Was there ever a Neolithic in the Neotropics? Plant familiarisation and biodiversity in the Amazon

Carlos Fausto[1] & Eduardo G. Neves[2,*]

The Amazon is one of the few independent centres of plant domestication in the world, yet archaeological and ethnographic evidence suggest a relatively recent transition to agriculture there. In order to make sense of this time lag, the authors propose the use of the concept of 'familiarisation' instead of 'domestication', to explain Amazonian plant management, and the long-term relationship between plants and people in the region. This concept allows them to cast a fresh eye over ancient and contemporary patterns of plant cultivation and management that may be distinct to the ones described for the Old World.

Keywords: Amazonia, plant domestication, cultivation, familiarisation

It is widely accepted that Amazonia was an independent centre of plant domestication (Piperno 2011; Clement *et al.* 2015). Archaeological and ethnographic data on plant cultivation and management in this region, however, show that it is often difficult to determine what is domestic and what is not (Lévi-Strauss 1952: 252). This situation has led to a proliferation of terms to characterise different stages of domestication. Clement *et al.* (2010: 73), for example, refer to 52 crops with domestic populations, 41 with semi-domestic populations and 45 with incipiently domesticated populations in Amazonia. Do these categories represent different stages of a universal linear domestication process, or do they index a different mode of relating to plants and the environment?

In the 1980s, archaeologists anticipated finding evidence for Amazonian agricultural intensification (Roosevelt 1980), yet this has never happened. Despite archaeological evidence of large-scale landscape management, very little data indicate agricultural

[1] *Museu Nacional, Universidade Federal do Rio de Janeiro, Quinta da Boa Vista s/n, Rio de Janeiro, 20.940-040 Brazil*

[2] *Museu de Arqueologia e Etnologia, Universidade de São Paulo, Avenida Professor Almeida Prado, 1466 São Paulo, 05508-070 Brazil*

* *Author for correspondence (Email: edgneves@usp.br)*

ANTIQUITY 92 366 (2018): 1604–1618 https://doi.org/10.15184/aqy.2018.157

intensification; some cases actually suggest a minimal reliance on agriculture (Schaan 2008). This does not mean that food production stalled at an intermediate incipient stage, or that environmental limitations prevented the full development of agriculture. Rather, we need to rethink how the relationship between Amazonian plants and people unfolded over time.

We here propose that a very basic conceptual and practical framework concerning the relationship between plants and people in the tropical forest has existed since at least the Middle Holocene. Previously, we have applied this framework to kinship, shamanism, warfare and pet-keeping (Fausto 1999, 2012a; Costa 2017). Here we suggest that it also provides an alternative model to domestication, in which the relationship with plants is part of a general concern for 'making kin out of others' (Vilaça 2002), as is typical of contemporary Amazonian indigenous societies. If valid, the adoption of such a framework may help us to understand apparent disjunctions between evidence for early plant domestication and what appears to be an Amazonian Neolithic that never fully developed.

The Formative as a New World Neolithic

The conceptualisation of a stage known as the 'Formative' was an attempt by archaeologists to define a developmental scheme for the Americas in a manner comparable to that of the Old World (Willey & Philips 1958). Ford (1969: 9) defined the Formative as:

> *the 3000 years (or less in some regions) during which the elements of ceramics, ground stone tools, handmade figurines, and manioc and maize agriculture were being diffused and welded into the socioeconomic life of the people living in the region extending from Peru to the eastern United States*.

It seems, however, as if the Amazonian Formative never ended. Despite the colonial-era introduction of exotic species, such as bananas (*Musa* sp.), and the progressive increase in the importance of crops such as manioc (*Manihot esculenta* Crantz), the knowledge and practice of contemporary Amazonian cultivation systems seem to be similar to that of the Middle Holocene, involving mixed agroforestry strategies combining the cultivation of perennial non-domesticated trees with domesticated annuals (Watling *et al.* 2018) (Figure 1).

In the Americas, the relationship between the beginning of plant domestication and the emergence of agriculture followed its own path: while the former developed at the beginning of the Holocene, from 7000–6000 BC, societies relying on agriculture emerged much later (Piperno 2011; Killion 2013). It is also interesting to note that there is a clear pattern in the archaeological record showing that, in South America, all centres of early ceramic production were located in the tropical lowlands. For example, the Taperinha fluvial shellmound in the Lower Amazon has yielded some of the oldest ceramics of the Americas, dating to 5000 BC (Roosevelt *et al.* 1991). All other sites with early ceramics are located along an arc across the north of South America: Mina-phase shell mounds at the mouth of the Amazon, dating to 3500 BC (Roosevelt 1995); the Valdivia sites of coastal Ecuador with ceramics dating to 3500 BC (Marcos 2015); sites on the Caribbean coast of Colombia such as Puerto Hormiga and San Jacinto with ceramics dating to 4000 BC (Oyuela-Caycedo 1995; Oyuela-Caycedo & Bonzani 2005; and Alaka shell mounds of coastal Guiana with ceramics dating to 4000 BC (Roosevelt 1995; Williams 1997).

https://doi.org/10.15184/aqy.2018.157 Published online by Cambridge University Press

*Figure 1. Tree orchard on the archaeological site, which also includes the cultivation of local and exotic tree crops such as Açaí palm (*Euterpe precatoria*), papaya (*Carica papaya*), banana (*Musa *spp.) and lime (*Citrus *spp.). (Lago do Limão, central Amazon (2005), photograph by Eduardo G. Neves.)*

With the exception of those on the Ecuadorian coast, these sites lie far from the early continental centres of plant domestication. Unfortunately, there are few archaeobotanical data for these sites except for San Jacinto, which shows no correlation between early ceramic production and food processing (Oyuela-Caycedo 1995). In the Amazon, such correlation appears much later and seems to be associated with the formation of anthropic dark earths starting around 500 BC (Neves *et al.* 2014). Again, there is a gap of more than 3000 years between the dates for early pottery production and the establishment of sedentary societies. The application of concepts such as the Formative to Amazonian contexts may, therefore, risk subsuming sophisticated forms of knowledge, based on the production of diversity that still unfold today, within a long 'transitional' stage (Neves 2007; Arroyo-Kalin 2010). Referring to such productive strategies of plant management or cultivation as an 'incipient' stage along a developmental course hinders our capacity to understand them fully. In order to grasp the complex interactions between humans and plants in Amazonia, a radically new heuristic strategy is required—one based on contemporary indigenous ontologies.

Plants as pets

Amazonian Indians did not practise animal husbandry before the Conquest, nor was it subsequently adopted (Descola 1994; Vander Velden 2012; Stahl 2014). Their disinterest in controlling the reproduction of animals presents a striking contrast with their passion for

https://doi.org/10.15184/aqy.2018.157 Published online by Cambridge University Press

keeping pets. Modern villages abound with animals of all kinds. These 'wild pets' are captured by hunters and cared for by their wives, breastfed and adopted as children. They are never eaten and rarely reproduce in captivity.

All Amazonian languages possess a term to designate these 'wild pets', whose reciprocal term is normally a word meaning 'owner' or 'master'. These reciprocal pairs designate a great number of relationships, besides actual pet-keeping: those between adoptive parents and adopted children, captors and captives, warriors and their victims, shamans and their auxiliary spirits, chiefs and followers, and cultivators and their plants (Fausto 2012b). All of these relationships are conceived as resulting from two moments: one of appropriation, the other of incorporation. As the former is often depicted as a violent process by indigenous peoples, we call it 'predation', and as the latter is considered a process of making kinship, we called it 'familiarisation'. In combination, this produces the concept of 'familiarising predation', which characterises the process by which alterity is apprehended from the outside to produce kinship on the inside (Fausto 2007). As is well known in the literature on Amazonian indigenous peoples, kinship is not taken as a given, natural phenomenon, but as a process in which people are constructed as akin to each other, in the sense of becoming both kin and alike. The input that triggers this process comes always from the outside in the form of souls, animals, enemies and captured children (Vilaça 2002).

In our previous work, we did not apply this concept to cultivation; domesticated plants seemed clearly different from non-domesticated pets. We had simply followed the ethnological maxim: Amazonian Indians are 'Neolithic people with a Palaeolithic mind'. Yet, what if there never was a Neolithic in Amazonia? Would it be possible to understand the relationship between peoples and plants under the single principle of familiarising predation? If so, would this help to understand the deep history of these permanently 'intermediate' stages?

Permanent 'intermediate' stages?

Agriculture is often defined as "productive strategies with the near- or total reliance upon domesticated plants" (Winterhalder & Kennett 2006: 3), yet although interrelated, agriculture, cultivation and domestication are distinct processes. Populations may rely partially on the cultivation of domesticated plants without being farmers, or, similarly, may cultivate non-domesticates. Considering this, is the concept of domestication at all useful for Amazonian contexts, or should one search for alternative ways to understand these co-evolutionary histories? In the New World, there was a long temporal gap between plant domestication and the adoption of ceramics and agriculture (Piperno 2011). In eastern North America this extends from 3000 cal BC–AD 900 (Smith 2001: 18). In the Amazon, there was a 4000-year interval between the first evidence for plant domestication and the emergence of permanent settlements (Neves 2013). In coastal Ecuador, squash (*Cucurbita* sp.) seeds associated with pre-ceramic Las Vegas occupation have been dated to *c.* 8000 cal BC (Piperno & Stothert 2003), whereas the evidence for agriculture dates to *c.* 3500 BC. In the Ñanchoc Valley of coastal Peru, the presence of *Cucurbita moschata*, peanuts (*Arachis* sp.) and cotton (*Gossypium barbadense*) pre-dates the emergence of sedentarism by 3000 (Piperno & Dillehay 2008). Conversely, macro-remains of maize (*Zea mays*) are associated with pre-ceramic contexts dating to 5000 cal BC at Huaca Prieta and the Paredones mounds (Grobman *et al.* 2012). Such

https://doi.org/10.15184/aqy.2018.157 Published online by Cambridge University Press

*Figure 2. House garden on the archaeological site showing the cultivation of local and exotic short-term crops such as maize (*Zea mays*), squashes (*Cucurbita *spp.) and onions (*Allium schoenoprasum*), as well as tree species such as the mucajá palm (*Acrocomia aculeata*) in the background. (Parintins, central Amazon (2016), photograph by Eduardo G. Neves.)*

long 'intermediary' strategies have been labelled 'mixed subsistence' (Killion 2013) or "low level food production systems" (Smith 2001: 33). There is mounting evidence, however, that Amazonian societies have consistently maintained such mixed strategies from the Early Holocene to the present day. Arguably, the transition from plant domestication to agriculture was never completed (Neves 2013; Moraes 2015).

Ancient Amazonian productive strategies were based on the cultivation of domesticated and non-domesticated crops, the management of long-lived non-domesticated tree species, hunting and fishing. Such mixed agroforestry systems worked beyond subsistence level, generating stable and long-lasting productive economies (Hermenegildo *et al.* 2017). Lathrap (1977) called attention to the importance of house gardens comprising transplanted plants as settings for management, selection and early domestication. The management of trees as sources of food and other resources is an example of non-domestication cultivation, or NDC (Piperno 2011: 463). As with house gardens, NDC falls within a general scheme including tending, tillage and transplantation (Ford 1985). In Amazonia, NDC includes the management of tree crops such as Brazil nut (*Bertholletia excelsa*), açaí (*Euterpe oleracea* and *E. precatoria*) and pequi (*Caryocar brasiliense*), among others. Tree cultivation differs from grain, legumes and tuber cultivation, due to their long productive cycles. A Brazil nut stand, for example, takes years to start producing and remains productive for centuries (Scoles & Gribel 2011; Shepard & Ramirez 2011). A pequi stand bears fruit after 5–7 years, and produces for the subsequent 50–70 years (Smith & Fausto 2016) (Figure 2).

https://doi.org/10.15184/aqy.2018.157 Published online by Cambridge University Press

Brazil nut and pequi are examples of megafaunal fruits (Guimarães *et al.* 2008)—species whose current dispersal patterns, fruit traits and phenologies can be explained by interactions with extinct Pleistocene fauna. In the Amazon, where trees comprise more than two-thirds of cultivated crops (Clement *et al.* 2010), a long history of megafaunal behaviour prior to the human settlement of the Americas probably had an important role in selecting for traits, such as fleshiness, which were later favourable for human consumption without the need of further domestication. During the Holocene, tree-management strategies played a vital role in promoting further changes in the entire structure of Amazonian forests (Levis *et al.* 2017). A compilation of modern tree inventories from the Amazon shows 227 'hyperdominant' species accounting for half of all trees (Ter Steege *et al.* 2013). Among the top-ten species, six are palms, all of which are of economic and symbolic importance. Apart from the peach palm (*Bactris gasipaes*), however, no Amazonian palm was domesticated (Clement *et al.* 2010).

Hyperdominance may have resulted from widespread NDC by ancient indigenous societies. A review of palm remains from archaeological sites in the Americas shows their widespread presence from *c.* 7000 years BC onwards (Morcote-Ríos & Bernal 2001). These findings complement research showing that native Amazonians systematically modify their surroundings, and that contemporary Amerindians explore and rely on previously managed areas composed of secondary forests (Balée 1989; Politis 2007). NDC was probably more important before the Conquest than it is today. If these data are correct, how can we account for the widespread evidence of manioc cultivation among contemporary Amazonian Indians?

The tropical forest pattern as a modern system

Manioc cultivation is fundamental in the modern Neotropics. It thrives in leached and poor soils, can be cultivated in short or long cycles, can be stored for some years in gardens and can be used to produce diverse foodstuffs from bread to beer (Figure 3). Genetic and archaeological data show that manioc was domesticated in South-west Amazonia (Olsen & Schaal 1999; Watling *et al.* 2018); by *c.* 5000 years BP, it was already being grown elsewhere in South America (Aceituno & Loaiza 2014). Today, slash-and-burn manioc cultivation is so widespread and appears so traditional that one assumes that its prominence dates, unaltered, back to pre-colonial times. The evidence for widespread manioc cultivation in ancient Amazonia, however, is scant. This may be due to its poor archaeological visibility; manioc is a shrub, and its cultivation leaves few hard fragments that could survive archaeologically. Food processing such as boiling may destroy starch grains, and phytoliths are only just becoming a secure proxy for the presence of manioc. The best evidence so far comes from contexts found along ecotones in South-west Amazonia and coastal French Guiana (Iriarte *et al.* 2010; Dickau *et al.* 2012).

The contemporary 'tropical forest pattern' based on shifting slash-and-burn manioc cultivation may have resulted from changes caused by the post-AD 1492 introduction of metal tools. Not only did agriculture became more itinerant due to the relative ease of opening new gardens (Denevan 1992), but the importance of crops may also have been altered. In coastal French Guiana, the archaeological evidence suggests the replacement of maize by manioc after the sixteenth century AD (Van den Bel 2015). The stress of enslavement, warfare

https://doi.org/10.15184/aqy.2018.157 Published online by Cambridge University Press

*Figure 3. A new manioc (*Manihot esculenta*) garden. (Kuikuro, central Brazil (2013), photograph by Carlos Fausto.)*

and massive dislocation on native populations following European colonisation, together with the growing demand for flour, may have favoured the adoption of extensive manioc cultivation. In summary, the 'traditional' pattern of extensive slash-and-burn manioc cultivation may be an adaptation to changes resulting from European colonisation, which shifted the relative importance of certain crops and reduced the range of cultivation and management practices. Even if that is the case, we propose that there have been no major ruptures between pre-colonial and contemporary traditional cultivation practices. This is probably due to the fact that manioc cultivation does not depend on intensive and constant labour input, nor on strict control of the plant's reproduction—it is cloned, not sown (Figure 4).

Contemporary practices can better clarify what we understand by the notion of familiarisation. Space precludes the presentation of all the cases on which our argument is based: see, among others, Hugh-Jones (1979), Taylor (2001), Santos (2006), Maizza (2014), Miller (2015) and Otero dos Santos (2015). Suffice to say, these cases refer to peoples from diverse regions speaking unrelated languages, thereby supporting our argument for a widespread and ancient pattern.

Familiarisation as a traditional system

Contemporary Amazonian productive strategies include a much larger area of managed agroforestry than meets the eye. There is much to be addressed beyond the realm of the house (the 'domus' of domestication). Let us give a first example: the Wayãpi are a Tupi-Guarani people

https://doi.org/10.15184/aqy.2018.157 Published online by Cambridge University Press

Figure 4. Geometric garden seen from the air—rectangular garden plot in the forest for slash-and-burn cultivation. Although seemingly traditional, the regular shape of such a garden results from the use of metal axes or chain saws introduced in the modern era. It is probable that pre-Columbian gardens had an irregular shape. (Maués, central Amazon (2004), photograph by Eduardo G. Neves.)

in North-eastern Amazonia who cultivate numerous manioc varieties alongside other products and combine garden work with forest trekking and hunting. Men are responsible for clearing new plots, while planting and tending is the work of women, who are said to be the garden's 'owners' (-jarã) (de Oliveira 2006: 70). The opening of a garden is a dangerous act, as it requires the appropriation of a forested domain that has its own previous other-than-human owners (de Oliveira 2006: 73–76).

The frontier between the garden and the forest remains fluid. Even the species reproduced in the gardens—those planted by the Wayãpi—are not exclusively owned by them, but fall also within the domain of a spirit-owner. This is why the mother with a newborn child does not go into a garden, lest the 'manioc owner' (*mani'ojarã*) attacks the baby (de Oliveira 2006: 80). There is always tension between the spirit-owner and the human-owner, as the latter is appropriating the offspring (the manioc tubers) of the former in order to produce human kinship by means of food production (Fausto 2007). This appropriation is a form of co-parenthood, as the manioc tubers are also the children of those who planted them. In Amazonia, manioc is raised rather than cultivated or planted (Emperaire 2005: 37), as are children and pets.

From an initial male act of predation (clearing the garden) that transforms a forest place into a human domain (Descola 1986: 170), there follows the female act of familiarisation, which translates into a maternal bond between the cultivator and her plants. Manioc roots

https://doi.org/10.15184/aqy.2018.157 Published online by Cambridge University Press

are cared for by their owners (both the spirit and the woman) until they are fully grown and ready to be extracted and made available as food for humans. When the whole process is complete, the garden begins to transform itself into fallows that, in due time, become forest again—a forest with a new vegetational composition, hosting a number of tree crops, especially palms.

The second example concerns sweet potato cultivation among the Ge-speaking Krahô, in the state of Tocantins, northern Brazil. The vegetation is savannah-like (cerrado), interspersed with gallery forests along the rivers. The sexual division of labour varies according to the species planted. Women plant sweet potatoes, men plant maize, while both plant manioc (Morim de Lima 2016: 208). The act of planting triggers a liminal state, so that cultivators must afterwards follow a series of interdictions, such as abstention from sex or certain foods. According to a Krahô woman, the reason for this practice is that "we consider our gardens as family" (Morim de Lima 2016: 87). The Krahô affirm that cultivars are 'persons' but not humans. They think and talk, and this is why they can be dangerous. Cultivators must be careful because the plant's 'chief' can either favour, or turn against, them. The tubers growing along potatoes' roots are deemed to be the chief's children. Women who abstain from sex and certain foods after planting potatoes are co-producing these tubers. Morim de Lima (2016: 150) calls the potato's chief 'the genetrix', and the cultivator the 'raising-mother', pointing to the same entanglement of motherhood relations noted above.

Negotiating ownership

The peanut is a domestic plant cultivated from seeds. It represents the core cultivar of the Kayabi (Kawaiweté), a Tupi-Guarani people of South-eastern Amazonia. As of the mid 2000s, they cultivate 20 varieties of peanuts. Self-pollination (with a low rate of cross-pollination) is the peanut's dominant reproductive behaviour, with a low rate of cross-pollination (Silva 2009: 206). Hence, peanut varieties are relatively stable, especially if the seeds are stored and planted separately, which is exactly what the Kayabi do (Silva 2009: 200). How, then, do new varieties appear?

The Kayabi are attentive to the appearance of off-types resulting from cross-pollination. Although this type of reproduction is rare, it plays a crucial role in allowing variation, which depends on the women's proficient knowledge for identifying off-types (Silva 2009: 207). The Kayabi, however, do not explain variation in terms of cross-pollination. They say that the 'owner of the cultivars'—an old lady named Kupeirup—is responsible for giving them the new varieties, depending both on the proper behaviour of the cultivators and on the shamans' mediatory role. All cultivars came from Kupeirup's incinerated body. A myth recounts that her sons only ate palm fruits, which they planted as crops. As these trees took a long time to grow and produce fruits, Kupeirup sacrificed herself in order for her sons to have abundant and fast-growing food. She told them to open a garden and burn her there; from her body, all the cultivars appeared (Silva 2009: 448–49). This myth recounts a similar story to our current explanation for the emergence of food production in the Amazon.

The final example is a tree crop: pequi (*Caryocar* sp.). Among the Kuikuro of the Upper Xingu in central Brazil, old gardens often become orchards of pequi trees planted by the garden owner for his/her descendants. Pequi is a cross-pollinating species, whose individuals can

https://doi.org/10.15184/aqy.2018.157 Published online by Cambridge University Press

*Figure 5. Pequi fruit (*Caryocar brasiliense*), variety tungui (spineless). (Kuikuro, central Brazil (2013), photograph by Carlos Fausto.)*

live for many decades, making it difficult to stabilise locally adapted varieties (Smith 2013). Wild and cultivated pequi present different flowering and fructification cycles, as well as different fruit sizes and tastes (Smith & Fausto 2016: 99–100) (Figure 5). The Kuikuro recognise 16 different types of cultivated pequi, of which half seem to correspond to biological varieties. This includes a spineless one, which has recently received attention for its potential economic value (Smith 2013; Smith & Fausto 2016). The Kuikuro, however, have no interest in planting an orchard with this single variety. Instead, they mix different seeds, not caring which kind of pequi will germinate as long as there is a diversity of fruits: those good to eat, to produce oil, to make jelly and so on. Pequi orchards remain productive for decades and, as with peach palms, they provide an index of previous human occupation. The orchards are not, however, an exclusively human space: the pequi has its other-than-human owners, who can cause illness in humans. If cured from this illness, the human patient becomes the master of these pequi owners, and will treat them as their spirit-pets, ritually feeding them for years to come by sponsoring their festival.

The breach: slowing down entropy

The above examples provide ethnographic substance to our understanding of plant cultivation in Amazonia as part of a general movement of appropriation and familiarisation. We also correlate this movement to agro-biodiversity, which can be approached on two levels. More abstractly, it relates to Lévi-Strauss's (1991) 'openness to the other'—a general orientation of Amerindian societies towards alterity rather than self-identity. This orientation promotes a recurrent outside-inside movement, in which life is created through the incorporation and preservation of small differences. Carneiro da Cunha (2015) translates this idea in terms of the laws of thermodynamics, suggesting that it slows down entropy by reinstating difference (agro-biodiversity) into the system.

On a more tangible level, generating diversity through plant cultivation requires the maintenance of a breach, which allows communication with that which is outside the system. Consider the paradox of cloning and variation in manioc cultivation: how can there be so many varieties of manioc in Amazonia when manioc is cloned? Although Amazonian people privilege manioc's vegetative reproduction, they neither control nor inhibit sexual reproduction (Emperaire *et al.* 1998; Elias *et al.* 2000); they just let it happen, experimenting with new varieties that emerge from cross-pollination. Some of these varieties sprout in fallows, as the result of a series of translation acts involving seeds, ants and fire (Pujol *et al.* 2002; Rival & McKey 2008) (Figure 6).

https://doi.org/10.15184/aqy.2018.157 Published online by Cambridge University Press

*Figure 6. Manioc fruit (*Manihot esculenta*), variety küake (*Atta *sp.). (Kuikuro, central Brazil (2014), photograph by Carlos Fausto.)*

Amazonian manioc cultivation aims to reproduce identical landraces, as much as to introduce new ones. In other words, it produces difference in small intervals: not new species but new varieties of the same species. This is made possible both by privileging vegetative propagation and by not controlling sexual reproduction. There is always a breach in which fallows play a central part. Instead of a marked discontinuity between cultivated land and forest, we have a chromatic succession caused by human 'creative disturbances' that result in further diversity (Balée 1989; Zent & Zent 2012). While the concept of domestication often implies a rupture between nature and culture, familiarisation may provide us with a more nuanced perspective to approach such interactions.

Concluding remarks

It may seem implausible to argue that present practices can inform us about a pattern that would have prevailed in pre-Conquest Amazonia. Can plants be incorporated into the model of ontological animism (Descola 2005; Rival & McKey 2008: 124)? Can they be considered an 'Other', as animals are? We think so. Cultivation in Amazonia is a technical activity that presupposes social skills for engaging in an extended network of relations with human and other-than-human persons. It implies the entanglement of different agents, crosscutting the nature-culture divide, and making it a risky cross-species enterprise of appropriation and familiarisation. This is why we argue for the necessity of reinserting it within a broader framework, as well as proposing the notion of familiarisation as an alternative and more inclusive concept than domestication. We also argue that the generation of diversity is a key aspect of such a mode of production.

In Amazonia, the lack of evidence for agricultural intensification—or for agriculture altogether—stems from the long-term successful operation of complex systems of knowledge. There is no convincing reason to suppose that Amazonian cultural history should replicate (albeit at a slower pace) what happened in the Old World cradles of plant domestication. Indeed, the pattern described here may hold true for other tropical settings away from the Americas (Barton & Denham 2016). Far from being backwaters, the tropics may reveal something deeply different from our past.

Acknowledgements

We wish to thank Nuria Sanz, Manuela Carneiro da Cunha, Colin McEwan, Sadie Weber, Manuel Arroyo-Kalin and Tim Denham for their constructive criticism and comments.

https://doi.org/10.15184/aqy.2018.157 Published online by Cambridge University Press

References

Aceituno, J. & N. Loaiza. 2014. Early and Middle Holocene evidence for plant use and cultivation in the Middle Cauca River Basin, Cordillera Central (Colombia). *Quaternary Science Reviews* 86: 49–62. https://doi.org/10.1016/j.quascirev.2013.12.013

Arroyo-Kalin, M. 2010. The Amazonian Formative: crop domestication and anthropogenic soils. *Diversity* 2: 473–504. https://doi.org/10.3390/d2040473

Balée, W. 1989. The culture of Amazonian forests, in D.A. Posey & W. Balée (ed.) *Resource management in Amazonia: indigenous and folk strategies* (Advances in Economic Botany 7): 1–21. New York: The New Botanical Garden.

Barton, H. & T. Denham. 2016. Vegecultures and the social-biological transformations of plants and people. *Quaternary International* 489: 17–25. http://dx.doi.org/10.1016/j.quaint.2016.06.031

Carneiro da Cunha, M. 2015. Traditional people, collectors of diversity. Paper presented at the 'Anthropological Visions of Sustainable Futures' conference, University College London, 13 February 2015.

Clement, C., M. de Cristo-Araújo, G. Coppens d'Eeckenbrugge, A. Pereira & D. Picanço-Rodrigues. 2010. Origin and domestication of native Amazonian crops. *Diversity* 2(1): 72–106. https://doi.org/10.3390/d2010072

Clement, C., W. Denevan, M. Heckenberger, A. Junqueira, E. Neves, W. Woods & W. Teixeira. 2015. The domestication of Amazonia before European conquest. *Proceedings of the Royal Society B: Biological Sciences* 282 (1812). https://doi.org/10.1098/rspb.2015.0813

Costa, L. 2017. *The owners of kinship: asymmetrical relations in indigenous Amazonia*. Chicago (IL): University of Chicago Press & Hau.

Denevan, W. 1992. Stone *vs* metal axes: the ambiguity of shifting cultivation in prehistoric Amazonia. *Journal of the Steward Anthropological Society* 20(1–2): 153–65.

de Oliveira, J.C. 2006. Classificações em cena. Algumas formas de classificação das plantas cultivadas pelos Wajãpi do Amapari (AP). Unpublished MSc dissertation, Universidade de São Paulo.

Descola, P. 1986. *La nature domestique: symbolisme et praxis dans l'écologie des Achuar*. Paris: Maison des Sciences de l'Homme.

– 1994. Pourquoi les Indiens d'Amazonie n'ont-ils pas Domestiqué le Pécari? Genéalogie des objets et anthropologie de l'objectivation, in B. Latour & P. Lemonnier (ed.) *De la préhistoire aux missiles balistiques*: 329–44. Paris: La Découverte.

– 2005. *Par-delà nature et culture*. Paris: Gallimard.

Dickau, R., M. Bruno, J. Iriarte, H. Prümers, C. J. Betancourt, I. Holst & F. Mayle. 2012. Diversity of cultivars and other plant resources used at habitation sites in the Llanos de Mojos, Beni, Bolivia: evidence from macrobotanical remains, starch grains, and phytoliths. *Journal of Archaeological Science* 39: 357–70. https://doi.org/10.1016/j.jas.2011.09.021

Elias, M., L. Rival & D. McKey. 2000. Perception and management of cassava (*Manihot esculenta* Crantz) diversity among Makushi Amerindians of Guyana (South America). *Journal of Ethnobiology* 20: 239–65.

Emperaire, L. 2005. A biodiversidade agrícola na Amazônia brasileira: recurso e patrimônio. *Revista do Patrimônio Histórico e Artístico Nacional* 32: 31–43.

Emperaire, L., F. Pinton & G. Second. 1998. Gestion dynamique de la diversité variétale du manioc en Amazonie du Nord-Ouest. *Natures Sciences Sociétés* 6: 27–42. https://doi.org/10.1016/S1240-1307(98)80006-X

Fausto, C. 1999. Of enemies and pets: warfare and shamanism in Amazonia. *American Ethnologist* 26: 933–56. https://doi.org/10.1525/ae.1999.26.4.933

– 2007. Feasting on people: cannibalism and commensality in Amazonia. *Current Anthropology* 48: 497–530. https://doi.org/10.1086/518298

– 2012a. *Warfare and shamanism in Amazonia*. Cambridge: Cambridge University Press.

– 2012b. Too many owners: ownership and mastery in Amazonia, in M. Brightman, V. Grotti & O. Ulturgasheva (ed.) *Shamanism in rainforest and tundra*: 85–105. Oxford: Berghahn.

Ford, J. 1969. *A comparison of formative cultures in the Americas: diffusion or the psychic unity of mankind?* (Smithsonian Contributions to Anthropology 11). Washington, D.C.: Smithsonian Institution.

https://doi.org/10.15184/aqy.2018.157 Published online by Cambridge University Press

Ford, R. 1985. The process of food production in prehistoric North America, in R. Ford (ed.) *Prehistoric food production in North America*: 1–18. Ann Arbor: University of Michigan Press.

Grobman, A., D. Bonavia, T. Dillehay, D. Piperno, J. Iriarte & I. Holst. 2012. Preceramic maize from Paredones and Huaca Prieta, Peru. *Proceedings of the National Academy of Sciences of the USA* 109: 1755–59. https://doi.org/10.1073/pnas.1120270109

Guimarães, P., M. Galetti & P. Jordano. 2008. Seed dispersal anachronisms: rethinking the fruits extinct megafauna ate. *PLoS One* 3: e1745. https://doi.org/10.1371/journal.pone.0001745

Hermenegildo, T., T. O'connell, V. Guapindaia & E. Neves. 2017. New evidence for subsistence strategies of late pre-colonial societies of the mouth of the Amazon based on carbon and nitrogen isotopic data. *Quaternary International* 448: 139–49.

Hugh-Jones, C. 1979. *From the Milk River: spatial and temporal processes in Northwest Amazonia*. Cambridge: Cambridge University Press. https://doi.org/10.18542/amazonica.v4i1.879

Iriarte, J., B. Glaser, J. Watling, A. Wainwright, J. Birk, D. Renard, S. Rostain & D. McKey. 2010. Late Holocene Neotropical agricultural landscapes: phytolith and stable carbon isotope analysis of raised fields from French Guianan coastal savannahs. *Journal of Archaeological Science* 37: 2984–94. https://doi.org/10.1016/j.jas.2010.06.016

Killion, T. 2013. Nonagricultural cultivation and social complexity: the Olmec, their ancestors, and Mexico's southern Gulf Coast lowlands. *Current Anthropology* 54: 569–606. https://doi.org/10.1086/673140

Lathrap, D. 1977. Our father the cayman, our mother the gourd: Spinden revisited, or a unitary model for the emergence of agriculture in the New World, in C. Reed (ed.) *Origins of agriculture*: 713–52. Berlin: De Gruyter Mouton. https://doi.org/10.1515/9783110813487.713

Levis, C. *et al.* 2017. Persistent effects of pre-Columbian plant domestication on Amazonian forest composition. *Science* 355: 925–31. https://doi.org/10.1126/science.aal0157

Lévi-Strauss, C. 1952. The use of wild plants in tropical South America. *Economic Botany* 6: 252–70. https://doi.org/10.1007/BF02985068

– 1991. *Histoire de Lynx*. Paris: Plon.

Maizza, F. 2014. Sobre as crianças-planta: o cuidar e o seduzir no parentesco Jarawara. *Mana* 20: 491–518. https://doi.org/10.1590/S0104-93132014000300003

Marcos, J. 2015. *Un sitio llamado Real Alto*. Quito: Editora de la Universidad Internacional del Ecuador.

Miller, T. 2015. Bio-sociocultural aesthetics: indigenous Ramkokamekra-Canela gardening practices and varietal diversity maintenance in Maranhão. Unpublished PhD dissertation, University of Oxford.

Moraes, C. 2015. O determinismo agrícola na arqueologia amazônica. *Estudos Avançados* 29 (83): 25–43. https://doi.org/10.1590/S0103-40142015000100004

Morcote-Ríos, G. & R. Bernal. 2001. Remains of palms (*Palmae*) at archaeological sites in the New World. *The Botanical Review* 67: 309–50. https://doi.org/10.1007/BF02858098

Morim de Lima, A. 2016. Brotou batata para mim. Cultivo, Gênero e Ritual entre os Krahô (TO, Brasil). Unpublished PhD dissertation, IFCS-Universidade Federal do Rio de Janeiro.

Neves, E.G. 2007. El Formativo que nunca terminó: la larga historia de estabilidad en las ocupaciones humanas de la Amazonía central. *Boletín de Arqueología PUCP* 11: 117–42.

– 2013. Was agriculture a key productive activity in pre-Colonial Amazonia? The productive basis for social equality, in E. Brondízio & E. Moran (ed.) *The Central Amazonia human-environment: current and future directions*: 371–88. New York: Springer.

Neves, E.G., V. Guapindaia, H.P. Lima, B. Costa & J. Gomes. 2014. A tradição Pocó-Açutuba e os primeiros sinais visíveis de modificações de paisagens na calha do Amazonas, in S. Rostain (ed.) *Amazonía. Memorias de las Conferencias Magistrales del 3er Encuentro Internacional de Arqueología Amazónica*: 137–58. Quito: IKIAM/IFEA.

Olsen, K. & B. Schaal. 1999. Evidence on the origin of cassava: phylogeography of *Manihot esculenta*. *Proceedings of the National Academy of Sciences of the USA* 96: 5586–91. https://doi.org/10.1073/pnas.96.10.5586

Otero dos Santos, J. 2015. Sobre mulheres brabas, parentes inconstantes e a vida entre outros: a Festa

https://doi.org/10.15184/aqy.2018.157 Published online by Cambridge University Press

do Jacaré entre os Arara de Rondônia. Unpublished PhD dissertation, Universidade de Brasília.

Oyuela-Caycedo, A. 1995. Rock *versus* clay: the evolution of pottery technology in the case of San Jacinto 1, Colombia, in W. Barnett & J. Hoopes (ed.) *The emergence of pottery: innovation and technology in ancient societies*: 133–44. Washington, D.C.: Smithsonian Institution.

Oyuela-Caycedo, A. & R. Bonzani. 2005. *San Jacinto 1: a historical ecological approach to an Archaic site in Colombia*. Tuscaloosa: University of Alabama Press.

Piperno, D. 2011 The origins of plant cultivation and domestication in the New World tropics: patterns, process, and new developments. *Current Anthropology* 52: S453–70. https://doi.org/10.1086/659998

Piperno, D. & T. Dillehay. 2008. Starch grains on human teeth reveal early broad crop diet in northern Peru. *Proceedings of the National Academy of Sciences of the USA* 105: 19622–27. https://doi.org/10.1073/pnas.0808752105

Piperno, D. & K. Stothert. 2003. Phytolith evidence for Early Holocene Cucurbita domestication in southwest Ecuador. *Science* 299: 1054–57. https://doi.org/10.1126/science.1080365

Politis, G. 2007. *Nukak: ethnoarcheology of an Amazonian people*. Walnut Creek (CA): Left Coast.

Pujol, B., G. Gigot, G. Laurent, M. Pinheiro-Kluppel, M. Elias, M. Hossaert-McKey & D. McKey. 2002. Germination ecology of cassava, *Manihot esculenta* Crantz, Euphorbiaceae, in traditional agroecosystems. *Economic Botany* 56: 366–79. https://doi.org/10.1663/0013-0001(2002)056[0366:GEOCME]2.0.CO;2

Rival, L. & D. McKey. 2008. Domestication and diversity in manioc (*Manihot esculenta* Crantz ssp. *esculenta*, Euphorbiacea). *Current Anthropology* 49: 1119–28. https://doi.org/10.1086/593119

Roosevelt, A. 1980. *Parmana: prehistoric maize and manioc subsistence along the Amazon and Orinoco*. New York: Academic. https://doi.org/10.1016/B978-0-12-595350-4.50010-4

– 1995. Early pottery in the Amazon. Twenty years of scholarly obscurity, in W. Barnett & J. Hoopes (ed.) *The emergence of pottery: innovation and technology in ancient societies*: 115–31. Washington, D.C.: Smithsonian Institution.

Roosevelt, A., R.A. Housley, M. Imazio da Silveira, S. Maranca & R. Johnson. 1991. Eighth millennium pottery from a prehistoric shell midden in the Brazilian Amazon. *Science* 254: 1621–24. https://doi.org/10.1126/science.254.5038.1621

Santos, G.M. 2006. Da cultura à natureza: um estudo do cosmos e da ecologia dos Enawene-nawe. Unpublished PhD dissertation, Universidade de São Paulo.

Schaan, D.P. 2008. The nonagricultural chiefdoms of Marajó Island, in H. Silverman & W. Isbell (ed.) *The handbook of South American archaeology*: 339–57. New York: Springer. https://doi.org/10.1007/978-0-387-74907-5_19

Scoles, R. & R. Gribel. 2011. Population structure of Brazil nut (*Bertholletia excelsa*, Lecythidaceae) stands in two areas with different occupation histories in the Brazilian Amazon. *Human Ecology* 39: 455–64. https://doi.org/10.1007/s10745-011-9412-0

Shepard, G. & H. Ramirez. 2011. 'Made in Brazil': human dispersal of the Brazil nut (*Bertholletia excelsa*, Lecythidaceae) in ancient Amazonia. *Economic Botany* 65: 44–65. https://doi.org/10.1007/s12231-011-9151-6

Silva, G. 2009. Peanut diversity management by the Kaiabi (Tupi Guarani) indigenous people, Brazilian Amazon. Unpublished PhD dissertation, University of Florida, Gainesville.

Smith, B. 2001. Low level food production. *Journal of Archaeological Research* 9: 1–43. https://doi.org/10.1023/A:1009436110049

Smith, M. 2013. Árvores de Cultura: Cultivo e Uso do Pequi (*Caryocar* sp., Caryocaraceae) entre os Kuikuro do Alto Xingu, MT. Unpublished PhD dissertation, Universidade de Brasília.

Smith, M. & C. Fausto. 2016. Socialidade e Diversidade de Pequis (*Caryocar* sp., Caryocaraceae) entre os Kuikuro do Alto Xingu (Brasil). *Boletim do Museu Paraense Emilio Goeldi. Antropologia*. 11: 87–113. https://doi.org/10.1590/1981.81222016000100006

Stahl, P. 2014. Perspectival ontology and animal non-domestication in the Amazon Basin, in S. Rostain (ed.) *Antes de Orellana. Actas del 3er Encuentro Internacional de Arqueolgía Amazónica*: 221–31. Quito: IKIAM/IFEA.

https://doi.org/10.15184/aqy.2018.157 Published online by Cambridge University Press

Taylor, A.-C. 2001. Wives, pets, and affines: marriage among the Jivaro, in L. Rival & N. Whitehead (ed.) *Beyond the visible and the material: the Amerindianization of society in the work of Peter Rivière*: 45–56. Oxford: Oxford University Press.

Ter Steege, H. *et al*. 2013. Hyperdominance in the Amazonian tree flora. *Science* 342. https://doi.org/10.1126/science.1243092

Van den Bel, M. 2015. Uma nota sobre a introdução de raladores de metal e sobre a produção e consumo da mandioca e do milho na zona costeira das Guianas durante o século XVII. *Amazônica—Revista de Antropologia* 7(1): 100–31. https://doi.org/10.18542/amazonica.v7i1.2153

Vander Velden, F. 2012. *Inquietas companhias: sobre os animais de criação entre os Karitiana*. São Paulo: Alameda.

Vilaça, A. 2002. Making kin out of others in Amazonia. *Journal of the Royal Anthropological Institute* 8: 347–65. https://doi.org/10.1111/1467-9655.00007

Watling, J., M. Shock, G. Mongeló, F. Almeida, T. Kater, P. De Oliveira & E. Neves. 2018. Direct archaeological evidence for Southwestern Amazonia as an early plant domestication and food production centre. *PLoS One* 13: e0199868. https://doi.org/10.1371/journal.pone.0199868

Willey, G. & P. Phillips. 1958. *Method and theory in American archaeology*. Chicago (IL): University of Chicago Press.

Williams, D. 1997 Early pottery in the Amazon: a correction. *American Antiquity* 62: 342–52. https://doi.org/10.2307/282516

Winterhalder, B. & D. Kennett. 2006. Behavioral ecology and the transition from hunting and gathering to agriculture, in D. Kennett & B. Hinterhalder (ed.) *Behavior ecology and the transition to agriculture*: 1–21. Berkeley: University of California Press.

Zent, S. & E. Zent. 2012. Jordi horticultural belief, knowledge and practice: incipient or integral cultivation? *Boletim do Museu Paraense Emilio Goeldi. Ciências Humanas* 7: 293–338. https://doi.org/10.1590/S1981-81222012000200003

Received: 1 December 2017; Revised: 30 March 2018; Accepted: 9 April 2018