18 THE MILPA CYCLE AND THE MAKING OF THE MAYA FOREST GARDEN

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The traditional Maya milpa has been widely misunderstood. A multicrop polyculture system cycles through stages that are skillfully managed towards regenerating a useful repertoire of plant habitats. Starting with a maize field that includes some 30 cultigens, the succeeding stages purposely favor first short-lived then long-lived perennials represented in the dominant species of the Maya forest. The Lakandon example demonstrates how the cycle begins with cutting the woody plants to produce fuel for a hot burn that is known as slash-and-burn. Then it cycles from a maize dominated field into a diverse hardwood forest based on skilled planting and selecting. The well-adapted strategy evolved to provide subsistence at every stage of landscape regeneration from the sun exposed open clearings to the shaded closed forest canopy. The economic plants that make the Maya forest today owe their presence to the pernicious human process of selection that has endured over the millennia.

Introduction

It is generally believed that the time between the domestication of crop plants and the adoption of an agrarian lifestyle was a short transition period, as the obvious advantages of agriculture would have been evident to early cultivators. Yet this does not appear to be the case, at least for Mesoamerica and in the Maya area. The 'transition stage' was quite long, more than 2,000 years, and judging from the steady expansion of archaeological habitation sites, was a very stable socio-ecological formation. During the millennia of intimacy not only were people and cultures profoundly influenced by the forest, but human practice began to shape the forest environment as well. This dialogue is evoked in the description of kanaan k'ax, a Yucatec term meaning 'owned' or 'managed forest' that, when used by contemporary Maya forest gardeners, implies both learning and stewardship (Barrera Vásquez 1980, McAnany 1995, Tzul 2001).

Plant domestication and even serious horticulture, such as forms of milpa, were practiced by the middle Holocene inhabitants of the lowland forests, long before the advent of sedentary agricultural villages (Smith 1998). Pollen evidence of maize cultivation begins to provide a recognizable signal in the sediment cores from the Archaic period only to become prominent in the Preclassic (Pope et al 2001), despite the highly degradable nature of maize pollen (Bryant 2003). Yet it is unlikely that these early horticulturalists as well as later agriculturalists, lacking steel tools, engaged in widespread forest clearance (Denevan 1992). Their adaptation was a gradual intensification (Johnston 2003). The Maya forest is as much a part of the archaeology of the Maya as the sites themselves. It was created with the development of the milpa (Ford and Nigh 2009).

The Milpa Cycle

The Maya forest is an anthropogenic landscape (Atran 1993) that developed as a result of generations of environment management responsive to critical human needs and sustainability during the precipitation chaos that marked the millennium after 4,000 ya (Hodell et al. 2008; Haug et al. 2001). The principal tool of the Mesoamerican and Maya agrarian system is commonly known as the milpa (Wilken 1987). The product of the long adaptation to the tropical forest of Mesoamerica beginning in the Archaic, the milpa is widely misrepresented. It is the milpa cycle that is the axis of the resilient Maya natural resource management system (Altieri 2002; Ford and Nigh 2009; Teran and Rasmussen 1994).

The milpa system is associated with the Mesoamerican smallholder. Among traditional farmers, it is a polyculture based on maize and intercropped with plants taken from a repertoire of over 70 crop species domesticated in Prehispanic times. The Maya milpa entails a rotation of annual crop with a series of managed and enriched intermediate stages (Table 1) culminating in the reestablishment of the forest on the once-cultivated parcel (Hernández Xolocotzi, Bello Baltazar, and Levy Tacher

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Figure 1. The Milpa Cycle

Figure 2. The Staged Sequence of the Milpa Cycle. (a) Stages 1 & 2~ open multi-culture maize field; (b) Stages 3 & 4 ~ long lived perennial succession; (c) Stages 5 ~ mature perennial harvests

1995, Nations and Nigh 1980, Terán and Rasmussen 1994).

From our perspective, the adaptation and resilience of the forest garden-milpa cycle (Figure 1) provides insight into the development of the ancient Maya landscape (Ford and Nigh 2009). The milpa was the core of the innovative Maya forest garden that underwrote the development of the ancient Maya. Understanding the Mesoamerican milpa as a basic component of the forest garden is essential. The foundation was created in the Archaic and the development of its adaptive qualities occurred under the duress of climate change (Hodell et al. 2008; Haug et al. 2001) as it evolved as a sustaining system (Ford and Nigh 2009), imminently conducive to intensification based on skill and labor (cf. Bray 1994).

The interdependence of Maya milpa agriculture with the tropical forest is largely misunderstood. We can gain some insight to this issue by examining a recent ethnographic example of the Lakandon from Chiapas. The Maya undoubted employed a wide variety of farming systems, as they do today. We are not suggesting that, for example, the Lakandon milpa is general model of ancient Maya subsistence. We are suggesting, however, that it illustrates the kind of sophisticated cultural engagement with the forest environment characteristic of many Mesoamerican adaptive management systems (Nigh 2008; Toledo et al. 2003).

The Lakandon rainforest is currently home to some 500,000 indigenous people largely of Maya ancestry. The Lakandon are the smallest of the Maya groups, but have the longest history of occupation of the lowland forest. The traditional Lakandon subsistence strategy is one of multiple land use, in which several ecological zones were managed and exploited concurrently.

In addition to milpas and homegardens around the Lakandon house site, regenerating forest derived from agriculture, mature forest, as well as aquatic and semi-aquatic areas were exploited. While these regenerating and forest zones have been perceived as abandoned, examining this subsistence system in detail reveals the enormous diversity of plant and animal resources utilized by the Lakandon (Durán Fernández 1999, Levy Tacher et al. 2002, Nations and Nigh 1980, Nigh 2008).

Lakandon men traditionally dedicated the greater part of their days to milpa work, in addition to hunting and gathering forest resources. Women and children helped during periods of high labor demand such as harvest, as is common in other parts of Mesoamerica. Such dedication to milpa work allowed diversification and productivity rarely noted for this agricultural system recent times. This provides us with a unique contemporary example of what Wilken (1971) called the "high-performance milpa," a form likely to have been far more commonly practiced in densely occupied ancient Mesoamerica.

The impact of Lakandon Maya management practices on regenerating forest, however, is where the true subtlety of the system is revealed. Lakandon Maya farmers chose cultivation sites surrounded by forest to maintain a source of mature forest seeds for succession. The result of this practice combined with intensive daily weeding of the cropping area, was a careful control of the soil seed bank oriented towards achieving rapid forest regeneration (Nigh 2008).

Careful weed management extended the useful life of the field for annual crop production, allowing five to eight years of high-yield continuous cropping (Figure 2A), while less-intensive milpas in this region today under conventional weeding or herbicide treatment can be planted for a maximum of three years running before being overwhelmed by herb and shrub competition (see Johnston 2003).

Weeding practices also resulted in a more judicious use of fire, avoiding negative effects on soil ecology (cf. Gleissman et al. 1981). By contrast, in the conventional, or less-intensive milpa widely practiced by contemporary farmers the entire field is weeded in a single effort lasting several days on two or three occasions during the cultivation cycle. Weeds are allowed to proliferate after the last cleaning as the maize crop grows to harvest stage, which means that the vegetation must be cleared and burned over the entire field in preparation for the next planting cycle.

In traditional milpa, epitomized by the Lakandon practice, however, small piles of weeds and crops residues were burned periodically throughout the year, and the ashes spread about the field. A hot burn over the entire field occurred only once in the five to eight year cultivation cycle, when the primary vegetation is cleared to initiate cropping. Most weeds pulled or cut were not burned at all, but left in the field to decompose. These practices provided a continuous supply of labile organic matter and biochar and resulted in a highly enriched anthropogenic soil observed on Lakandon fields (cf. Wilken 1987), similar in some ways to the terra preta of the Amazon (Glaser et al. 2001, Peterson, Neves, and Heckenberger 2001). This is a system typically called slash-and-burn, but is really select-and-grow, so essential to the establishment of the forest garden.

Control of the seed bank has a profound effect on the successional processes that follow the end of the cycle of maize cultivation (Figure 2B & C). Academics and others usually describe the stages of succession on agricultural fields, especially in the tropics, as periods of 'abandonment' after cultivation. The idea is that the farmer simply lets his fields rest, allowing the natural processes of regeneration to restore fertility. This description is far form the truth. For the Lakandon Maya, the phases that follow cultivation received attention equal to that of the milpa and gainsays the notion of 'abandoned' fields.

According to forest ecologists, processes of secondary forest succession develop as an ordered series of stages that can be identified by the functional relations of woody species (Chazdon 2008). The Lakandon recognize and name these stages and the associated functional groups. Successional communities on traditional Lakandon fields have a species composition that is more similar to the original rainforest than on those that derive from contemporary milpa practices (see Table 1). Thus, forest recovery is hastened under traditional management (Nigh 2008).

Lakandon farmers dispersed seed of balsa (Ochroma pyramidale), in order to create thick stands of this fast-growing, short-lived canopy tree (Levy Tacher and Golicher 2004). This species has been used by generations of Lakandon farmers to reduce the forest regeneration period, replenishing soil organic matter and enhancing weed control. Perhaps a dozen other trees were also managed for their beneficial effects on soil fertility (Levy Tacher 2000). Through these means, the Maya obtained a selection of species of interest to humans during the process of forest regrowth.

As the Lakandon example illustrates, Maya milpa cycle is a complex multicropping system built around the rotation of maize fields with secondary stages of forest. Forest regeneration and succession is managed, tree species are selected—eliminated, planted or encouraged to grow—so that composition is affected and the trajectory of regeneration is directed to desired states of economic and cultural utility. The milpa is a central tool in the creation, development, and maintenance of the forest garden (Teran and Rasmussen 1994, Ford and Nigh 2009).

Implications

An understanding to the Lakandon system and the importance of the milpa cycle in the management of the Maya forest provides insights into the nature of Archaic mobile horticulturalists. These early cultivators would have employed and expanded small clearings in the forest, observing and eventually intervening in the processes of forest succession, similar to the Lakandon system discussed above. Other tools were available to the early forest gardeners, the precursors of what we know would become sophisticated forms of silvicultural and agroforestry practices by indigenous peoples throughout the Neotropics (Peters 2000). These systems left their imprint on the forest long after the management activities have been abandoned (Campbell et al. 2006).

An example is the pet kot, a form of forest modification practiced until recently by the Yucatec Maya and first described by Gómez Pompa and colleagues (1987). The pet kot is a tall, managed stand created in niches in the forest that contrast greatly with surrounding lower deciduous vegetation. Pet kot may arise from old fields or simply from special attention

Milpa Stages	**Dominant Plants/Preparation plants of the Milpa Cycle-Forest Garden** ***bold indicates wind pollination***
Stage 1-2 1-3 yrs 3-7 yrs	Open milpa: ~30 cultigens selected from ~ 70 spp, including **maize,** squash, beans**, tomato,** macal, chili, **herbs**. Also major families**: Ambrosia, Compositae, Amaranthaceae, Cecropia, Trema, Mimosa, Cyperaceae, Melastomataceae, Poaceae, Asteraceae, Urticaceae, Euphorbiaceae,** Palms; Coppiced bushes and trees to re-sprout; as well as short lived perennials; Seedling fruit trees for Stage 3-4
Stage 3-4 7-15 yrs 15-30 yrs	Long lived Perennials ~ Fruit trees: *Annona muricata* L., *Sabal morrisian* Bartlett, *Attalea cohune* C., *Ceiba pentandra* L., *Ananas comosus* (L.) Merr., ***Bursera simarouba*** (L.), *Opuntia cochenillifera* (L.) P. Mill, *Pachyrhizus erosus* (L.), *Carica papaya* L., ***Cecropia peltata*** L., *Calophyllum brasiliense* Cambess, *Bucida buceras* L., *Cucurbita pepo* L., *Cnidoscolus chayamansa* McVaugh, *Manihot esculenta* Crantz, *Acacia cornigera* (L.) Wild, *Enterolobium cyclocarpum* (Jacq.) Griseb. , ***Quercus oleoides*** **Schltdl. & Cham.**, *Persea Americana* P. Mill, *Byrsonima crassifolia* (L.) Kunth, *Guarea glabra* Vahl, ***Brosimum alicastrum*** **Sw.**, *Pimenta dioica* (L.) Merr., *Psidium guajava* L., *Hamelia patens* Jacq., *Simira salvadorensis* (Standl.), *Talisia oliviformis* Radlk., *Manilkara zapota* (L.) van Royen, *Pouteria sapota* (Jacq.) Moore & Stearn, *Guazuma ulmifolia* Lam. Seedling long lived perennial hardwoods interspersed with fruit trees for Stage 5 Hardwoods shade fruit trees in later stages
Stage 5 Harvest & ready for Stage 1	Closed Canopy well managed forest ~ Kanan Kaax *Spondias mombin* L., *Aspidosperma cruentum Woodson, Attalea cohune C. Mart, Cryosophila stauracantha (Heynh.) R. Evans, Sabal morrisian Bartlett, Bursera simarouba (L.), Licania platypus (Hemsley) Fritsch, Lonchocarpus castilloi Standley,* *Piscidia piscipula (L.) Sarg, Zuelania guidonia Britton & Millsp., Swietenia macrophylla King,* ***Brosimum alicastrum Sw****, Alseis yucatanensis Standley, Simira salvadorensis (Standl), Talisia oliviformis Radlk, Pouteria reticulata (Engl.), Pouteria campechiana (Kunth) Baehni, Manilkara zapota (L.) van Royen, Vitex gaumeri Greenman*

Table 1: Dominant Plants of the Milpa Cycle showing the Biodiversity at Each Stage of the Cycle

given to favorable sites by continual enrichment with new species. Many are species common to local home gardens such as Brosimum, Spondias, Pithecellobium, Malmea, Bursera, and Sabal. In similarly enriched areas around cenotes, Gómez Pompa's team observed cacao trees of a variety found commonly far to the south in Chiapas (Gomez Pompa et al. 1990). These microenvironments create their own water regime, producing more humidity and mist than unmanaged areas.

Such forest modification practices would have preceded established agriculture. When wet forests retreated to the most humid areas in response to periodic region-wide climatic drying, a condition that occurred cyclically in Maya history (Ford and Nigh 2009), patches of modified and enriched forest created by the Maya would have served as species-rich refugia, and sources of seeds for the future. Foragers enhanced fertile microniches and created enriched forest patches around campsites or as areas of valuable resources to be revisited on a seasonal basis (cf. Steward 1930). Lakandon farmers are by no means unique in employing these agroforestry techniques. Such sophisticated agroforestry systems have been documented for all the Americas (Alcorn 1990, Toledo et al. 2003).

The Lakandon milpa and pet kot are but two examples of the processes that probably arose during the 'long transition' as the Mesoamerican mixed cultivation and foraging smallholder ecological culture was established in Mesoamerica (Gomez Pompa and Kaus 1999, Peters 2000). Eventually a true agrarian society emerged from this ecological matrix with increasing dependence on settled agriculture. This system imposed a domesticated landscape that transformed the forest into cultural feature cultivated by the Maya (Fedick 2010). The creation of the Maya forest garden is the result of an accumulated investment and intensification of milpa cycle and other agroforestry systems.

Conclusion

The agroforestry management of the milpa cycle is a resource management system that is initiated in closed-canopy forest when

clearings were opened by natural processes of tree falls and hurricanes as well as with cutting tools and fire, the fundamental abilities that came to the Americas across the land bridge. Landscape knowledge of the tropical Maya forest was cumulative over at many millennia. The adaptation incorporated the selection for useful plants and the development of domestic crops that were suited to the environment.

The Lakandon example shows that annual cropping is practiced where fields are visually dominated by maize in the first years, but these fields include many types of companion crops selected from over dozens of cultigens, many that have been cultivated for more than five millennia. The milpa includes its own ecology that deters pests, enhance soil nutrients, and maintain moisture of the soil. The selection of trees and bushes for succession begins at the earliest phase of planting and it is this intensity that determines floral composition that has become the Maya forest. In the act of enrichment selecting and planting in the phases of succession, the Maya shape the forest to their needs and create the forest garden.

The Maya forest, thus, is the result of plant selection and the skills of smallholder farmers engaged with a variable environment and the local landscape (Griffith 2000). Traditional Maya farming, still practiced today, represent investment in the conservation of the landscape, from the soil to the trees, promoting biodiversity and animal habitat essential to the sustainability of the subsistence system. The ancient and contemporary Maya rely on gradient of intensity of agroecological systems. Milpa cycle itself admits of degrees of intensification depending on the amount of labor devoted to the various phases of the cultivation and successional cycle. Where urban demand increased, the system was intensified with he input of labor and skill.

The dynamic result is a resilient system that builds a diversified mosaic landscape. Plants of economic importance to the Maya dominate the milpa cycle at all the successive stages of managed forests. This flexible and adaptive system coevolved with the development of the tropical forest when the ancestral Maya became familiar with the landscape and are conserving the Maya forest as a garden today.

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