Fruit in the Soil of Magic: Horticultural practices as socially conditioned techniques in the formation of Anthropogenic Amazonia

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Abstract: This study aims to accentuate the effect of social realities that influence indigenous horticultural practices. The purpose of which is to help with the understanding of the formation of Amazonian Dark Earths (ADE's), fertile anthropogenic soil patches that are widespread across Amazonia. A tentative operational chain is proposed, delineating the processes that go into the formation of a garden (swidden), using data collected on the Kayapó and Ka'apor Indians, in order to demonstrate that the choices of technique and technology involved in horticulture are socially conditioned. Combining pedological, biological and geographical approaches with anthropological ethnographies explaining indigenous cosmology helps to elucidate the processes that go into the creation of Amazonia as anthropogenic.

Keywords: indigenous environment; horticulture; Amazonia; cosmology.

1. Introduction: Techniques and Magic

> Techniques are like seeds which bore fruit in the soil of magic.
> Mauss, 1972 [1950], p.142

The above analogy by Mauss can be applied with uncanny accuracy to this study. Here I approach indigenous horticultural practices as a framework for understanding anthropogenic soil formation in Amazonia. This soil is referred to as Amazonian Dark Earth, (ADE), which includes both *terra preta* (black earth), *terra mulata* (brown earth).

The criteria for this division of soils, apart from colour, include the absence of artifacts within *terra mulata* (compared with an abundance in *terra preta*), and the lower levels of Phosphorous (P), Carbon (C), Magnesium (Mg), Calcium (Ca) and PH levels in *terra mulata* (Kämpf *et al.* 2003). This led Sombroek (*et al*. 2002), a pioneer of ADE scholarship, to attribute *terra preta* formation to be the result of kitchen midden accumulation, and *terra mulata* the result of agricultural practices.

The separation of these two soils, and the exclusion of agricultural habits from studies of cultural practices, rest on tentative historically grounded notions of the Amazonian environment, and should be reappraised. Following an approach that includes agricultural practices in the social and cultural sphere may elucidate information not normally considered by scholars involved in studying ADEs. This is

valid because there is little consensus on the formation of ADE's (Neves *et al*, 2003; Neves and Petersen, 2006; Oliver, 2008).

ADE (and *terra mulata*) is magical in the sense that it is far more nutrient-rich (eutrophic) than surrounding Amazonian soils, which vary in composition but are generally nutrient-poor (oligotrophic). Therefore to pedologists and other scientists the magic lies in the mystery of its creation; how pre-historic Indians created eutrophic soils. Mauss' (1972 [1950]) 'seeds,' in the context of this study, are the choices involved in the creation of agricultural plot or swidden, hereafter referred to as garden on account of the social realities that occur during creation. Lemonnier (1993, p.22) notes that the choices that go into the creation of artifacts are socially produced and "always embedded in some symbolic system," for which reason the garden is here viewed as an artifact.

1.1 Fixing Horticulture in Western Theories of Nature

The social production of gardens is a little-studied topic, most anthropology and archaeology focusing on domestic spaces, which are in turn the implied and implicit limits of cultural activity. However scholars such as Descola (1996), Fausto (1999), Latour (1993), Lima (1999), and Viveiros de Castro (2004), amongst others, are increasingly interested in how this separation between nature and culture came to be, and what the consequences are for the discipline of anthropology and the study of non-western cultures.

Latour (1993) demonstrates that the study of the 'Other' originated from a perceived boundary that arose as a consequence of science. He asserts that since science arose, those who have it "…differentiate absolutely between Nature and Culture, between Science and Society." (Latour, 1993, p.99) In the western imaginary, this conflates nature with Amazonian Indians, and within western cultures, creates an internal divide between nature and society.

In Amazonia there has been a wealth of studies on indigenous people and the environment (*cf.* Balée, 1994; Erickson, 2006; Fausto, 1999; Lima, 1999; Viveiros de Castro, 1998, 2004). But until recently the disciplines of ecological anthropology and social anthropology found little common ground in Amazonia. Viveiros de Castro (1996, p.184) explains this was entirely predictable; ecological anthropology assumed an "immanent rationality of an evolutionary kind," whereas social anthropologists "have

tended to emphasize the historical, socially determined nature of interaction with the physical environment." With the general (and recent) acknowledgement that ADE's are of anthropogenic origin, both ecological anthropologists and social anthropologists have overlapping interests in the form of ADE's.

Returning to the concept of science as a barrier to western understanding of indigenous interactions with nature, Balée (1994) encounters this issue in the parameters of plant classification, in particular, in reference to plants used for magic and those used for medicine. As he notes, "[i]t was seventeenth century Protestant thought that divided the concepts of 'science' and 'religion'," (Balée, 1994, p.91) whereby science and religion were complimentary, but not magic and religion nor magic and science.

Magic is considered here as the process of creating a garden from the forest. This may not be such a leap from Mauss' (2006 [1939], p.143) intended meaning: "Magic…is concerned with understanding nature." The extent of comprehension of nature is indeed admirable in Amazonia; the large number of domesticated species that have arisen is testimony to the level of magical accomplishment (many are described in Balée, 1994). Mauss (2006 [1947]) mentioned the most important Amazonian staple as evidence of technological accomplishment: manioc (*Manihot esculenta*). He cites the use of poison as a sign of the perfection of techniques (Mauss, 2006 [1947], p.100). The preparation of manioc, which involves removing certain poisonous toxins in order to make it edible, is an example of this perfection.

The transformation of manioc into edible food, or of elements from nature into gardens, demands skilled processes of making. Gell (1992, p.43) considers the processes of making as a defining characteristic of art objects, separating them from unmade objects that are aesthetically valued. This he calls the 'enchantment of technology' (Gell, 1992). Following this understanding the processes of garden-making are what defines it as art object.

I begin in Section 2 by describing the phenomena of ADE's, establishing the importance of horticultural practices as critical components to their formation. Landscape alteration by subsistence activities introduces the issue of environmental determinism, a theory that has lingered in Amazonian literature since it was first applied by Meggers (1954) in connection with the prehistoric Marajoara culture of the Amazon delta. Section 3 details plant use and the environmental determinist perspective, contrasting it with Heckenberger's (2005) theory of the 'ecology of power,' where the effects of the social in the economic are viewed in a prehistoric village layout.

Section 4 provides a hypothetical operational chain, whereby choices that go into the creation of a garden are extracted and analysed. Ethnobotanical data is drawn from the Ka'apor (documented by Balée, 1994) and Kayapó (from Posey, 2002 [1982, 1985]; and Posey and Hecht, 2002 [1989]).

In Section 5 and my conclusion horticultural practices of contemporary less-sedentary peoples are introduced to identify and analyse some of the theories embedded in the operational chain proposed in Section 4. These include ethnographies by Politis (1996) who worked with the Nukak, Rival (1996, 2001) who worked with the Huaorani, Descola (1994) among the Achuar, and Arhem (1996) from the Makuna.

2. Anthropogenic Amazonia

ADE's cover 0.1-0.3% of forested Amazonia (Sombroek *et al*, 2003, p.130), or 15,500-20,700 square kilometres (Denevan, 2006, p.156). ADE size and depth is affected by the water-type of the nearest river, commonly divided into 'white', 'clear' or 'black' water. Different river categories hold different quantities of aquatic resources, so while white-water rivers (eg. the Amazon) are the richest in fish, black-waters (eg. the Negro) are the poorest, and clear-waters (eg. the Xingu), are in-between. Though there are small ADE's located along black-water rivers, such as the Negro, the majority and the largest (measuring up to 500 hectares) are located near the confluences of large white-water rivers, such as the Madeira, Purús, Tocantins, Uatumã, Ji-Parana and Amazon rivers (Kern *et al*, 2003, p.52)

Though few Amazonianists have focused on the region as ecologically heterogeneous, Gragson (1992, p.429) notes that these water-type distinctions are extremely flexible and localized. For example water quality is often seasonal, and may depend on activities and natural phenomena that occur further upstream. Gragson (1992) intimates doubt over water-type as an environmentally limiting factor on human populations, and notes that fish distributions are responses to short-term changes in landscape and habitat, and that "native groups simply adjust their procurement tactics to account for fish density." (1992, p.436)

There may be advantages to ichthyology in relation to indigenous settlement, but Gragson's (1992) argument negates the fact that ADE's are smaller near black-water river systems which reflect smaller settlement size. Black-waters are oligotrophic because they drain soils that are oligotrophic. Though there are many vegetation types

on soils that drain into black-water rivers, one predominant variety is Caatinga, which is xeromorphic and characterised by species dominance and low species diversity (Moran, 1991, p.364). Moran (1991, p.368) proposes manioc as a solution to the problem in Amazonia of cultivation in oligotrophic soils.

Moran (1991) correlates extreme dependence on manioc with black-water systems, such as the Negro. This would seem to correspond with plant adaptation to xeromorphic conditions, where biomass is concentrated in plant roots in much higher quantities (34-87%), than most *terra firme* (interfluvial) forest areas (typically 20%) (Moran, 1991, p.366). The formation of ADE's is linked to manioc cultivation across Amazonia, and seems a more important subsistence method than varied fishing techniques.

Smith (1980) published a seminal paper outlying the rate of accumulation of human debris that would have formed ADE, as ADE depth is correlated with time. He proposed a rate of 1cm per 10 years of settlement (Smith, 1980, p.564). Although this has largely been accepted, Neves (*et al* 2003) suggest that with higher levels of intensity the rate of incremental growth could have been even faster.

ADE's are between 5,000-2,500 years old (Neves *et al*, 2003, p.37). The oldest is dated to 4,800 BP in the Jamari River area (near the Ji-Parana river at the source of the Madeira), but most are dated to 2,500-2000 BP (Neves *et al*, 2003, p.38). Neves (*et al* 2003, p.29) suggest that this indicates a radical shift in economic subsistence practices, correlated to social change. This has been described by Petersen (*et al* 2001, p.103), and Heckenberger (2005), as the 'Formative Period.'

2.1 Formation of ADE's

The earliest dates of ADE's are from the central and lower Amazon River. Petersen (*et al*. 2001, p.101) emphasise the importance of manioc cultivation and intensive use of aquatic resources in the move to sedentism. In the understanding of plant interactions across Amazonia geographically as well as diachronically, it is necessary to include sedentary and less sedentary lifestyles. Heckenberger (2006, p.320) states that macroregional systems of interaction between the two lifestyles began in the Formative period. This interrelationship across ecological zones (upland and riverine), and lifestyle types (sedentary and less-sedentary), is an essential component to the studies provided by researchers.

For pedologists it is the high nutrient content of ADE's that are of interest. Upland soils in Amazonia generally are either clayey Acrisols and Ferralsols or sandy Podzols (Lehmann *et al*, 2003, p.105). The major question that arises in ADE formation is "whether these soils were managed for agricultural use or are a byproduct of human habitation." (Lehmann *et al*, 2003, p.105)

Applying contemporary horticultural practices to understand the socio-cultural realities that went into the formation of ADE's is problematic as the past is not isomorphic with the present in Amazonia (Heckenberger, 2006, p.323). Contemporary Indians seldom live in large-scale, sedentary communities on account of the demographic rupture that occurred with the arrival of Europeans in the 1500's, which resulted in slavery, disease, etc. Nonetheless combining ethnographic studies with archaeological data may be an extremely practical method to approach the distinction in the formation of *terra pretas* and *terra mulatas.*

Silva (2003) notes that amongst the Asurini of the lower Xingu, communal spaces, where rituals occur, are unlikely to be sources of ADE formation as they are frequently swept clean. This is correlated by Heckenberger's (2005) reports of the Kuikuru in the upper Xingu. However when the domestic space where food is prepared and ceramic containers are stored is cleared, the refuse is deposited in discard areas, which according to Silva (2003) are the most likely sources of ADE formation. In the case of village abandonment, the domestic space with litter may also be a source of ADE formation.

One vast ADE which was among the first archaeological sites to have been extensively excavated are the mounds of earth, (they are classified as a form of ADE), on Marajó Island. Whilst reviewing the research at Marajó, the very early evidence of plant use must be stated in order to comprehend subsistence practices prior to the Formative Period, in both fluvial and interfluvial environments. This is because, as Neves and Petersen (2006, p.282) remind us, both fluvial and interfluvial environments were utilised since the initial occupation of Amazonia.

3. Ethnobotany and Environmental Determinism

The separation of Amazonia into *várzea*, seasonally flooded regions, and *terra firme*, interfluvial tracts, has been the source of much academic interest into human/environment relations. The line of argument that complex societies could not

have developed in interfluvial zones because (amongst other factors) the soil was not fertile is known as 'environmental determinism,' and was a popular theory around the time (mid-20th century) that Meggers (1954) archaeologically investigated Marajó Island.

The environmental determinist approach in Amazonia is that riverine habitation and the fertile soil of the fluvial environment encouraged social complexity. The archaeological presence of a complex society, the Marajoara, in the *várzea*, was attributed to migration of people from the Andes into an ultimately unsuccessful environment. Meggers (1954, p.809) claimed this was supported by the Marajoara culture having complex societies and technologies in its early stages.

At the core of environmental determinism, it was believed that the domestication of flora (agriculture) led to sedentism which in turn led to civilization. Many contemporary scholars now agree to a different sequence, which is, as Oliver (2001, p.55) states; "agriculture followed domestication and settled life."

Oliver (2001) has pointed to the climatic change at the end of the Pleistocene that led to the Holocene period as an important factor in the human manipulation of plants. The archaeological sites of Caverna Pintada, (at the mouth of the Tapajós River) and Peña Roja (between the Upper Negro and Solimões Rivers) both have radiocarbon dates supporting human occupation over 9,000 years ago (Oliver, 2001, p.56), which is within the time that modern climatic conditions began to prevail. As Oliver (2001, p.57) notes, around 11,000 – 8,000 BP humans occupied both upland forest and savannah habitats.

Plant distribution, influenced by climatic conditions, played an important role in the subsistence practices of these very early inhabitants. During the late Pleistocene (18,000-12,500 BP), reduction in carbon dioxide, coupled with homogenous mean temperatures and precipitation would have been disadvantageous for tuberous root plants and forests (Oliver, 2001, p.54). Tubers would have been low-ranking dispersed food resources for hunters and gatherers/foragers (Oliver, 2001, p.54). Grasses of the savannah (including the ancestor of maize), would have thrived under these conditions.

Climatic changes that happened at the transition to the Holocene would have been conducive to the advance of lowland forest and tuberous plants. High-ranked food sources would have dissipated at this time, thus a stimulus was provided for a broader, more diversified diet in order to obtain a higher return rate (Oliver, 2001, p.56). Most modern staple root crops, such as manioc (*Manihot*), sweet potato (*Ipomoea*), yam (or

American Taro) (*Dioscorea*), cocoyam (or American cocoyam) (*Xanthosoma* sp.), and arrowroot (*Maranta*) "develop in response to marked dry and wet seasons," (Oliver, 2001, p.54) those conditions that emerged at the start of the Holocene. Thus a smaller foraging range, with a more diverse diet, would have lead to sedentism.

Between 11,000 and 9,000 BP at Pedra Pintada botanical remains including palm seeds and fruits testify to a directed subsistence pattern, not evidence for agriculture as such but "incipient silviculture focused on a broad spectrum of palm species adapted to both flood plain and upland conditions." (Oliver, 2001, p.211) Most of the identified botanical remains are from trees that fruit during the rainy season, except two palms, *Attalea microcarpia* and *Attalea spectabilis*, which fruit throughout the year. The wet season is notoriously bad for fishing, but good for fruiting palms. Thus seasonality would have increased dependency on the availability of other food sources.

Clement (2006, p.166) describes fruit-production phenology as a reason for the decline in importance of palm tree fruits towards the middle Holocene, and the increase in use of tuberous plants, leading to their domestication. Tubers and roots are important food sources in tropical zones of wet and dry seasonal variation, such as in Africa, Oceania, and the tropical Americas. He argues that fruit phenology is all the more important considering the often rudimentary nature of food processing and storage techniques (Clement 2006, p.166).

3.1 Moundbuilders and the Ecology of Power

The floodplain was seen by Roosevelt (1991) as inimical to the cultivation of tuberous plants such as manioc, which are long-maturing and susceptible to water-logging (though the possibility of short-maturing tubers was precluded). Short-maturing crops such as maize were better suited to the seasonally inundated floodplains, and this demanded a large investment of labour, particularly in the manual transportation of silt to agriculture areas (Roosevelt 1991, p.405). At the beginning of the Marajoara phase, which Schaan (2001, p.111) suggests began around 500 AD, mounds were built in order to create platforms to protect the inhabitants from the floods.

Research by Roosevelt (1991) revealed that manioc was not a staple, thus supporting a theory of heterogeneity across Amazonia. Instead there is evidence of "appreciable maize consumption by some people (20-30% levels) and a few showed

rather high levels (over 60%).” (Roosevelt, 1991, p.377) David Greene, (the project’s physical anthropologist) proposed a multiagricultural diet supported by bone chemistry, osteology, and archaeobotany (Roosevelt, 1991, p.394).

Roosevelt (1991, p.5) intimates that the Marajoara were a culture that expanded, whose population exploded, and then whose populace became weakened on account of intensive economies that were ecologically unstable and over-taxed the resources. Roosevelt (1991, p.405) suggests physiological stress of the population may have been a factor in the demise of the culture, as there was pathological evidence of “disease, poor diet, and hard labour.”

These are strong implications that she follows Meggers’ (1954) adaptation theory: Stressing the fertility of *várzea* soil avoids contradicting Meggers’ (1954) environmental limitation theory. Roosevelt’s (1991) data contradicted Meggers’ (1954) theory by proving that a complex society arose out of Amazonia, rather than originated in the Andes.

There are no contemporary indigenous populations that can either support or disclaim theories of environmental adaptation in the *várzea*. In contrast Heckenberger (2005) claims the Upper Xingu Cultural Area has been continuously inhabited for at least one millennium, probably more, and so provides a wealth of information because the scale of demographic rupture in this region was not as thorough as in most of Amazonia.

According to Heckenberger (2005, p.25), hierarchical social relations are tied to where one lives, what area of the village a house is located, where one sits, sleeps, and walks, in relation to other village members, and this is basically the same as in ancient times, just on a smaller scale. In contemporary villages, Heckenberger (2005, p.307) notes that their circular shape “allows the special expression of separation and opposition.” Hierarchies of power are represented by house position and angle. This he calls ‘the ecology of power’, and therefore complex hierarchies exist even in the absence of administrative or economic centralization, which are the traditional criteria for social complexity (Heckenberger, 2005, p.25).

The galactic configuration of the 16th century Kuhikugu village demonstrates the embeddedness of social hierarchy in the landscape: Powerful families lived close to the plaza, physically partitioning the villages (Heckenberger 2005, p.123). The plaza is the most sacred ‘owned’ space, which belongs to an individual, the chief, and “can be seen as the incarnation of that individual.” (Heckenberger, 2005, p.306) Heckenberger (2005)

describes the plaza, the men's house and the cemetery as institutions, on account of the sacred power they represent, and the fact that the chief embodies the power of the plaza.

The studies of contemporary, small scale societies in the present does not include the large and extensive trade network systems that were in place with more complex societies in pre-Columbian times (Heckenberger, 2006, p.323). Heckenberger (2006, p.323) notes the basis of power and prestige in early complex societies in Amazonia (as well as Africa and Oceania) was not based on economic centralization, but rather "the concentration of symbolic and social capital."

In the context of an Amerindian garden, to what extent symbolic concentration and social capital is linked to economic centralization is hard to measure. Using the documentation of the Ka'apor and Kayapo horticultural practices and the format of an operational chain, I aim to illustrate the presence of the symbolic and social in economic activities.

4. Technological choices in the garden

Operational chains have been developed by the French school of anthropology that focuses on technological processes as being socially imbued. The line of theory has as its progenitor Marcel Mauss, who in 1948 (2006, p.150) highlighted the sociality characteristic of techniques.

Technological choices may or may not complement physical factors. For example, Ingold's (1993) research into reindeer herders' choice of technology in Finland provides an example of a decision that is socially conditioned but does not provide the best answer to a physical problem, which is minimum energy input versus maximum production. The reasons for herders' refusal to adopt to modern and more practical technology of lasso in the north of Finland "is dictated as much by considerations of who he is as it is by the mechanical effect he desires to achieve." (Ingold, 1993, p.124) Such social influences to technological decisions are not visible in the archaeological record, and are not considered by many scientists in their understanding of human interactions with the environment. There is a risk of concluding that actions, technological choices, are always the most energy efficient methods of achieving a desired goal.

It must be noted that it is impossible to give a total and real operational chain here, as field-work for a particular case study is necessary. Examples of the necessity

for fieldwork to describe a functional system include: 1) The gendered nature of horticulture in Amazonia, 2) the question of ownership of garden plots and individual plants, and the relation between plant and owner (if there are similarities to the relation between pet and master (*cf.* Fausto, 1999), and 3) the time and labour investment.

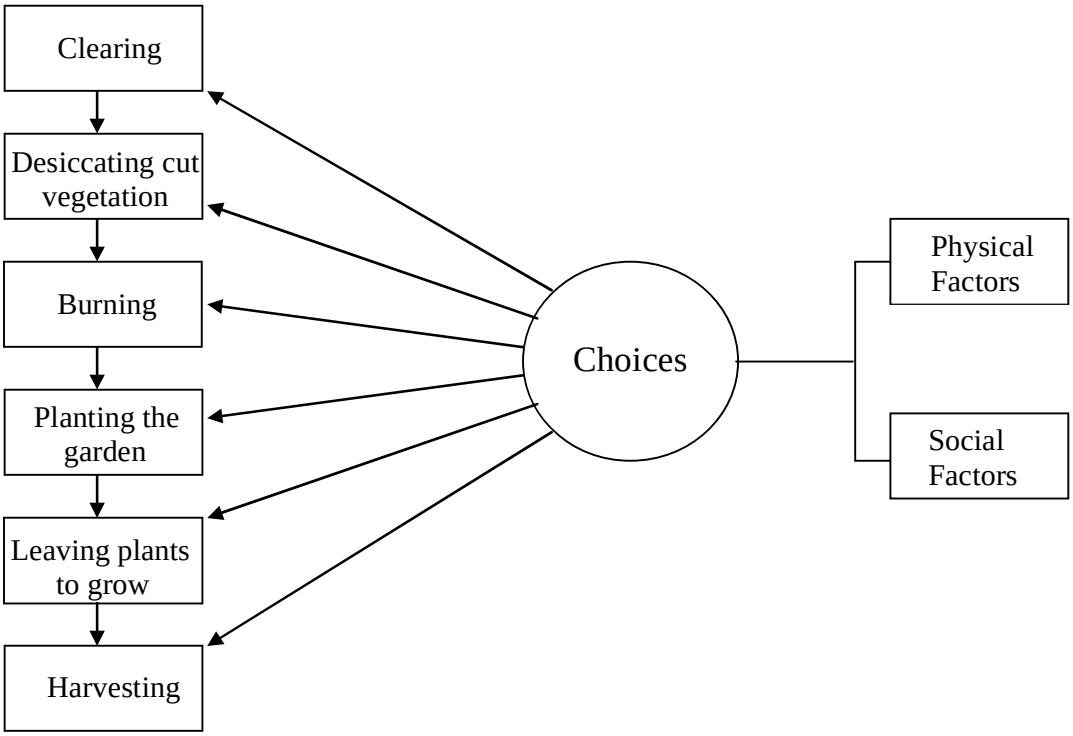
Concerning time and labour, research by Descola (1994) among the Achuar of the Peruvian Amazon provides information in terms of labour hours invested in swidden gardening. After calculation the number of hours spent gardening by each sex is approximately equal (Descola, 1994). Balée's (1994, p.50) research among the Ka'apor of eastern Amazonia confirms Descola's (1994) conclusion.

4.1 Operation Garden

My operational chain is made following gardening practices documented by Balée (1994) and Posey's (2002 [1982, 1985,]) (and Posey and Hecht's 2002[1989]) research amongst two primarily sedentary groups, the Ka'apor (from eastern Amazonia), and Kayapó (from the middle Xingu River). Unlike Heckenberger's (2005) Kuikuru, both Kayapó and Ka'apor groups have histories involving large-scale movement and cultural rupture over the past few centuries, primarily because of European presence in the region. Heckenberger's (2005) hierarchy of power cannot therefore be easily applied to garden spaces in this context. It is excluded on account of absence of sufficient data, however it is presumed there may be an 'ecology of power' visible in horticultural practices, and in the resulting garden and plant demarcation.

The proposed diagram aims to indicate why environmental determinism has intrinsic limitations in revealing either how ADE's were formed or how pre-Columbian Indians survived in Amazonian ecosystems. The choices that result from social pressures may be solutions to environmental limitations, or they may not. Ethnographies do not commonly detail when technological choices are not the most efficient method of environmental manipulation, but such instances can be inferred through hermeneutically revisiting existing data and providing analogous situations.

Analysing horticultural practices of the Kayapó and Ka'apor within the framework of the operational chain below will reveal some of these limitations, and how they could be overcome. As Lemonnier (1993, p.10) remarks, the questions regard to what extent "technologies are a mediation (as well as a compromise) between inescapable universal physical laws and the unbounded inventiveness of cultures."



Operational chain of Amazonian indigenous horticulture

The left-hand side of the diagram is read vertically, from top to bottom, in six identifiable stages, firstly 'clearing', lastly 'harvesting.' In reality harvesting does not happen as one event but is staggered, as the garden is multicrop, and therefore harvesting is a process interspersed with replanting, weeding and soil amelioration . Each stage of the garden-making process involves choices that are affected by social and physical factors, displayed at the right hand side of the diagram. Only the first four stages ('clearing', 'burning', 'vegetation left to dry', and 'planting'), will be discussed, as they are actions resulting from easily identifiable social elements.

Stage 1: Clearing

The social meaning of clearing space is important. Descola (1994, p.136) explains how the Achuar conceptualise the preliminary stages of garden creation as "the result of an act of predation committed on the forest." Predation and reciprocity are themes extensively studied by anthropologists, though rarely in reference to

horticulture. The significance of taking, or predating land from an imaginary is vital, as predation is extremely important in Amerindian societies.

Fausto (1999) explains the logic behind historic accounts of indigenous cannibalism as being deeply embedded in symbolic reproduction. Warfare and shamanism are parts of a dialectic that exists between predation and familiarization. Predation has been suggested as the primary mode of interaction with the outside (Fausto, 1999), in which case the act of clearing forest to create a horticultural plot is embedded in social modes of cultural reproduction. Conversely, familiarization of the predated land must also be included in the sociality of the choice of land, which also affects the size of predated land.

Among the Piaroa of Venezuela, Santos Granero (1986, p.660) describes their view of the environment as a subject. Viveiros de Castro (1998, 2004) supports this notion of subjectified nature as a universal amongst Amerinidian societies. The original state of nondifferentiation between humans and animals becomes blurred in the realm of plants. Some are more 'social' than others. Viveiros de Castro (2004, p.466) notes that "[c]ultivated plants may be conceived as blood relatives of the women who tend them." The affinity between plants that are most useful and their cultivators is relational. Manioc thus plays an important role in mythology, as manioc-derived products (beer, bread and soup) are important foods. Manioc dominates the garden layout, both in the Kayapó and Ka'apor garden.

Plants are perceived to have had a humanoid ancestor, as with all living things (Viveiros de Castro, 1998, 2004). It is affiliated in a familial way, as pets are, into the social life of Indians, which is reflected by the way the gardens are created and maintained, and how the crops are harvested and ingested. The major difference between pets and plants is that pets are not eaten, whereas plants (or their 'fruits') are. Pets are familiarized when included into the village, a phenomena Fausto (1999) refers to as 'adoptive filiation.' Pets are subjectified when captured, and then familiarized.

Gardens are a social construction for the indigenous communities who transform them from nature, a cultural artefact in anthropological terminology. The following choices are demonstrations of reactions to practical limitations that are strongly influenced by cultural determinants.

Among the Kayapó Posey and Hecht (2002 [1989]) describe processes of 'mulching' that improve soil quality so that oligotrophic soils are enriched. How the soil is mulched and by whom, and what exactly is added (ash and various plant parts) are

socially defined factors. Algae from silt has been found in some ADE's, indicating the transportation of fertile silt to less fertile soil to enrich it (Mora, 2003). Research by Arroyo Kaolin (2009, p.3) illustrates evidence of tillage and soil amendments.

Denevan (1996, 2006) has repeatedly emphasised the inefficiency of stone axes compared with metal tools in tree-felling, emphasising the probability of change from sedentism to more nomadic lifestyles upon contact and trade with Europeans. Balée (1994, p.51), reports that the Ka'apor simply girdle very large trees, "since it is believed that an attempt to cut them down might break one's axehead," a factor included by Denevan (1996, 2006), in his calculations of labour, time and energy involved in clearing forest.

Posey and Hecht (2002[1989], p.175) note that the Kayapó method of tree felling determines to an extent the garden layout, and so trees are felled so that their crowns face the perimeter of the plot. Where the tree bowls fall, and are subsequently burned, large nutrient input into the soil occurs, of which the Kayapó are aware, and consequentially planting is coordinated to match particular species' soil and nutrient requirements.

For the Ka'apor Balée (1994) describes a domino-like process of tree felling, whereby one large tree is cut, and the surrounding trees are weakened so they collapse when the big tree falls. The result of this method on garden layout is not provided. This type of human ingenuity that overcomes physical realities can potentially undermine Denevan's (1996, 2006) theory that is essentially determinist, where stone technology is the reason for sedentism.

Among the Ka'apor the clearing happens in stages, the first of which includes felling vines and shrubbery using machetes, and is done by men, women and older unmarried children (Balée, 1994, p.51). Approximately one month later men and older, unmarried boys continue clearing, this time larger trees with steel axes (Balée, 1994, p.51). The practice of clearing larger shrubbery by men and older boys, compared with the initial clearing done with the inclusion of women seems pertinent, but neither is elaborated on by Balée nor Posey.

Stages 2 and 3, burning the desiccated vegetation

The second and third stages overlap in social and physical determinants. Both the Kayapó and Ka'apor leave the cut vegetation to dry before setting it alight. The

timing of this period involves climatic conditions, as the vegetation has to become desiccated prior to burning, which must happen before the wet season arrives. Recounting Ka'apor practices, Balée (1994) documents the spiritual significance of the wind, that it is called upon by the blowing of a horn the morning burning begins.

The importance of wind in the burning process is complemented by Kayapó fire management recorded by Posey (2002 [1982], p.195), who notes that the appropriate day for burning is decided by the elders, who meet to discuss the conditions and timing. He (Posey 2002 [1982], p.195) states that there has to be a wind, but not too strong, so the fire burns the vegetation thoroughly rather than race over it in patches. This is known as a 'cool fire', as opposed to a 'hot fire', which may scorch the earth (Posey, 2002[1982], p.195). Scorched earth is not good for nutrient retention, but also a 'hot' fire would damage the roots of fire-tolerant cultivars of sweet potato (*Ipomoea*), that are planted even before the burning stage has ended (Posey and Hecht, 2002[1989], p.175).

The Kayapó repeatedly burn patches of garden (called by Posey and Hecht; (2002[1989]) 'in-field' burning) which effectively cleans the garden of potentially harmful pathogens. The 'cool' burning as described for the Kayapó appears to be knowledge of physical environmental practices that are understood in terms of Kayapó sociality. What cannot be discerned from Posey's (2002) recounting of gardening practices is any social factor that may contravene physical laws, thus providing a danger of nobilizing indigenous actions, and imbibing intentionality of a Western type in landscape management.[1] Balée (1994) does not attempt to claim indigenous knowledge of soil chemical make-up as Posey and Hecht (2002[1989]) insinuate, rather an indigenous knowledge of plants through lexicology and a history of horticulture.

Amongst the Ka'apor, fire occasionally escapes into surrounding forest, which is not subsequently turned into swidden, but left to regenerate (Balée, 1994, p.51). The burnt forest is called by the same name as burnt patches that are caused by lightening (*ka'a-kai*) (Balée, 1994, p.51), and provides evidence for a social factor in the parameter of the garden space, as burnt areas are not cultivated.

[1] See Parker (1992, 1993) for criticism of Posey's (2002 [1985]) description of the anthropogenic formation of Apêtê's, forest islands in the savannah

Stage 4, planting the garden

Systematic emic documentation of indigenous horticultural practices at garden organisation level are uncommon in anthropological ethnographies in Amazonia, surprising given the labour time involved in gardening and the cosmological importance of flora and fauna. Posey (2002 [1982]), and Posey and Hecht (2002[1989]) correlated plant distribution to soil fertility: The plants that survive and produce most fruit in rich soils, for instance sweet potato (*Ipomoea batatas*), are planted in the most nutrient-rich locations, perhaps by the burnt stump of a tree, or under a mound of ash.

Balée (1994, p.159) gives a diagram of a garden, showing the spacial distribution of the various plant species that are used in a specific Ka'apor garden. He notes that "the most significant food species are to be found in the sunny center of the swidden." (Balée, 1994, p.158) The location of crop-type may not be solely because of edaphic conditions, but indicate dietary preferences also, contradictory to Posey and Hecht's (2002[1989]) theory of soil gradients.

Many plant species originate outside the Americas, and are incorporated into Ka'apor and Kayapo gardens, not just for consumption, but sometimes as commodities (eg. rice). The choice of plants with economic value is a factor that would have been germane in pre-Columbian times, as trade across regions occurred. People from different regions utilized a variety of ecological niches. As Moran's (1992, p.369) studies of indigenous survival in the comparatively infertile black-water ecosystem demonstrates, smoked game meat and forest fruits from upland groups were traded in exchange for fish and agricultural products from the riverine inhabitants, resulting in populations exploiting both fluvial and interfluvial ecosystems.

Returning to contemporary upland groups, Balée (1994) and Descola (1994) (and numerous others) document extensive plant knowledge, both in terms of cultivated and non-cultivated plants. Balée (1994, p.169) notes how plants are identified more by shape, colour, leaf texture, smell, and taste of the bark than by fruiting parts, confirming knowledge based on multi-sensory and multi-valence rather than solely consumption interests.

5. Ethnographies indicating sociality in environmental relations

Ethnographies by Politis (1996) and Rival (1993, 1996) amongst less sedentary peoples indicate sociality in their subsistence strategies which are easily visible to anthropologists, and less visible in the archaeological record and to physical scientists. Amongst the Huaorani, Rival (1993) documents the stages that are involved in the creation of a manioc garden. The gardens of manioc are grown solely for the production of manioc beer for festivals. Horticulture is devoted to the purpose of feasting, whereas everyday consumption is dominated by peach palm fruit (*Bactris gasipaes)* and other semi-domesticated species, such as plantains and bananas, that are 'grown in the wild,' so as to be available on expeditions (Rival, 1993, p.644).

Rival (1993, p.648) notes that their gardens involve very little labour: They are not weeded, and the same location is never used twice. These choices are made in order to retain their extractive traditions and communal identity as different from that of sedentary societies, of which the Huaorani are aware (Rival, 1993).

Another horticultural choice is the duration of growing-time. "The greater the number of guests, the larger the plantation, and the longer the roots are left to grow." (Rival, 1993, p.646). The size of the garden is also important, Huaorani gardens being typically small, 15 m x 18 m, (Rival, 1993, p.645) sufficient only for the quantity of manioc that is desired for the feasting ceremonies.

After harvesting, the pulp is extracted and buried in the ground 'for about ten days', until it smells 'strong and sweet', and is considered 'as sweet as a fruit.' (Rival, 1993, p.646). This metaphorical transformation from root to fruit is important in the understanding of manioc ingestion in Huaorani society. The pollinating practices of birds are analogous to the feasting of Huaorani on manioc. Great importance is attributed to large trees, and fruit-bearing trees, and the Huaorani see themselves as being like birds on a fruiting tree, because birds gorge on the fruit, and therefore so must the Huaorani gorge on manioc beer (Rival 1993, p.647).

Politis (1996, 2001) has conducted extensive research into the environmental effects of the Nukak subsistence practices, who live a primarily hunter-gatherer lifestyle in the Colombian Amazonian *terra firme* forest. Gathering involves limited horticultural practice, extensive hunting, and being extremely mobile, relocating up to 80 times a year (Politis, 1996, p.492). The effect of non-sedentary, non-agriculturalist indigenous

peoples on the environment is a subject little documented, either in Amazonia or other tropical forest regions.

Politis (1996, 2001) documents subsistence practices that transform plant densities and locations irreversibly. The practice of obtaining palm grubs involves chopping down palm trees, waiting for the insects to lay their eggs in the decomposing palm hearts, and then collecting the larvae (Politis, 2001). Among the Achuar Descola (1994, p.254) observes that palm trees are also felled to get at the edible part at the base of the fronds, but palms located closer to the village are spared so that they can be regularly beaten and the fruits obtained over a longer period. This consequently reverses expected density of palm populations relative to village location.

For the Nukak, certain palm species' fruiting seasons are factors that influence the decision to move location, which happens before there is a decline in available resources, which preserves those resources in the long-term (Politis, 1996, p.504). Politis (1996, p.504) is unable to explain how exactly some species of plants came to be concentrated in specific locations, for example popere (*Oenocarpus bataua*), guana (*Dacryodes peruviana*), seje (*Oenocarpus mapora*) and tarriago (or plantain) (*Phenakospermum guyanense*), but he postulates that their density and location is affected by Nukak mobility patterns, primarily on account of the seeds that are left scattered on the ground in camps that are abandoned. This concentration of seed, and the lack of competing plants that have been removed to create the camps provide improved conditions for their propagation.

To confuse the notion of Amazonia as anthropogenic, Politis (2001) states that there are naturally occurring stands of some plant species (eg. *Caryodendron orinocense* and *Mauritia flexuosa*), though what impact successive generations of human resource abstraction over millennia may have had is hard to determine.

Conclusion: Nature, Cosmology and Indigenous Technologies

Indigenous understanding of flora and fauna is crucial in forming an ecological history of Amazonia. Descola (1994) maintains that clearing a space for a garden is a form of predation, an activity with a gender bias. Among the Makuna, Århem (1996, p.199) states: "Hunting … is a form of male gardening, a point which is explicitly made in mythic narratives." Descola (1994, p.252) comments that among the Achuar "wild

fruit is consumed mainly by women," and that the approximately five kilometer radius of 'extended garden' is often covered with women and children gathering such fruits.

Århem (1996, p.194) interprets the cosmological process of consumption:

> Eating involves a process of partial consubstantiation and contextual identification between eater and food – and therefore also the potentiality of the eater being 'consumed' by the very food consumed.

All foods are blessed by the shaman before being eaten (Århem, 1996). Ritual transformation of the food into edible (safe) product is important, and exposes the underlying notion that "all natural foods are inherently dangerous to human beings." (Århem, 1996, p.195)

This cosmology of food is carried forward to the extent that it can have implications as to the level of modification of the environment in the long-term. The reciprocity ideology of food consumption "imposes strong sanctions against over-exploitations of forest and river sources." (Århem, 1996, p.200) The power of mythology in dictating environmental use results in large areas of Makuna land being effectively periodically untapped. This Makuna interaction with the environment Århem (1996, p.200) describes as "cosmology turned into ecology," and it is an extremely useful method of understanding long-term human effects on the environment. The theme of predation and reciprocity is not restricted to the Makuna but is found all over Amazonia (Århem 2006, p.201; Fausto, 1999, p.936).

When plants in the garden are viewed as consanguinal (by the Achuar) or predatory (by the Makuna), the reciprocity element inherent in Amerindian cosmologies reveals the power of some plant species (eg. manioc) in both everyday life and belief. And because manioc cultivation has been intimately linked to ADE formation, Amerindian cosmologies are also crucial to the comprehension of the origins of ADEs.

Barcelos Neto (2004, 2006) documents the link between Amerindian cosmology and the mundane activities of everyday living among the Wauja of the Upper Xingu, interpreting the omnipresence of *apapaatai*; beings that lie at the origin and cure of illness. The technologies involved in manioc processing are powerful, believed to have derived from the *apapaatai*, and as such are physical evidence of the omnipotent dangers of illness.

The study of technology among indigenous peoples has been approached by Ingold (2000, p.314), who comes to the conclusion that pre-modern societies don't have technology at all. This, he argues (Ingold, 2000, p.314), is because the concept of

technology in Western usage meant that it is used to distance society from nature. As is evident among the Wauja, all tools used in the production of horticulture are a part of indigenous cosmology, and should be approached as such. They are not used to distance the Wauja cosmologically from the environment. This supports an anthropological approach to the study of technology as advocated by Pfaffenberger (1992), Lemonnier (1993) and Ingold (2000).

The reason for the proposed anthropological approach to the study of technology is the same as my proposed anthropological approach to the study of horticulture: It bypasses the division of disciplines created when science, magic and religion meant that magic became inimical to science and religion, and technology became included in the study of science. Horticulture also became included in the study of science.

Following Gell's (1992) technological regard of art as 'that which creates magic,' horticulture can therefore be described as art production. In describing magic and technical efficacy, Gell (1992, p.57) links the production of art with the production of social relations, and explains that social relations that are generated by technical relations are "technical processes of the production of subsistence and other goods." The various systems of relations are thus intimately intertwined, totally inseperable. Returning to Mauss, (2006 [1947], p.100) this notion can be drawn together into processes that become compiled into industries or crafts.

Industry is taken here as centuries of magical transformation of the soil involving technologies of enchantment creating ADE's. If domestication is the achievement of levels of understanding of nature, indigenous societies in Amazonia are experts of magic. Gardening among indigenous societies is a form of production, and is an industry involving techniques, and is understudied by anthropologists, and misunderstood by physical scientists who deny magic in the form of art in the production of ADE's. The practices of cooking and gardening among Amerindian peoples are perpetually affected by cultural determinants, factors that repeatedly skew the statistics of pedologists and archaeologists. Further research from a cross-disciplinary approach, including physical and social scientists, would prove fruitful in the comprehension of Mauss' (1972[1950]) 'seeds' and the soil of magic in Amazonia.

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Frutos no Solo de Magia: Práticas de Horticultura como Técnicas Socialmente Condicionadas na Formação da Amazônia Antropogênica

Resumo: Este estudo procura acentuar o efeito das realidades sociais que influenciam as práticas indígenas de horticultura. O objetivo é colaborar para a compreensão da formação das Terras Pretas da Amazônia (TPA), que constituem solos férteis antropogênicos disseminados em toda a Amazônia. Propõe-se aqui uma "corrente provisória de funcionamento," delineando os processos que participam na formação de um jardim (roça) a partir de dados coletados junto a indígenas Kayapó e Ka'apor a fim de demonstrar que a escolha da técnica e da tecnologia empregadas na horticultura são socialmente condicionadas. Combinando abordagens pedológicas, biológicas e geográficas com observações etnográficas e antropológicas referidas às cosmologias indígenas intenta-se elucidar os processos que propiciam a criação da Amazônia como antropogênica.

Palavras-chave: indígenas; ambiente; horticultura; Amazônia; cosmologia.

* This is a revised edition of my MA dissertation, submitted in July 2008, at the Sainsbury Research Unit for the Arts of Africa, Oceania and the Americas. University of East Anglia.
Supervisor: Aristóteles Barcelos Neto

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Recebido em 02/10/2009
Aceito para publicação em 14/10/2009