

“Made in Brazil”: Human Dispersal of the Brazil Nut (*Bertholletia excelsa*, Lecythidaceae) in Ancient Amazonia¹

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“Made in Brazil”: Human Dispersal of the Brazil Nut (*Bertholletia excelsa*, Lecythidaceae) in Ancient Amazonia. The Brazil nut, *Bertholletia excelsa*, is a colossal tree of *terra firme* forest whose seeds represent the most important non-timber forest product in Amazonia. Its peculiarly inefficient dispersal strategy and discontinuous distribution have led some to hypothesize anthropogenic origins, but evidence to date has been inconclusive. Here we present results of a multidisciplinary study addressing this question. A review of the geographic distribution of *B. excelsa* and comparison with that of similar *Lecythis* species suggest a number of anomalies that are consistent with a recent and wide colonization of *Bertholletia*. Published studies and field observations indicate that anthropogenic disturbance facilitates Brazil nut regeneration. Recent genetic studies showing no sequence diversity and no geographical structuring of within-population variability support a rapid and recent irradiation from an ancestral population. Historical linguistic analysis of indigenous terms for Brazil nut suggests a northern/eastern Amazonian origin for *Bertholletia*, with a concomitant spread of Brazil nut distribution or cultivation to the south and west. Such an expansion would have been particularly facilitated by the emergence of intensive bitter manioc cultivation and networks of interethnic trade beginning in the first millennium C.E. Together, ecological, phytogeographic, genetic, linguistic, and archeological data reinforce the hypothesis that ancient Amazonian peoples played a role in establishing this emblematic and economically important rainforest landscape.

‘Made in Brasil’: A dispersão antrópica da castanha-do-Pará (*Bertholletia excelsa*, Lecythidaceae) na antiga Amazônia. A castanha-do-Brasil, *Bertholletia excelsa*, é uma árvore enorme da terra firme cujas sementes representam o produto florestal não-madeireira mais importante da Amazônia. Alguns pesquisadores, observando sua estratégia ineficiente de dispersão e sua distribuição descontínua, propuseram a hipótese de que suas origens são antrópicas, mas as evidências até a data são ambíguas. Aqui se apresentam resultados de um estudo multidisciplinar sobre essa questão. Uma revisão da distribuição geográfica de *B. excelsa* e uma comparação com as sapucaias (*Lecythis* spp.) sugerem várias anomalias compatíveis com uma recente colonização de *Bertholletia* pela Amazônia. Estudos publicados e observações em campo sugerem que a perturbação antrópica facilita a regeneração de castanhas. Estudos genéticos recentes demonstram nenhuma diversidade genética de seqüências de cpDNA e nenhuma estruturação geográfica da variabilidade intra-populacional, o qual sugere uma expansão rápida e recente. Estudos lingüísticos sugerem uma origem para *Bertholletia* no norte/leste da Amazônia, com uma expansão mais recente da distribuição ou cultura para o sul e o oeste. Tal expansão teria sido facilitado pela emergência do cultivo intensivo de mandioca amarga e redes de contato inter-étnico especialmente a partir do primeiro milênio dC. Dados ecológicos, fitogeográficos, genéticos, lingüísticos, e arqueológicos reforçam a hipótese de que os povos

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amazônicos antigos tiveram um papel significativo no estabelecimento dessa paisagem amazônica emblemática.

Key Words: Amazonia, non-timber forest products, plant genetics, landscape domestication, historical ecology, historical linguistics, Amazonian archeology.

Introduction

Brazil nut (*Bertholletia excelsa* Humb. & Bonpl.) is a signature Amazonian species and an important resource for local populations. Brazil nut's nutritious, oil-rich seeds are eaten fresh, roasted, or pressed to produce a milk-like extract. The colossal trees reach up to 60 m in height and 16 m in circumference (Pires 1984; Villachica et al. 1996). The Brazil nut family, Lecythidaceae, includes the oldest known tree in the American tropics, a specimen of *Cariniana micrantha* Ducke dated to 1,400 years old (Chambers et al. 1998). Brazil nut trees ~150 cm in diameter have been dated to 270 years (Chambers et al. 1998), while the largest individuals (~500 cm in diameter) may be over 1,000 years old (Pires 1984; cited in Peres and Baider 1997).

Carbonized Brazil nuts were identified at Pedra Pintada, an upper Paleolithic cave site in the central Brazilian Amazon that was occupied some 11,000 years ago by ancient hunter-gatherers (Roosevelt et al. 1996). Although archeologists have found a diversity of oily seeds, especially palm nuts, in Paleolithic sites throughout lowland South America (e. g., Morcote Ríos et al. 2006), Pedra Pintada is the only one where Brazil nut consumption is clearly documented.

Brazil nuts were introduced to Europe in the late 18th century by Dutch traders, with trade increasing greatly in the late 19th century (Mori and Prance 1990a). Today, Brazil nut is Amazonia's most important non-timber forest product. It is also the only globally-traded seed crop collected from natural forests (Clay 1997). Historically, Brazil has been the leading producer, but Bolivia has now taken the lead, with 2004 exports valued at \$50 million, compared with \$15 million for Brazil and \$10 million for Peru (Wander et al. 2008). From 2002–2006 annual harvests in Brazil have varied from 24,895 to 30,555 metric tons (IBGE–Instituto Brasileiro de Geografia e Estatística 2004, 2007). Overall, the industry employs some 200,000 people, mostly forest-based extractivists (Peres et al. 1997).

Brazil nut grows in well-drained *terra firme* forests throughout the Brazilian Amazon and adja-

cent areas in Bolivia, Peru, Colombia, Venezuela, and the Guianas. The Brazilian state of Pará contains the largest populations (Müller et al. 1980). Brazil nut trees are found in groves (Fig. 1) of 50–100 individuals known as *castanhais* (Portuguese), *manchales* or *castañales* (Spanish), with groves separated by considerable distances of compatible habitat where the species is completely absent (Peres and Baider 1997). This patchy distribution led Adolpho Ducke (1946) to suggest that Brazil nut groves might be plantations left by ancient Amazonian peoples. This “anthropogenic hypothesis” has been echoed by numerous authors since (Balée 1989; Müller et al. 1980; Posey 1985; Tupiassú and Oliveira 1967) without empirical test or systematic review. Here we review the literature and present new results from the authors' studies of Brazil nut ecology and genetics, management practices by local people, and linguistic analysis of indigenous terms for the species. Based on these findings we suggest that the Brazil nut was spread or facilitated throughout much of its current distribution by ancient indigenous populations.

Botany, Taxonomy, and Ecology

Bertholletia is a monotypic genus of Lecythidaceae, a pantropical family of small to very large trees. Lecythidaceae in the Americas are found from Mexico to Paraguay and southern Brazil, with diversity and abundance centered on Amazonia. The family includes about 200 species divided among ten genera; however, recent genetic studies demonstrate that major taxonomic revisions are needed in at least four of them (Mori et al. 2007). *Bertholletia excelsa* was named in 1807 by Alexander von Humboldt and Aimé de Bonpland in honor of the chemist L. C. Berthollet; the species epithet refers to its lofty stature. A second species, *Bertholletia nobilis*, described by John Miers in 1874, was later rejected as synonymous with *B. excelsa*. Morphological features place *Bertholletia* closest to the genus *Lecythis*, with affinities to *L. lurida* (Miers) S. A. Mori (Mori and Prance 1990a:135), but



Fig. 1. Approximately 50 m tall Brazil nut tree in terra firme forest of the Amaná Sustainable Development Reserve, Amazonas, Brazil (photo © 2001 G.H. Shepard).

genetic studies were unable to elucidate its taxonomic status within the Lecythidaceae (Mori et al. 2007).

The edible Brazil “nut” is not technically a nut, but rather a seed, encased within a large (11–15 cm. in diameter), heavy (–0. 6 to 1. 2 kg.), woody, exceptionally hard fruit or pyxidium. The fruits of the Brazil nut are unique within Lecythidaceae being both the hardest in the family and yet also functionally indehiscent. All other Lecythidaceae with fruits that fall to the ground at maturity either have a fragile fruit wall (pericarp) that soon breaks open, or else have a “lid” which falls off the operculum (goblet-like opening), allowing the seeds to disperse. The opercular lid of the Brazil nut falls inward, rather than outward, blocking the opening which in any case is far too small (about 1 cm in diameter) to release the seeds, which average 2.0 cm wide by 5.0 cm long (see Peres and Baider 1997). The Brazil nut fruit is so dense and heavy that it sinks in water like a stone, ruling out the possibility of aquatic dispersal (G. Shepard,

pers. obs.). Fruit development in *Bertholletia* is extremely slow, taking 15 months, compared with half that time for most Lecythidaceae. *Bertholletia* seeds (i. e., the Brazil “nut”) also take the longest period of time to germinate of any Lecythidaceae, requiring 12–18 months for natural germination, compared with almost instantaneous germination for most species (Müller 1981; cited in Mori and Prance 1990a:12).

Seed Dispersal and Grove Formation: Natural and Anthropogenic Factors

Some have suggested that certain elements of the Pleistocene megafauna, including the elephant-like gomphothere, extinct for more than 10,000 years, may have been involved in dispersing certain large-seeded plant species including the Brazil nut (Janzen and Martin 1982). Today, the main and perhaps only significant natural disperser of the Brazil nut is the humble red-rumped agouti (*Dasyprocta leporine*) and related species. The agoutis, *Dasyprocta* spp., are large-bodied, diurnal, terrestrial rodents (infra-order Caviomorpha) with extremely sharp and permanently-growing teeth. After gnawing through the pericarp and removing the tightly-packed seeds, the agoutis shell and consume them on the spot or carry individual seeds a short distance to be buried in shallow “scatter-hoards” to be eaten later. Peres and Baider (1997) show that a quarter of Brazil nut seeds are consumed immediately by agoutis, while 65% are scatter-hoarded an average of 5.0 m (range 0.5–28.4, n=217) from the point of origin. Presumably, some scatter-hoards are forgotten, providing short-range dispersal within existing stands. Arboreal seed predators including the bearded saki monkey (*Chiropotes satanas*), the red-necked woodpecker (*Campephilus rubricollis*), and macaws (*Ara macao* and *A. ararauna*) are able to pry open green fruits in the forest canopy; however, the seeds at this stage are not viable (Peres et al. 1997; Trivedi et al. 2004).

Peres and Baider (1997) assert the fundamental role of agoutis in dispersing Brazil nuts and reject the anthropogenic hypothesis proposed by Ducke (1946) and others. However, given the lack of any evidence that agoutis disperse seeds long-distance, Peres and Baider (1997:613) suggest that macaws or other arboreal seed predators may be involved in rare, long-distance dispersal events. Once a single individual is established, however,

agouti scatter-hoarding would presumably lead to the establishment of a new grove.

Several published studies as well as our own field observations indicate that human disturbance and intervention greatly facilitate Brazil nut regeneration, and may be crucial for the establishment of new groves. Indeed, the weakness of Peres and Baider's (1997) argument is that, while scatter-hoarding agoutis are ubiquitous in Amazonia, Brazil nut saplings are exceedingly rare in primary forest habitats (Pires 1984), requiring significant canopy gaps to develop (Myers et al. 1996). Peres et al. (2003) have argued that commercial over-harvest may be responsible for a "demographic bottleneck," though this interpretation has been criticized in the light of significant human facilitation of Brazil nut recruitment (see Stokstad 2003). Agoutis appear to disperse Brazil nuts preferentially into garden fallows, where densities of seedlings and saplings are much higher (two and four times, respectively) than in undisturbed forest (Cotta et al. 2008). Human predation of agoutis—an abundant game species often hunted by indigenous peoples in their gardens (e. g., Ohl-Schacherer et al. 2007)—would only tend to magnify the agouti's importance as a seed dispersal agent, freeing more abandoned scatter hoards for germination.

In the basin-wide survey of Brazil nut populations published by Peres et al. (2003), by far the highest densities of saplings and trees overall were registered by Shepard (2002) in a small, fire-impacted grove near Alter do Chão, Pará, with 50 individuals/ha, mostly in the size class of 10–60 cm diameter. This was a clear outlier in the dataset, where most groves had 10–100 times lower densities of *Bertholletia*, and the majority of individuals were larger than 100 cm in diameter. What made the Alter do Chão site unique was its situation in a drier, central Amazonian climate zone with high susceptibility to fire. Local informants reported that the region suffered a major fire in the 1980s, which cleared away significant areas of forest understory but also completely exterminated the local agouti population. This was the only region surveyed where multi-trunked Brazil nut individuals were found: nearly 50% of the trunks surveyed at the site (45 of 93 trunks) were fused in groups of 2–5 individuals (see Shepard 2002). This was puzzling until multiple seedlings were observed emerging from single, unopened seed cases. Without agoutis to open and disperse the seeds, the seeds

germinate within the fruit cases. Peres and Baider (1997:599), citing de Souza (1984), claim that seeds left inside unopened *Bertholletia* pyxidial rarely if ever germinate, succumbing to fungus. Perhaps the drier climate or high levels of human disturbance in Alter do Chão facilitate germination in these circumstances. Notably, Alter do Chão is within the proverbial stone's throw of the Pedra Pintada site where Roosevelt et al. (1996) discovered the earliest evidence of Brazil nut consumption in ancient Amazonia.

Associations between Brazil nut groves and anthropogenic dark earths have been mentioned in the literature (Balée 1989; Conklin 2001), and we found similar associations in our field expeditions. In the Amaná Sustainable Development Reserve of Brazil, the community of Boa Esperança harvests Brazil nuts from a large and productive grove nearby known as "Castanhal Urumutum." The community is located within a patch of anthropogenic dark earths where over 200 pre-Columbian funerary urns were discovered, indicating a significant ancient occupation (Shepard 2001). Guix (2005) found high densities of useful, large-seeded plants including Brazil nut in soils rich with archeological remains along the Rio Negro River. Similar observations have been made in recent archeological and botanical surveys in the Rio Trombetas (Magalhães 2009). Guix (2005) suggests that humans may have replaced extinct Pleistocene megafauna species in dispersing a number of economically useful, large-seeded tree species that might have otherwise gone extinct or suffered range reductions in the sudden climatic and ecological changes that occurred approximately 10,000 years ago (Piperno and Pearsall 1998). Brazil nut trees have also been found in association with geoglyphs—square or circular man-made trenches dated to between 1,000 and 2,500 years ago (Pärssinen et al. 2009; Ranzi et al. 2007)—that have become visible in newly deforested areas in Acre. Similar formations, also rich in Brazil nut trees, were observed in Riberalta, Bolivia, near the junction of the Beni and Madre de Dios rivers (H. Ramirez, pers. obs.).

Field observations made during a year-long survey of *Bertholletia* populations throughout the Brazilian Amazon by Shepard (2002) revealed specific ways in which local populations have promoted Brazil nut stands through management and direct plantation. For example, Ponta da Castanha is a managed Brazil nut grove on Tefé lake near the Mamirauá Sustainable Development

Reserve. The owner, Vitor Azevedo (Fig. 2), is the son of a Peruvian immigrant who bought the land in 1944, when Vitor was four years old, from a Turkish merchant who, in turn, had acquired it as collateral from an indebted customer. Ponta da Castanha covers about 20 ha of rich dark earth full of pre-Colombian artifacts. It originally contained 38 productive Brazil nut trees that were overgrown with lianas. Vitor's father cleared the trees of lianas and began planting additional trees in small manioc plantations he opened through the years to feed his family. Within the first few years of management, production of Brazil nuts had increased from 160 to 1,000 liters per year. His father, and later Vitor himself, eventually planted some 280 additional trees throughout the property. Vitor remembers the exact year many individual trees were planted. Today, the density of Brazil nut there is 20 to 25 trees/ha, among the highest densities observed anywhere, and Vitor harvests about 3,000 liters of

Brazil nut per year. Vitor's father experimented with different plantation methods, at first planting whole, unopened pixydia—producing multiple individuals with fused trunks, as noted above—until finally learning to pre-germinate individual seeds. Vitor observed, “You have to take care, protect the trees from vines and remove weeds; otherwise they don't grow. And this business about 15–20 years to fruit is a lie! Maybe in the forest, but in a garden fallow, it'll give fruit in five or six years.” Pointing at a small fallow area on an adjacent property, Vitor remarked, “That fallow there, it was pasture. What, about 10 hectares? You can plant a hundred Brazil nut trees. A hundred trees, that's a *castanhal* [Brazil nut grove]! A hundred trees will produce 100–200 liters per year.”

The approximately 200,000-ha extractive reserve “Rio Preto de Ouro” near Guajará-Mirim, Rondônia, contains a vast and diffuse Brazil nut grove of over 50,000 ha with an average density of 1 to 4 *Bertholletia* individuals per ha (Shepard 2002). Through the early 20th century, this region had been the economic and cultural heartland of the Wari' (Fig. 3), a formerly isolated and bellicose group known for their cannibalistic funerary customs (Conklin 2001). The Wari' were displaced from Rio Preto de Ouro by rubber tappers during the “Rubber Boom” first in 1895–1917, and then during and after World War II. Traditional Wari' funeral practices involved the complete destruction of all reminders of the deceased, including consumption of the body. When Wari' families return to their customary Brazil nut groves after a death in the family, they burn the underbrush and discarded fruit capsules from the previous years' collecting seasons (Fig. 4), altering the appearance of the grove and eliminating physical reminders of past moments shared with the deceased (Conklin 1989). By generating localized disturbance and fertilizing the soil with ash, this practice certainly facilitates Brazil nut sapling recruitment. Conklin (2001) also notes an association between Brazil nut stands and anthropogenic dark earths (*terra preta do índio*) in Wari' territory. Culturally unrelated Uru-Eu-Wau-Wau Indians in an adjacent reserve were observed to cut away vines and undergrowth around Brazil nut trees to facilitate their healthy growth and longevity. Commercial Brazil nut harvesters throughout Amazonia remove underbrush in groves to facilitate fruit collection and to reduce the likelihood of snakebite (Scott Mori, pers. comm.). These diverse ethnographic



Fig. 2. Vitor Azevedo, who helped his father plant most of the Brazil nut trees currently found at Ponta da Castanha, Lago Tefé, Amazonas State, Brazil (photo © 2001 G.H. Shepard).



Fig. 3. The Wari' indigenous people of Rondônia gather prodigious amounts of Brazil nut both for domestic use and, today, commercial sale (photo © 2000 G.H. Shepard).

observations and other published accounts (Posey 1985) attest to how indigenous and other peoples have facilitated the recruitment of Brazil nut groves in different parts of the Amazon.

Geographic Distribution and Genetic Diversity

The Brazil nut is found throughout a large geographic range, from 5° N latitude in the upper Orinoco to 14° S in the upper Madre de Dios (Fig. 5, adapted from RADAM-Brasil 1973–1981; Mori and Prance 1990a:137; Desmoulière n.d. -a, b). *Bertholletia* is found as far east as the Brazilian Atlantic coast and as far west as the Marañon river in Peru. However, Brazil nut trees found at the extreme eastern (Atlantic coast) and northern (Guianas) limits of distribution were probably planted during early colonial times (S. Mori, pers. comm.; see also Mori and Prance 1990a). Within this broad range, Brazil nut is curiously absent from most of the Juruá, Jutái, and Javari basins, despite occurring in adjacent areas to the south (Purús), north (Japurá, Rio Negro), east (Solimões, lower Purús), and west (Marañon; see Fig. 5).

The so-called “sapucaia” or *pisonis* group within *Lecythis* is a morphologically and genetically coherent set of species (Mori and Prance 1981, 1990b; Mori et al. 2007) including *L. ampla* Miers, *L. lanceolata* Poir., *L. pisonis* Cambess. (containing two subspecies), and *L. zabucajo* Aubl. (= *L. tumefacta* Miers). The edible seeds, known in Brazil as *sapucaia* and appreciated by local populations, are superficially similar to the Brazil nut. Unlike the Brazil nut, however, the fruit case is soft and fully dehiscent when ripe, allowing the seeds fall to the ground. Bats may also be involved in sapucaia dispersal (Greenhall 1965).



Fig. 4. The Wari' first gather and then burn scattered Brazil nut seed cases in the forest after a funeral to help forget painful memories of dead loved ones (photo © 2000 G.H. Shepard).

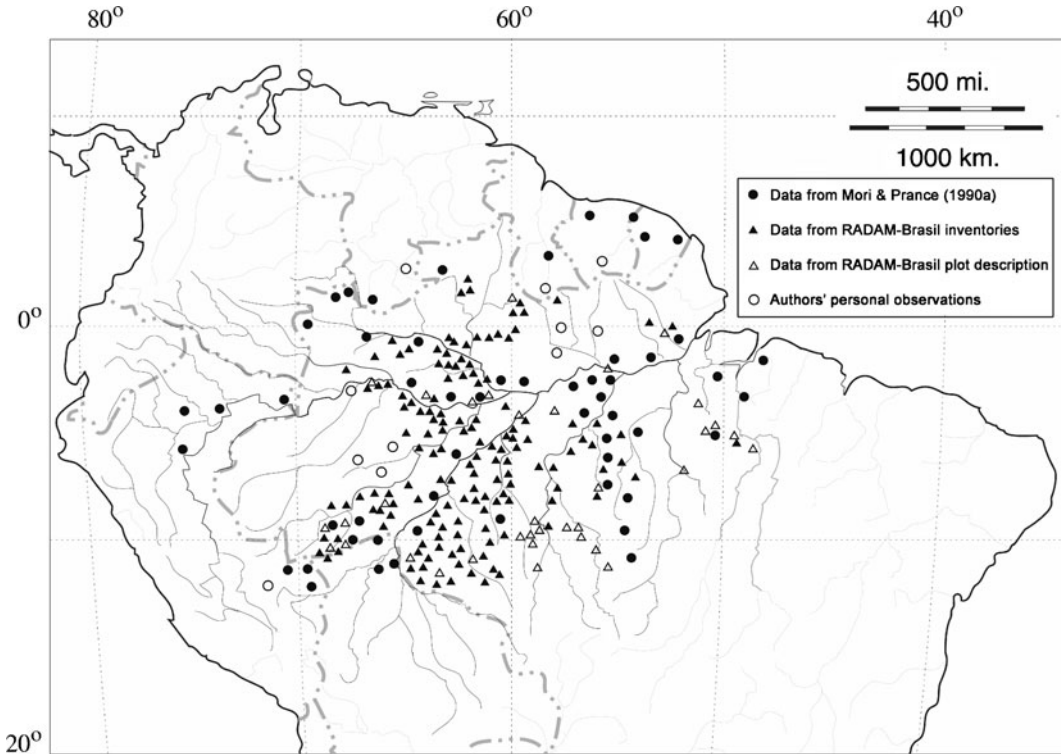


Fig. 5. Distribution of the Brazil nut (*Bertholletia excelsa*). Data synthesized from Mori and Prance (1990a:137), a spatial analysis of RADAM-Brasil (1973–1981) inventory data conducted by Desmoulière (n.d. -a, b), and authors' pers. obs.

Comparing the geographical distributions of species within the sapucaia group (Fig. 6) with that of Brazil nut (Fig. 5), a strikingly different pattern emerges. The sapucaias are distributed among well-defined and geographically distinctive populations, as might be expected of a lineage with a long history of dispersal and geographical isolation between populations. Brazil nut, by contrast, demonstrates an extensive geographic range—equal to or exceeding that of the two Amazonian sapucaias, *L. zabucajo* and *L. pisonis* ssp. *pisonis*—and yet shows no internal taxonomic differentiation as might be expected of an ancient evolutionary lineage. Given the cumbersome dispersal mechanism of *Bertholletia*, compared with the dehiscent and more easily dispersed seeds of the sapucaias, one would expect *Bertholletia* to show more rather than less geographical isolation between populations, unless of course the Brazil nut's evolutionary history has been more recent, and its dispersal process more rapid.

Reinforcing this conclusion, two prior studies found exceptionally low levels of genetic diversity

in *Bertholletia* compared with other tropical trees (Buckley et al. 1988; Kanashiro et al. 1997). Though Buckley et al. (1988) originally attributed this result to special ecological characteristics of the species, Kanashiro et al. (1997) noted the hypothesized interventions of indigenous people as a more likely explanation (see also Mori and Prance 1990a). Both studies, which used nuclear DNA markers, found far greater levels of genetic diversity *within* Brazil nut groves than *between* them, a result that is uncommon for wild woody plant species (see Buckley et al. 1988) but common among cultivated species such as *Eucalyptus globulus* Labill. and *Camellia sinensis* (L.) Kuntze (Kanashiro et al. 1997). Curiously, Kanashiro et al. (1997) found the highest levels of within-grove phenotype diversity for the central Amazon Santarém population (adjacent to Alter do Chão and Pedra Pintada) and the lowest diversity for populations from Acre in the western Amazon. Though the authors do not comment on this fact, the data might suggest a central Amazonian center for Brazil nut genetic diversity.

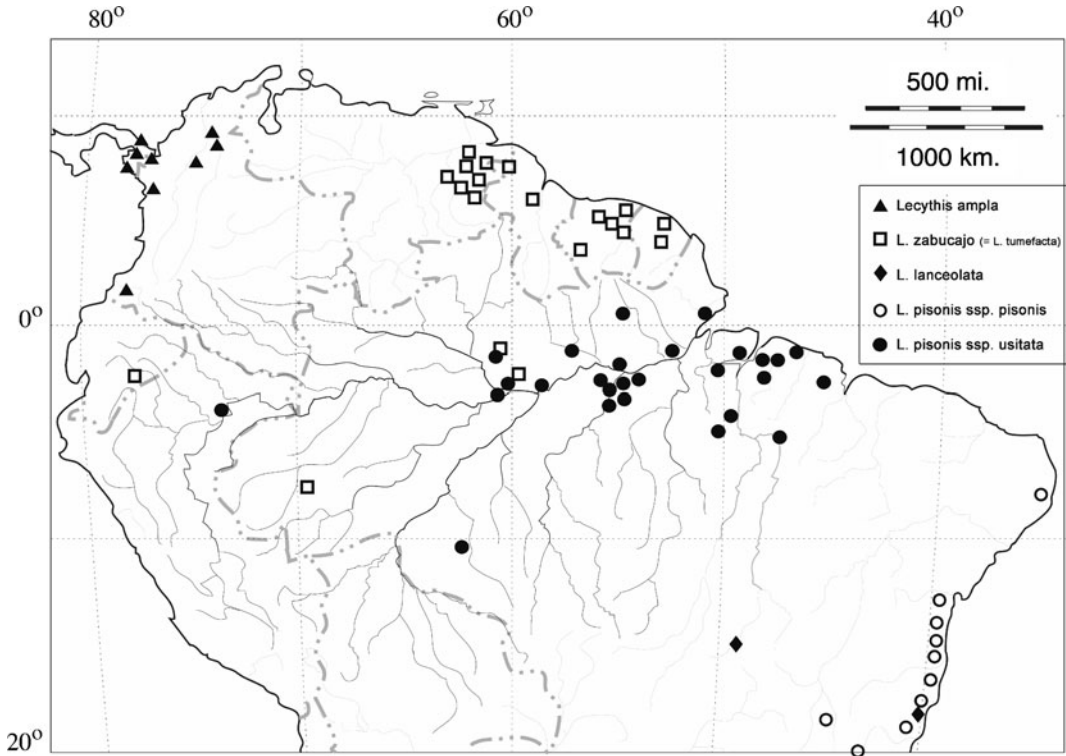


Fig. 6. Distribution of *Lecythis* spp. in the “sapucaia” or *pisonis* group. Data adapted from Mori and Prance (1981:72).

A Brazilian research group led by Rogerio Gribel and Maristerra Lemes used contemporary chloroplast gene (cpDNA) sequencing and microsatellite markers to study genetic diversity of the Brazil nut (Gribel et al. 2007; Shepard 2002). The chloroplast genome, analogous to the mitochondria genome in animals, is transmitted along maternal lines and thus relevant to studying seed dispersal. The results of this study revealed no variation for six non-coding cpDNA markers amplified and sequenced for eight widely separated (up to 2,800 km apart) Brazil nut populations (Gribel et al. 2007). This result contrasts with cpDNA sequence variability documented at local scales (populations separated by as little as 30 km) for other *Lecythidaceae*, including *Lecythis zabucajo* (Hamilton et al. 2003). Microsatellites are highly variable regions of DNA used to study genetic diversity within populations, analogous to paternity testing in humans. Using eight microsatellite markers, Gribel et al. (2007) identified 21 haplotypes for 116 individuals from the eight widespread populations. An analysis of molecular variance revealed no signifi-

cant geographical structuring, with 93% of the genetic variation found *within* populations, reinforcing the prior findings of Buckley et al. (1988) and Kanashiro et al. (1997) using different techniques. If Brazil nut distribution depended mostly on short-distance seed dispersal by agoutis, with rare, long-distance dispersal events of single seeds to form new groves, the process would have taken a very long time, and a geographically coherent pattern of genetic variability should have emerged, as is the case for other *Lecythidaceae*. Instead, low genetic variability at a large geographical scale suggests a recent and rapid irradiation of the species from a geographically limited population origin.

Hans Carlos Müller, who has spent decades gathering *Bertholletia* throughout Amazonia for agronomic experimentation (see Müller 1981; Müller et al. 1980), suggests the phenotypic variation he has observed may be the result of human selection (H. C. Müller, pers. comm.). For example, the Brazil nut variety known as *abufari* produces extremely large seeds (about 7 cm in length) arranged like the individual slices

of a grapefruit. He describes other varieties that produce exceptionally large or numerous seeds, that have exceptionally low tree crowns, or that present variable fruiting and maturation dates, characteristics which are reproduced in offspring, ruling out mere ecological variation. Such phenotypic variables (fruit size, low crown, etc.) are typical of traits selected for by humans in incipient domestication of managed species (Clement 1990).

Linguistics and Cultural History

Historical linguistics has been used to shed light on the dispersal of ancient peoples and their crops, languages, and genes (Bellwood 2001; Bellwood and Renfrew 2002; Brown 2006; Comrie 2002). Though caution is needed in interpreting such data (Campbell 2002; Moore and Storto 2002; Roosevelt 1992), proto-language reconstruction and the study of loan words can provide evidence about the timing and direction of agricultural, technological, and cultural

innovations (Balée 2000; Balée and Moore 1991; Comrie 2002; Urban 1992).

Henri Ramirez has collected a large database of vocabulary words in numerous South American languages, including botanical and zoological terms (see also Ramirez 2001). Results for the Brazil nut, published and analyzed here for the first time (Appendix), suggest an intriguing pattern (Figs. 7 and 8). Of the three major language families within Brazil nut’s range—Arawak, Carib, and Tupi—only Arawak and Carib have terms for Brazil nut that reconstruct to the respective proto-languages. Tupi, on the other hand, shows variable terms for Brazil nut across different subfamilies that do not appear to reconstruct. The suggested proto-Arawak term for Brazil nut is **maiña* or **maina*, while the suggested proto-Carib word is **tutka* or **tutuka* (the asterisk denotes hypothetical proto-vocabulary terms deduced from modern forms). When specific vocabulary items (plants, animals, tools, etc.) reconstruct to the proto-language (barring recent loan words, which can be detected through

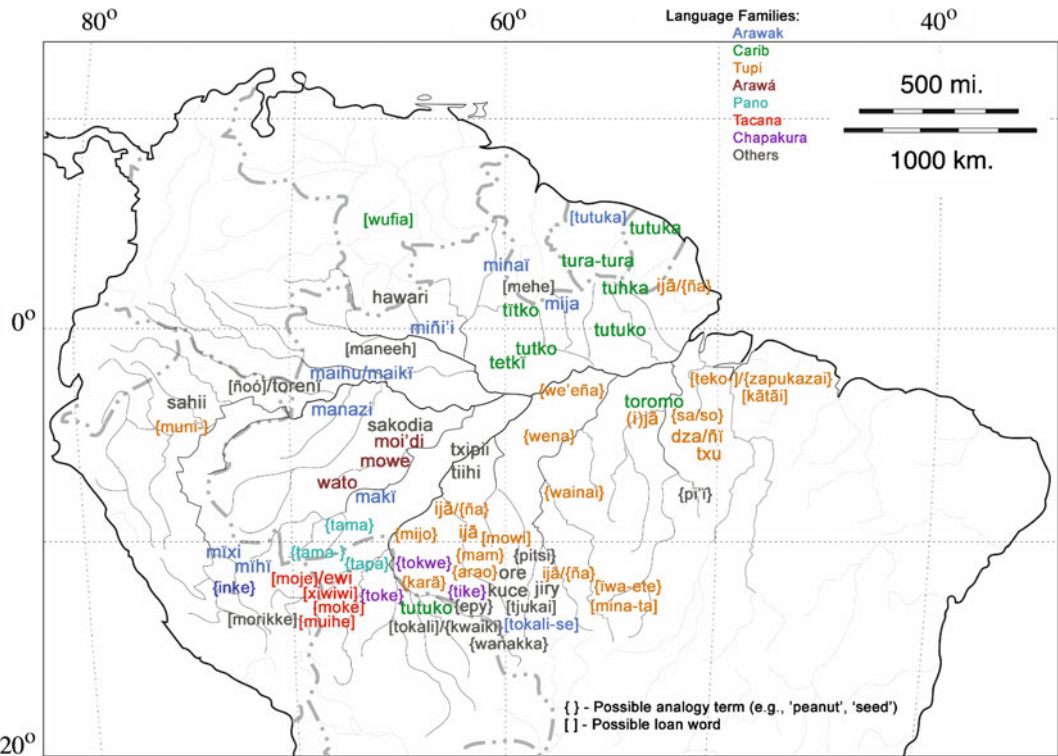


Fig. 7. Indigenous terms for Brazil nut in the Amazon, showing approximate geographical location of each group, color-coded for language family.

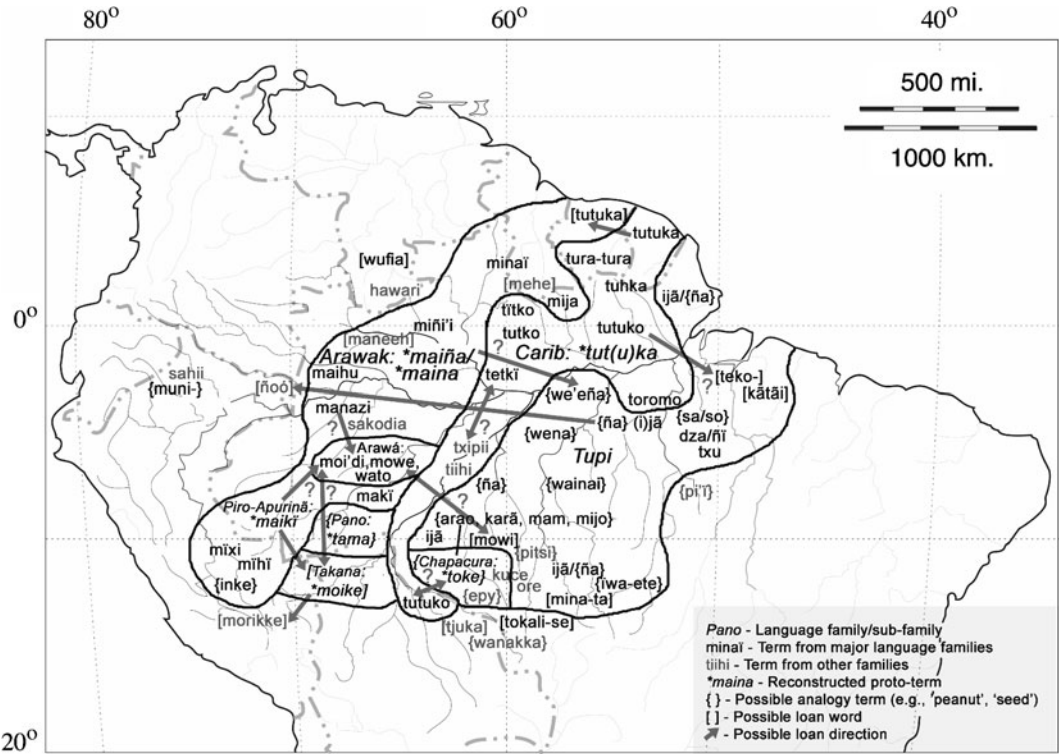


Fig. 8. Preliminary historical/geographical analysis of indigenous terminology for Brazil nut.

careful study), it is presumed that these items were present in the cultural and environmental milieu at the time the proto-language was spoken (Facundes 2002; Moore and Storto 2002).

Contradicting earlier hypotheses, which were based on fragmentary or flawed evidence (Noble 1965; Schmidt 1917), more recent archeologists and linguists propose that Arawak peoples originated in the northern portion of the Amazon basin, though opinions are divided as to the precise center of origin, whether in central (Lathrap 1970; Ramirez 2001:26) or northwestern Amazonia (Heckenberger 2002:99; Oliver 1989). Arawak speakers began a vigorous expansion approximately 3,000 years ago and came to occupy a vast region from the savannas of southern Brazil, to the Caribbean, to the Andean foothills of Peru and Bolivia (Hill and Santos-Granero 2002; Payne 1991). Carib languages were long thought to have emerged in the southern Amazon (Rodrigues 1985; Steinen 1894). However, a more recent internal classification by Meira (2006:200) suggests a northern origin in the Guianas (see also Heckenberger 2005; Lathrap 1970; Meira and Franchetto

2005). Regardless, the relatively close linguistic proximity among existing Carib languages suggests a relatively recent common ancestor, with perhaps only half the time depth of the Arawak or Tupi language families, estimated to have begun internal diversification more than 3,000 years ago (Payne 1991; Rodrigues 1999). Wherever proto-Carib speakers found themselves some 1,500 to 2,000 years ago, Brazil nut appears to have been a salient element of their environment.

The Arawak and Carib cases contrast with that of the Tupi family, for which a proto-word for Brazil nut does not appear to reconstruct. Variable proto-words for Brazil nut reconstruct for some of the Tupi subfamilies (Tupi-Guarani, Tupari) and perhaps other intermediate groupings (see Appendix). This speculative linguistic evidence suggests that the earliest proto-Tupi speakers might not have known the Brazil nut, but came to know it (either through migration or interethnic contact) after certain subfamilies had diverged. Both linguistic and archeological data provide strong support that the Tupi language family originated in the southern Amazon, likely in the upper Tapajos and Madeira rivers in what is

now the Brazilian state of Rondonia (Heckenberger et al. 1998; Métraux 1928; Rodrigues 1964). This region currently contains large and important populations of Brazil nut; thus the absence of a clear proto-word is striking and anomalous. Indeed, Eurico Muller, the preeminent archaeologist of Rondonia's prehistory (see Miller 1992), remarked on the curious absence of Brazil nut remains (though charred palm nuts are common) from 4,000-year old sites he has excavated in regions where Brazil nut groves are a dominant element of the current landscape (E. Muller, pers. comm.).

Diverse language groups near the limits of the current distribution of the Brazil nut refer to it using loan words from neighboring languages. For example, the Arawak-speaking Lokono in the Guianas call the Brazil nut *tutuka*, clearly a loan word from neighboring Carib speakers. Likewise the Tupi-speaking Tembé in Pará (eastern Amazon) call it *teko-ingwer*, the first element of which may be a loan from Carib (an alternative name for Brazil nut in Tembé, *zapukaza'i* refers to *Lecythis pisonis*, an example of naming by analogy; see below). The word for Brazil nut in Tikuna, *ñoo*, appears to be a loan word from the reconstructed Tupi-Guarani *ña*, associated with the late western expansion of Tupi speakers along the main Amazon channel (Rodrigues 1999). Other indigenous groups along the fringes of its distribution refer to the Brazil nut with regional vernacular terms: the Yekuana (Carib) term, *wufia*, is a loan word from the regional Venezuelan term, *jubia*, while multiple groups in southern and eastern Brazil have terms derived from the Portuguese *castanha* or the regional term *tocari*, probably of Carib origin (see Appendix, Figs. 7 and 8).

In the Tupi-Guarani subfamily of the Tupi family, the reconstructed proto-term for Brazil nut, **(i)ña*, is close enough to the proto-Arawak **maina* to warrant further scrutiny. The term *minata* in Kamayurá (within Tupi-Guarani) is especially similar to the Arawakan form. *Manéeh* in Maku (northwest Amazon) and *méhe* in Taruma (Guiana region) are more clear-cut cases of Arawak loan words to unrelated languages.

In some cases, regional loan word patterns suggest longer chains of interethnic contact or migration. For example, along the Madeira River, the Mura word for Brazil nut, *tihii*, is similar to the word among the unrelated but neighboring Matanawi, *txipii*. In the headwaters of the

Madeira, the Takana-speaking Esse-Eja refer to Brazil nut as *xiwiwi*, more similar to the Mura and Matanawi words than the cluster of terms (*moke*, *moje*, *muihe*) used by their Takana neighbors. The Mura and Matanawi terms (*tihii*, *txipii*) bear at least superficial resemblance to nearby Carib forms such as *tetki*, and even to the word for peanut, *dihii*, among the Leko in the upper Madeira (see discussion below about peanut/Brazil nut associations). The Iquito term *sahii* (Peruvian Amazon), Katawixi *sákodia* (central Amazon), and Asurini *sa* (Tupi-Guarani of Tocantins) also show a superficial similarity. Similarity among vocabulary items can also emerge by chance, and thus more systematic investigation would be required to test these speculations.

A stronger case for chains of linguistic borrowing can be made for a cluster of unrelated language families located in the Purús basin and Madeira headwaters in the southwest Amazon. Terms in the Arawá (not be confused with the Arawak) language family such as *mowe* and *moi'di* are strikingly similar to the Tupian Arara term *mowi*, and also resemble nearby Arawak terms such as Kaixana *maihu* and Marawá *manazi*. Further south in the Madeira headwaters between Bolivia and Perú, the reconstructed proto-Takana term **moike* is similar both to these modern Arawá terms (*mowe*, *moi'di*) and to **maiki* as reconstructed for the proto-Piro-Apuriná subgroup of Arawak (see Fig. 8, Appendix). The Harakmbut word *morikke* is a clear loan word from the proto-Takana **moike*.

The Harakmbut presents a particularly interesting case, since Brazil nut is virtually absent from their current territory on the Manu and upper Madre de Dios rivers in Peru (upper Madeira tributaries). A few isolated individuals of Brazil nut are currently found in the forest interior several kilometers from the Pakitsa guard post of Manu National Park (G. Shepard, pers. obs.), far from the commercially viable Brazil nut groves on the lower Madre de Dios that have been considered the southernmost distribution limit (Mori and Prance 1990a). These isolated Brazil nut trees in Manu are not likely to have arrived at Pakitsa by natural dispersion, and were instead probably brought by indigenous people such as the Harakmbut-speaking Toyeri who occupied Manu before being decimated by rubber tappers beginning in the 1890s (Shepard et al. 2010). The Harakmbut word for Brazil nut, and

the Brazil nut trees themselves, appear to have been acquired either through downstream trading with the Takana, or as a result of an earlier upstream migration. In the latter regard, Adelaar (2000) suggests tentative linguistic connections between Harakmbut and the Katukina language family of Brazil. This example suggests a link between processes of linguistic borrowing and actual plant dispersal.

A number of unrelated, geographically separated languages in the southern and western Amazon appear to have named the Brazil nut through analogy to some other edible nut (see Appendix), particularly the peanut (*Arachis hypogaea* L.). Novel plants or animals are often named by analogy with more familiar local species (Berlin 1992; Witkowski and Brown 1983). The Portuguese and Spanish words for Brazil nut represent precisely such a case, where the terms *castanha* and *castaña* referred originally to the chestnut (*Castanea* spp.), and later came to refer to the Brazil nut through analogy. The Matsigenka (Arawak) live in the Andean foothills outside the Brazil nut distribution, and came to know it only in recent decades through trade; they refer to Brazil nut either as *inke*, literally “peanut,” or else use the Spanish term *castaña*. In a similar fashion, the linguistically unrelated Sharanahua (Panoan) and Kokama (Tupi), who live near the southern and western limits (respectively) of Brazil nut distribution, refer to it as “large peanut” (see Appendix). These groups, like the Matsigenka, appear to have encountered the Brazil nut relatively recently. Among the Panoan languages there seems to be thorough interchangeability between terms: while the Sharanahua call the Brazil nut “large peanut” (*tama wan*), the Chacobo call the peanut a “ground Brazil-nut” (*mai tapa*).

Among multiple subgroups of southern Tupi languages, the word for Brazil nut is suspiciously similar to the word for peanut: in Makurap, *arao* (where *arawī* is “peanut”); in Mondé, *mam* (where *mam kap* is “peanut”); Karitiana, *mijo* (where *mīi* is “peanut”); and Munduruku, *wenijl wenā* (where *wenā-bin ñe* is “peanut”). The isolated languages Kanoe and Rikbaktsa (Rondônia) show a similar semantic overlap between Brazil nut and peanut (see Appendix). Likewise in the two Nambikwara dialects (southern Amazon), Brazil nut is *wana*’ and *wanakka*, respectively, while peanut is *waiki* and *waikki*. In the related Sabanê language, *kwaiki* for Brazil nut is

reminiscent of the word for peanut, *wai-se*, among the neighboring Arawak-speaking Pareci. The peanut, curiously, was probably first domesticated nearby in the dry south Amazon border region (see Piperno and Pearsall 1998).

Among the more northerly Tupi groups (Tupi-Guarani subgroup), the word for Brazil nut in some languages is closely related to the general word for “seed,” even showing systematic sound correspondence between for example *ña* (“Brazil nut”) and—*a’ña* (“seed”) in Wayampi-Kawahip-Apiaká, and *sa* (“Brazil nut”) and—*a’ša* (“seed”) in Asurini. Likewise the Chapacuran (Rondônia/Bolivia) terms *tokwe*, *tokā*, *tike*, *teke* are very close to the general terms for “seed” (*tokwin*, *toki*).

Linguistic borrowings depend upon complex factors involved in sociolinguistic contact (Campbell 2002; Comrie 2002; Dixon 1999), and interpretation of such data presents numerous challenges. We speculate, based on analysis of loan words and semantic extension (“nut”/“peanut”), that some of the language groups around the fringes of the Brazil nut distribution, and along certain key river routes (e. g., upper Madeira, western Amazon), encountered the Brazil nut relatively recently through migration, trade, or contact. The Tupi case is particularly important, since they are presumed to have originated in the upper Madeira/Tapajos region, which currently contains vast, commercially productive Brazil nut groves. Our preliminary linguistic analysis suggests that some four millennia ago, when the Tupi language family emerged, the Brazil nut may not have been present in their environment.

Recent archeological studies (Arroyo-Kalin 2008; Neves et al. 2003) have demonstrated that the large patches of anthropogenic dark earths, or *terra preta do índio*, found mostly in the Brazilian Amazon, resulted from the intensification of agriculture and the emergence of sedentary lifestyles, especially during the first millennium C.E. Arawak peoples have been implicated in the spread of sedentary agriculture in the Amazon (Schmidt 1917), the generation of these dark earth soils (Arroyo-Kalin 2008), and the formation of large-scale interethnic trade networks (Hill and Santos-Granero 2002). Sedentary lifestyles and dark earths are especially associated with the cultivation of bitter manioc, which requires labor-intensive processing that generates large amounts of charcoal during the cooking and toasting of various kinds of manioc flour and other byprod-

ucts; bitter manioc cultivation predominates in the eastern half of Amazonia, the Orinoco basin, and the Guianas (Arroyo-Kalin 2008). Sweet manioc (“yuca”), by contrast, requires no special processing other than simple cooking, and is predominant in the western Amazon where semi-nomadic shifting cultivation is the norm, and where both the Brazil nut and anthropogenic dark earths are mostly absent. The intensive agriculture practices required to create large patches of anthropogenic dark earths provide exactly the combination of anthropic factors that would have facilitated the establishment of Brazil nut stands. Brazil nut groves are often associated with anthropogenic dark earths, and Arawak languages appear to represent an important hub of loan words for Brazil nut to other language families. Indeed, the distribution of Brazil nut shows striking similarities with the distribution of known dark earth sites in the Amazon basin (see Kern et al. 2004:54).

Several authors have noted the conspicuous absence of the Brazil nut in the Juruá basin (Mori and Prance 1990a; Fig. 5). While soil conditions may be a factor, the Juruá is also a region of cultural disjunction between more geographically circumscribed Arawá and Panoans, surrounded to the north and south by suggested routes of Arawak and multiple Tupi expansions along the Madeira and Amazon proper (Aikhenvald 1999; Hornborg 2005; see also Heckenberger 2002:105). Thus the limits of the Brazil nut distribution may represent at least in part the limits of various cultural-linguistic “diasporas” (Heckenberger 2002) associated with the intensification of agriculture, especially beginning in the first millennium C.E. (Arroyo-Kalin 2008; Neves and Petersen 2006). Speculative dating of language families (see Appendix) supports a similar time frame (1,500–2,000 years ago) for the acquisition of loan words or analogy terms (“peanut,” “seed”) for Brazil nut in several Amazonian language families in the southern and western Amazon (Tupi, Pano, Takana, Nambikwara, etc.).

Conclusion

There is so far no “smoking gun” that proves Brazil nut groves are the forest plantations of ancient indigenous peoples, as Ducke (1946) once hypothesized. However, a preponderance of evidence from independent lines of research,

some already published and some presented here for the first time, lends credence to some degree of human involvement in the dispersal of the Brazil nut to its current range. A review of the geographic distribution of *B. excelsa*, and comparison with that of several *Lecythis* species with similar, more easily dispersed seeds, suggest a number of anomalies that are consistent with a relatively recent colonization of *Bertholletia* throughout Amazonia. The dispersal ecology of the Brazil nut renders it highly responsive to and perhaps largely dependent on anthropogenic disturbance for the establishment and expansion of groves, at least given post-Pleistocene ecological conditions. Field observations and a review of ethnographic examples suggest how specific cultural practices might have facilitated the expansion of Brazil nut populations from ancient through recent times. Phenotypes observed in certain Brazil nut populations suggest a degree of selection and incipient domestication. Past genetic studies suggesting low degrees of inter-population genetic diversity were confirmed and made more emphatic by our own more recent studies of chloroplast DNA, suggesting a recent and rapid dissemination from a restricted population of origin.

Historical linguistic analysis of indigenous terms for the Brazil nut reinforces our interpretation of previously published genetic (Kanashiro et al. 1997) and archeological (Roosevelt et al. 1996) data, suggesting a northern/central Amazonian origin for *Bertholletia*, with a more recent spread of Brazil nut distribution (and cultivation?) to the south and west. Such an expansion would have been particularly facilitated by the emergence of intensive bitter manioc cultivation and networks of interethnic trade associated with the Arawak diaspora of the first millennium C.E. (see Heckenberger 2002). The often-noted association between Brazil nut groves and anthropogenic dark earths—themselves a result of intensive pre-Colombian sedentary agriculture—lends support to such an interpretation. Our arguments contribute to a body of relatively recent discoveries challenging the long-standing view of pre-Colombian Amazonian peoples as small, low-impact nomadic populations, revealing instead the significant legacy of ancient indigenous peoples in shaping modern Amazonian landscapes (Balée and Erickson 2006; Heckenberger et al. 2008; McCann et al. 2001; Roosevelt 1980).

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Appendix

Regional, vernacular, and indigenous terms for Brazil nut (*Bertholletia excelsa*), researched and organized by H. Ramirez. All vernacular terms were collected in the field except where bibliographical sources are noted.

REGIONAL AND VERNACULAR TERMS:

- **noix du Brésil** (French) < *Latin **nuc(e)** “fruit of a european tree (*Juglans regia*), or any similar kind of fruit with an almond” < *Indo-European **knu(t)**.
- **Brasil nut** (English) < *Germanic **knut** “hard seed” < *Indo-European **knu(t)**.
NOTE: The German and English words for the peanut (*Arachis hypogaea*) have been formed from the same linguistic root: **pea** + **nut** in English and **erd** + **nuß** *nut of earth* in German.
- **castanha** (Portuguese), **castaña** (Spanish) < *Latin (**nux**) **castanea** “nut of the chestnut tree (*Castanea vesca*) or any similar kind of fruit” < *Greek **kástanon** < Asiatic language (cf. English **chestnut** < *Old English **chesten nut** < *Old French **chastaigne** “chestnut”).
- **almendra** (Spanish, cf. Portuguese **amêndoa**, French **amande**, English **almond**) < *Latin **amygdala** “almond” < *Greek **amygdále** “amygdalis”.
- **to(ro)cari** (Brazil of XVIIIth century) < probable Carib loan, with the non-Carib suffix **-ri**.
- **touca** (French Guiana) < probable Carib loan: **tutuka** in Kari’ña.
- **yuvíá, jubia** (Venezuelan Spanish) < loanword from an unknown indigenous language.

Symbols, abbreviations, and orthography:

N.P.	Brazil nut not present in locality
†	extinct language
[<...]	etymological meaning or loan word
— / —	synonyms
(— yrs.)	approximative time depth for the proto-language
*—	hypothetical reconstructed proto-form
ĩ	high central vowel
Ä	mid central vowel
y	high round front vowel (like <u>y</u> in French)
ñ	palatal nasal
j	palatal semivowel (like <u>y</u> in English)
x	voiceless palatal fricative
tx	voiceless palatal affricate
’	glottal stop
ã, ě,...	nasalized vowel

INDIGENOUS TERMS:

NOTE: Terms are organized by linguistic families. Roman numbers (I, II, III, etc.) indicate the subfamilies, while letters (I^a, I^b, I^c, etc.) show further subgroupings. New internal classifications have been suggested here by H. Ramirez for Arawá, Arawak, Chapacura, Carib, and Pano families. Where ongoing lexico-statistical study permits, suggestions for language family time depth are provided in parentheses. Supplemental terms for “peanut,” “nut,” etc. are provided where relevant.

Aikana**jiry** (**wikere** / **wita** *peanut*)**Arawá** (2,000 yrs.)I) **PAUMARI****moi'di** (**mowa** *flower*)II) **ZOROWAHA** **namĩ-wasazu**(**namĩ** *high?*, **wasazu** *inajá* [*Attalea* sp.])III) **YARAWARA-DENI**III^a) **YARAWARA** **mowe**(**mowe** *flower*) (cf. Arara-Aripuaná [Tupi] **mowi**)III^b) **DENI****wato****Arawak** (Aruak, Maipure) (4,500 yrs.) ***maiña**/***maina**I) **KAIXANA****maĩhu** / **maikĩ** (**sĩmi** / **sumi** *seed*)II) †**BAHUANA****miñi'i**III) **WAPISHANA****minai**IV) **MAWAYANA****mija**V) †**MARAWÁ****manazi** (**usi** *seed*) (data from Tastevin 1920)VI) **PIRO-APURINÁ** (2,000 yrs.) ***mai(-)kĩ** (cf. proto-Takana ***moike**, Harakmbut **morikke**, Paumari [Arawá] **moi'di**)VI^a) **PIRO** **mĩxi** / **janajsi** (**-xi** *seed*)VI^b) **INAMPARI** **mĩhĩ** (**-hĩ** *seed*)VI^c) **APURINÁ** **makĩ** / **make** / **mitjatakuru** (**-kĩ** *seed*)VII) **LOKONO****tútuka** (< Carib)VIII) **PARECI****tokali-se** / **tokware-se** (< Carib) (**wai-se** *peanut*)IX) **CAMPA/MATSIGENKA****inke** (= peanut), **kastaña** (<Sp.)**Cahuapana** **xiwako'**,**monopi**, **tanpa'pi** *nuts spp.***Carib** (2,500 yrs.) ***tut(u)-ka** (cf. Mura-Piraha **tíihĩ**)I) **GUIANA**I^a) † **PALMELLAS****tutuko** (data from Fonseca 1880–1881)I^b) **WAIWAI****tĩtko****HIXKARYANA****tutko****KAXUYANA****tutko**I^c) **TRIÓ****tuhka** / **tuuka**† **OYARICOULÉ****tura-tura**I^d) **APALAI****tutuko****WAYANA****tutukä** / **tutuko****WAIMIRI-ATROARI****tetkĩ****KARİ'ÑA****tutuka**

II) YEKUANA	wufia (< Venezuelan Spanish 'jubia')
III) ARARA	toromo
IV) KUIKURO	N.P. (tigite <i>peanut</i>)
Chapacura (1,300 yrs.) *toke/*tike	(< <i>seed</i> / <i>nut</i> ?; cf. Carib <i>*tutka</i> ?)
I) CHAPAKYRA	
I ^a) WARI' tokwe	(tokwi-n <i>seed</i>), kaji-tokwe <i>peanut</i> (< kaji <i>introduced</i> , tokwe <i>nut</i>)
I ^b) MIGUELENHO	tike (toki <i>seed</i>)
I ^c) ORO-WIN	teke (toki <i>seed</i>)
II) CHAPAKURA (MORÉ)	tokä (toki-n <i>seed</i>)
Harakmbut	morikke (cf. Takana *moike , Piro-Apurinã *maĩkĩ)
Iquito	(bogpi[h] <i>peanut</i>)
Jabuti (1,500 yrs.) *ore	sahii (Lev Michael, pers. comm.) (cf. Katawixi sákodia , Asurini sa)
I) JABUTI ore	
II) ARIKAPU orä	
Kanoe	epy (epy-kwā <i>peanut</i> , -kwā <i>seed</i>)
†Katawixi	sákodia / sakudga (cf. Iquito sahii , Asurini sa) (data from Tastevin 1909/1920)
Kayapo	pi'i (pi <i>tree</i>)
Kwaza kúc	(c rí <i>peanut</i>)
Leko	N.P. (dihi-wo <i>peanut</i> , -wo <i>round</i> , cf. Mura-Piraha tíihí <i>Brazil nut</i>)
Maku	(nadëb) manecéh (< Arawak)
†Matanawi	txipií (cf. Mura tíihí) (data from Nimuendajú 1925)
Moseten	N.P. (dabah <i>peanut</i> , cf. Pano tapa)
Munku	tjuka-i (< Pareci)
Mura-Piraha	tíihí (cf. Leko dihi-wo <i>peanut</i>)
Nambikwara (2,500 yrs.)	
I) SABANÊ kwaiki (cf. Pareci wai-se <i>peanut</i>)	/ tokali' (< Pareci)
II) NAMBIKWARA	
II ^a) NORTHERN	wana' (wai-ki <i>peanut</i> , -ki <i>seed</i> < Pareci wai-se)
II ^b) SOUTHERN	wanakka (waik-ki <i>peanut</i> , -ki <i>seed</i> < Pareci wai-se)
Pano (1,500 yrs.) *tama/*tapa <i>peanut, Brazil nut</i>	
Note: Pano is now considered genetically related to Takana	
I) KASHARARI	tama <i>Brazil nut</i>
II) CENTRAL PANO	
II ^a) CHACOBO	tapa <i>Brazil nut</i> (mai-tapa <i>peanut</i> < mai <i>earth</i> , tapa <i>nut</i>)
II ^b) SHARANAHUA	tama-wan <i>Brazil nut</i> (< tama <i>peanut</i> , wan <i>big</i>)
II ^b) OTHERS (Brazil-Peru)	N.P. (tama <i>peanut</i> : Amahuaca, Yora, Kashinawa, Katukina-Pano, Shanenawa, Yawanawa, Shipibo-Conibo, Capanawa, Cashibo, Wariapano)

Rikbaktsa**Takana** (1,500 yrs.) ***moike** (cf. Harakmbut **morikke**, Piro-Apurinā ***maĩkĩ**)

Note: Takana is now considered genetically related to Pano

I) CAVINEÑA	moke
II) TAKANA CENTRAL	
II ^a) TAKANA PRÓPRIO	muihe
II ^b) REYESANO	muihe
II ^c) ARAONA	moje / ewi
III) ESSE-EJJA	xiwiwi (cf. Mura-Piraha tíhí)
Taruma	méhe (<Arawak?)
Tikuna	ñoó (< Tupi-Guarani) / toreñi
Tupi (4,000 yrs.)	
I) MUNDURUKU-KURUAYÁ	wenĩ(j) / wená / wa(i)nai / waeraña / erai (wená-bĩn n <i>peanut</i>)
II) JURUNA	(i)já
III) TUPI-GUARANI	
IIIa) TUPI-GUARANI * já / *(i) ña (man^du[w]i / mun^du[w]i <i>peanut</i>)	(i)já / ñá (Wayampi, Kawahip, Apiaká) (-a'ĩn[a] <i>seed</i>) ñĩ / dja (Asurini Xingu) sa /so (Asurini Tocantins) (-a'ĩs[a] <i>seed</i> ; cf. Iquito sahii , Katawixi sákodia) txu (Parakanã) kátái (Urubu) (< Portuguese 'castanha') mina-ta (Kamayurá) (cf. proto-Arawak * maĩña /* maina) zapuka-z-a'i (Tembé) (< zapukaj <i>sapucaia</i> [Lecythis sp.], a'i <i>seed</i>) teko-ingwer (Tembé) (< Carib?) muni-watsu (Kokama) (< muni <i>peanut</i> , watsu <i>big</i>) ĩ'wat / iwa-ete (Kayabi) (< iwa <i>tree</i> , ete <i>true</i>) wẽ'ẽñã (-ã'ĩn[a] <i>seed</i>)
IIIb) MAUÉ	
IV) TUPARI-MAKURAP	
MAKURAP	arao (arawĩ <i>peanut</i>)
TUPARI	
TUPARI	aráo-'a / kánã (hiráp <i>peanut</i> , kit <i>seed</i>)
WAYORO	kará (aragwi <i>peanut</i> , kiit <i>seed</i>)
SAKIRABIAT	kará (araakwi <i>peanut</i> , kiit <i>seed</i>)
V) MONDÉ	mam / mom (mam-kap <i>peanut</i> , kap <i>seed</i>)
VI) ARARA / RONDÔNIA	ijã
VII) KARITIANA	mijo (m'ĩ <i>peanut</i>)
VIII) ARARA / ARIPUANÁ	mowi (cf. Yarawara [Arawá] mowe)
IX) PURUBORÁ	mam-ka / ham-ka ([h]e' -kap / i-kap <i>peanut</i> , kap <i>seed</i>)

Yanomami
Yurakare

hawari

N.P. (**sebbe** *peanut*, cf. Pano **tapa**, Moseten **dabah**)

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