologists worldwide who have long recognized the difficulty of vegetation reconstructions where there is a disparity in pollen distribution syndromes and even in production (Bradley 1999:362–64). That the Maya forest is a garden today and that the traditional forest gardens share native species suggests that the Maya have historically invested in the forest, and that the forest is dependent on management by people in a relationship that may very well reach into the distant past.

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