

Plant agency, gender, and ritual in Indigenous tropical cultivation systems

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Abstract

Through an ethnographic and ethnobotanical investigation of Amazonian Shuar gardening practices, I aim to (1) unravel the basic and more complex relationships exhibited by Shuar gardening activities, which involve humans, tubers, and mythical originators and mediators of ecological and biological processes; (2) compare Shuar horticultural practices with those of other Indigenous tropical horticulturalists; and (3) unveil how and to what extent concepts of plant agency shape traditional cultivation systems. My study reveals that the rapid growth and high yield of tubers significantly depend on women's sophisticated cognitive skills, manifested through specific nurturing methods for cultivated plants and gardening rituals to engage with cosmic and mythical forces. Beyond the embodied practices of tending tubers and the ritual behaviors displayed by women, the agential qualities of plants play a crucial role in shaping the ritual and mytho-cosmological structure underlying gardening activities. Ultimately, biosocial, mythical, cosmic, and ontological connections between biological kingdoms inform growth patterns, fertility, and reproduction within the garden domain.

Keywords: Horticulture, *Manihot esculenta* Crantz, *Guadua* spp., gardens, ritual, Shuar, Amazonia

Introduction

Yasmin, a Shuar woman from the Tawasap community, explained the uses and names of the plants. She stated bluntly: "Most of the trees and plants in this garden are persons." Astonished by her statement, I pointed to the different plants, asking which were considered persons. It was

remarkable that the Indigenous ontological categories of people (Shuar) and person (*aents*) do not encompass all plants. More specifically, some of the weeds and bushes surrounding the garden's paths seem to be objects excluded from the domain of sociality. This pattern aligns with what Karsten (2000 [1935]: 280) reported, that the Shuar socio-cosmological system only includes those beings essential for their practical life, and it aligns more generally with Radcliffe-Brown's (1952 [1929]: 129) enduring conjecture about the key role (both social and ecological) played by certain aspects of the flora and fauna in shaping the ritual structure of small-scale societies. These societies view the natural world as an integral part of a socially established order (Radcliffe-Brown, 1952 [1929]: 129–130; see also Descola, 2006: 137–8), and, therefore, natural objects removed from the social order hold little significance in society's relational structure.

Yasmin recognized the morphology, Indigenous taxonomies, and mytho-cosmological connotations of plants. Like the term *pemon* for the Makushi of Amazonian Guyana (Daly, 2021, p. 385) or *masa* for the Makuna of the Colombian Amazon (Århem, 1996, p. 188), the Shuar word *aents* applies to most natural entities endowed with personhood, including plants. This concept of "person" aligns with Hallowell's (1960: 21) observation among the Ojibwa and suggests that plants are, in principle, persons with gender differences who, under certain conditions, may establish consanguineous relationships with humans (Descola, 1994, 2001; Taylor, 2001). According to Yasmin, plants with underground storage organs (USOs), such as manioc (*Manihot esculenta* Crantz), sweet potato (*Ipomoea batatas*), and taro (*Colocasia esculenta*), are viewed as children. Societies from the Amazon to the Cerrado biome often regard staple crops (primarily tubers) as embodied practices of childcare and motherhood (Hugh-Jones, 1979; Jackson, 1983; Descola, 1994; Mentore, 2012; Miller, 2016; Daly, 2021).

Tubers, as biophysical entities embedded in intra- and interspecific relational processes—i.e., interactions that span trophic, social, and metaphysical levels (Abad Espinoza, 2022b)—are "concrete" triggers of sensory experiences (Lévi-Strauss, 1966, 1969) and, therefore, potential subjects within Indigenous animic and perspectival worlds (Viveiros de Castro, 1998; Bird-David, 1999; Ingold, 2006; Descola, 2013). For example, the Shuar, like the Waiwai of Southern Guyana (Mentore, 2012) and the Canela of northeastern Brazil (Miller, 2016, 2019), maintain strong biosocial and mytho-cosmological bonds with the beings who inhabit the gardens. Human-plant interactions are thus rich with bodily and multi-sensory experiences.

Is there something intrinsic in plant behavior patterns that may have stimulated Indigenous Peoples' cognitive capacities? A simple answer might suggest that, in addition to the complex adaptive and reproductive capabilities of underground storage organs (for a discussion about manioc, *Manihot esculenta* Crantz, see Rival & McKey, 2008), these organs serve as significant sources of carbohydrates in Indigenous Peoples' diets (see, e.g., Vincent, 1985 for the Hadza of northern Tanzania; Fraser, 2010 for the Caboclos of Amazonian Brazil; see also Lebot, 2009 for a comprehensive review of the tropics), and thus their potential social and mytho-cosmological significance may hinge on feeding behavior patterns. However, this functional explanation has epistemological limits in that it completely overlooks the interspecies bodily and cognitive engagements involved in horticultural activities. It also fails to consider that, similar to the behavioral and adaptive plasticity exhibited by the genus *Homo* in responding to diverse environmental pressures (O'Brien et al., 2023), plants also demonstrate phenotypic plasticity (Pigliucci, 2001; Denham et al., 2020), and even possess particular forms of cognition, communication, and intelligence (Trewavas, 2003; van Loon, 2016; Calvo et al., 2020; Segundo-Ortin & Calvo, 2022; Marder & Parise, 2024; Parise & Marder, 2024). This organismal agency may have endowed plants with the most basic forms of connection, modification, and immersion in physical and metaphysical spaces (Coccia, 2019). Not surprisingly, this wide array of plants' properties has significantly influenced the biosocial lives of tropical forest peoples and thus appears prominently in their ritual and mytho-cosmological framework (e.g., Herdt, 1981; Zent, 2009; Daly & Shepard, 2024).

It may be hypothesized that, depending on the degree and extent of trophic exchanges, plants' behavioral and cognitive traits are likely the primary cause of the emergence of ontological systems. For the Shuar, if tubers are regarded as persons embedded in a chthonic and terrestrial realm and function as catalysts for trophic, social, and metaphysical associations, all these relational processes must have been rooted in ancient behavioral patterns. Interestingly, it has been reported that our closest primate relative, the chimpanzee (*Pan troglodytes*), uses stick tools to gather and consume underground storage organs (Hernandez-Aguilar et al., 2007). It has also been suggested that incorporating cooked starch (e.g., tubers) may have been crucial in human biological evolution (Pennisi, 1999; Wrangham et al., 1999; Hardy et al., 2015). Against this background, a recent study led by Yilmaz et al. (2024) posits that the duplication of the salivary amylase gene (*AMY1*) likely occurred around 800,000 years ago; this finding thus supports other evidence that underscores the vital role of starch-rich plant foods in shaping

the evolution of complex social and cognitive behaviors, ranging from the controlled use of fire to tool use for plant processing (Larbey et al., 2019; Ahituv et al., 2025).

I suggest that (1) high levels of human-plant interactions, including tool-assisted technology and culinary fire for acquiring and consuming underground storage organs, were likely fundamental to human socio-cognitive evolution, and (2) the morphological, behavioral, reproductive, and sensory characteristics of plants may have further shaped Indigenous concepts of growth, reproduction, regeneration, and well-being. To test these hypotheses, I holistically analyzed Shuar horticultural practices and compared them with those of other Indigenous tropical horticulturalists to assess (1) the extent of socio-ecological relationships and the bodily and cognitive engagement with tubers, and (2) the implications of plant properties for developing a complex theoretical framework underlying patterns of cross-species interactions in traditional horticulture.

Recent ethnographic and ethnobotanical inquiries highlight the implications of human-plant entanglements for constructing Amazonian social schemes and personhood; the biological, chemosensory, and metaphysical properties of plants thus affect the behavioral and cognitive frameworks of Amazonians (Zent, 2009; Daly & Shepard, 2019, 2024; Shepard & Daly, 2022). However, with the sole exception of the works by Daly & Shepard (2019, 2024; see also Shepard & Daly, 2022) among the Amazonian Makushi and Matsigenka, as well as Herdt (1981) among the Sambia of New Guinea, little has been done to explain the cognitive and embodied dimensions of human-plant interactions and their implications for structuring higher-order metaphysical and cosmological categories. Therefore, if Amazonian horticulture is a subsistence strategy infused with multispecies connections, as recent ethnographies indicate (e.g., De Oliveira, 2016; Maizza, 2017; Daly, 2021; Miller, 2019; Cardoso & de Arruda Campos, 2023), then elements of the plant kingdom must play a primary role in shaping organismic interactions and should thus be analyzed as agential beings on par with those in the animal kingdom. This suggests that horticulture involves high levels of bodily and cognitive engagement with biological agents, which provide the material platform critical for further shaping social, ritual, and cosmological systems.

Taking these factors into account, I aim to unravel the basic and intricate mytho-cosmological relationships demonstrated by Shuar gardening practices, which primarily involve humans,

tubers (particularly *Manihot esculenta* Crantz), and mythical origin figures and mediators of ecological and biological processes, such as the mother of crops (Nunkui) and Guadua bamboo (Kenku). By comparing Shuar horticultural practices with those of other Indigenous tropical horticulturists, I also seek to provide a general overview of this subsistence strategy's ecological, biosocial, mytho-cosmological, and ontological significance. The goal is to reveal how and to what extent concepts of plant agency and properties across different ontological planes influence traditional cultivation systems.

Methods

Study site and population

The study area is in the Morona Santiago province of the Ecuadorian Amazon and includes the Shuar communities of Twasap, Yawintz, and Wawaim. The Shuar sustain themselves through hunting, gathering, fishing, and horticulture (Stirling, 1938; Harner, 1972; Karsten, 2000[1935]). Their population consists of approximately 110,000 individuals and, together with the Achuar, Awajun, Wampis, and Shiwiar, forms the *Aents Chicham* ethnic group (formerly Jivaro) (Deshoullière & Utitaj Paati, 2019). Each Shuar community comprises about 15-20 households, totaling roughly 100 individuals, and except for older adults, most community members are fluent in Shuar and Spanish. The local landscapes feature numerous deforested areas and a few forest patches; ecological disturbances are primarily due to cattle ranching, logging, extractivism, and cash crop plantations (e.g., *Pitahaya*, *Hylocereus* spp.). The Shuar's sedentarization and, consequently, the construction and demarcation of the communities have also led to the gradual alteration of local ecosystems. Traditional subsistence strategies, such as hunting and fishing, have diminished, but horticulture is widely practiced, with tubers being the primary source of carbohydrate intake; gardens thus serve as the locus of multispecies human-plant interactions spanning different ontological domains.

Research design

I conducted participant observation and unstructured and semi-structured interviews during two fieldwork periods: July-November 2018 and March-October 2023. Participants (n=25) were

chosen based on their ecological and mythical knowledge of traditional gardening activities. The sample included 11 females and 14 males across the following age cohorts: elders (aged 65 and above [n=9]), adults (aged between 35 and 64 [n=13]), and young adults (aged between 18 and 34 [n=3]). Most conversations and interviews occurred through social interactions involving commensality or gardening activities. Conversations and interviews were primarily conducted in Spanish, except for the elders, for whom conversations sometimes required the mediation of a bilingual Shuar. Notably, due to the author's gender, most interviews with women (the prominent participants in gardening activities) needed the presence of a male relative; this approach effectively served as a heuristic research strategy to explore women's lives, which are intricately connected to their gardens. Interviews were recorded or transcribed during brief and informal discussions in an ethnographic notebook. Significant attention was paid to the multi-sensory nature of human-plant interactions, ranging from physical encounters with plants to oral narratives of the mythical, cosmological, and ontological relationships among the entities in gardens; the latter were critically significant as interlocutors could enact ancestral ritual practices that are no longer present in the communities.

Results and discussion

Conceptualising the gender of cultivated plants

The symbolic and social significance of underground storage organs (USOs), such as yams, taro, sweet potato, and manioc, has been extensively documented among the Indigenous Peoples of Amazonia (e.g., Barasana: Hugh-Jones, 1979; Makushi: Rival, 2001; Piaroa: Heckler & Zent, 2008; Waiwai: Mentore, 2012; Jarawara: Maizza, 2017) and Melanesia (e.g., Trobrianders: Malinowski, 1935; Wola: Sillitoe, 1983; Enga: Wiessner, 2005; Ambrym: Rio, 2007; Abelam: Coupaye, 2021). How the Shuar and other tropical forest horticulturalists conceptualize the gender of cultivated plants might serve as a valuable starting point to demonstrate the symbolic associations between tubers and humans. For instance, the Shuar attribute agential qualities to the plant kingdom, and gender differences are anticipated in plant social life. In this regard, the anthropologist Rafael Karsten reported over a century ago that:

The Jivaro go much further to attribute particular sex to each class of plants: some plants and trees are supposed to be men, others, and thereby most of them, are supposed to be

women. This belief also explains the division of agricultural labour that prevails among the Jivaro. Those plants that are "men" must be planted and cared for by men, whilst those that are "women" must be cultivated by women. Most of the fruits, which are the staple food for the Indians, are considered female. For this reason, among the Jivaro as well as among all the Indian tribes, agriculture is essentially, but not exclusively, an obligation of the female sex ([1935]2000: 111, author's translation).

Even if some Shuar, primarily young people, do not appear to view plants as gendered beings, the perception of plant life as entities with gender qualities persists among older adults. During gardening activities, participants were asked which plants possess gender identification, and they identified the staple crops that are planted, tended, and harvested by women. Tubers (mainly manioc) are thus regarded as inherently female, a notion consistent with other Amazonian peoples, such as the Yukuna of the Colombian Amazon (van der Hammen, 1992: 163). The ethnographic records of Papua New Guinea societies also document this way of conceptualizing tubers (Wiessner, 2005; Sillitoe, 1983; Coupaye, 2013). Similarly, the Makushi of the Guiana Shield associate cultivated manioc with the regenerative figure of the mother. In contrast, wild manioc, which reproduces from seed, is seen as male (Rival, 2001, p. 73). Notably, the Shuar conception of manioc as an entity endowed with feminine traits contrasts with other *Aents Chicham* societies, such as the Achuar (Descola, 1994, p. 197) and the Awajun/Aguaruna (Brown & Van Bolt, 1980 p. 173; Brown, 1986: 105), who suggest that the tuber exhibits both feminine and masculine attributes. Although some variations exist in the way these societies perceive the gender attributes of tubers, the ethnographic examples may nonetheless indicate the fluidity of indigenous concepts surrounding plant biology that challenge Western-based categories of gender (Subramaniam & Bartlett, 2023).

In summary, for the Shuar and other Indigenous tropical horticulturalists, cultivated plants are primarily considered female and/or endowed with feminine attributes. This conception arises from the fact that (1) women are the primary caretakers who nurture the growth and reproduction of tubers, and (2) tubers are intricately linked to women's roles and qualities, such as mothering. These notable parallels in conceptualizing cultivated plants likely indicate similar patterns of human-plant relationships. Among the Shuar, gardening activities involve a profound relational dimension of physical and intellectual engagement with plants. In this sense, planting, tending, and harvesting tubers will likely be deeply rooted in ecological

knowledge. Moreover, it appears that the transmission of this ancestral knowledge has equipped the Shuar with essential means to secure vital sources of carbohydrates and influenced specific ways of perceiving tubers as gendered entities. As described below, biosocial relationships with tubers might further clarify structural mechanisms for the complexity of social relations devised by this society.

Manioc and biosocial relations

In addition to plants' gender and reproductive traits, the concept that cultivated plants are the offspring of the people who care for them throughout all their growth and reproductive stages has been recognized among Indigenous horticulturalists (Seeger, 1981; Mosko, 2010; Miller, 2016; Maizza, 2017; Panoff, 2018; Daly, 2021). Among the Shuar, this parenthood model has limitations, as women primarily fulfill the nurturing role. It is noteworthy that other Amazonians exhibit a similar socio-structural framework, including the Tukanoans (Hugh-Jones, 1979; Jackson, 1983), the Achuar (Descola, 1994), and the Rio Negro societies (Emperaire et al., 2012; Cardoso & de Arruda Campos, 2023). This, in principle, suggests that maximum care must be given to plants that provide many carbohydrates, essential nutritional elements in a diet that also includes fat and protein obtained by men through hunting (see Goldman, 1963: 58). The Shuar recognize that their society relies heavily on cultivars for biosocial reproduction. However, if tubers are viewed as children by the women who nurture them in the gardens, what could be the potential consequences for humans consuming this plant-person? The situation with manioc consumption is particularly worth mentioning. Examining manioc processing patterns may reveal how mechanisms involving high levels of cognition likely play a critical role in ensuring the procreative cycle of social and biological order.

A remarkable aspect of most of the interviews and conversations was the nearly ubiquitous presence of manioc beer. According to the informants, in the past, a lengthy hunting trip, an excursion into enemy territory, or cleaning the garden required the prior consumption of manioc beer. The Shuar often emphasized the primary importance of this as an energy source (e.g., Daly, 2019: 140), with its effectiveness depending on the woman's skills to transform manioc into a fermented beverage. Although the Shuar regularly use manioc for various culinary preparations, recognizing its nutritional properties, like other Amazonian peoples (e.g., Desana:

Reichel-Dolmatoff, 1971; Yanasha: Santos-Granero, 2000; Piaroa: Heckler, 2004; Makushi: Daly, 2019), manioc beer is fundamentally viewed as a catalyst for social bonding.

If manioc beer triggers social relations among humans, this level of sociality is achieved through a prior lower-order relational process. The Shuar women who peel, wash, boil, mash, chew, and spit pieces of manioc into the mash, and finally bring it to a fermenting point, are engaged in complex ecological interactions. Its transformation into a fermented beverage requires the combination of various agentive forces and behavioral sequences. First, women's bodily and cognitive engagement with organic and inorganic materials enables a raw product's partial but efficient transformation. Second, the final transformation into a fermented product and subsequent consumption may instigate a microbial exchange between the human microbiome and the environment (Colehour et al., 2014). Notably, Colehour et al. (2014) reported that these likely co-evolutionary relationships may have conferred health benefits to the Shuar of the Cross-Cutucú region since *Lactobacillus* taxa were found in manioc beer samples. This further corroborates the informants' notion of manioc beer as an energy and nutritional source and its intimate association with Indigenous concepts of sociality and well-being.

Indigenous societies use complex techniques to address the toxicity of tubers. In lowland South America, detoxification processes for the "bitter" variety of manioc have been documented among the peoples of the Northwestern Amazon, Guiana Shield, and Gran Chaco (C. Hugh-Jones, 1979; Kamienskowski & Arenas, 2017; Daly, 2019). Although the Shuar typically consume the "sweet" variety of manioc, which lacks toxicity, preparing manioc beer requires sophisticated sensorimotor skills demonstrated through mashing, chewing, and spitting. These activities expose women to sensory inputs, mainly triggered by their close physical contact with tubers and utensils. As a fermented drink, the production of manioc beer is also a multispecies process (Daly, 2019, p. 130), involving women, manioc, and microorganisms. The deeply embodied nature of women's relationships with manioc—from its care in the gardens to its transformation into beer and food—illustrates how themes of "motherhood" and "childcare" likely arose from the close connection between women's and gardens' reproductive capabilities. Nevertheless, these procreative cycles display varying predation patterns and reciprocity, likely modeling the interconnections among plant life, humans, and mythical beings.

Gardens, generative cycles, and the agential qualities of tubers

Informants frequently indicated that the garden is the quintessential female domain. The Shuar conceptualization of gardens as fundamentally female spaces aligns with that of their Achuar neighbors (Descola, 1994). However, it diverges from other lowland South American societies, such as the Amazonian Jarawara (Maizza, 2017) and the Canela of the Cerrado (Miller, 2016). Furthermore, the Shuar, like the Tukano of the Colombian Amazon, associate the generative qualities of gardens with women's capacity for reproduction (Reichel-Dolmatoff, 1996: 67). Therefore, the parallel between women's bodies and gardens is not arbitrarily conceived; on the contrary, the reproductive and nurturing abilities of both women and gardens are understood in ways that extend beyond their physical conditions.

The Shuar women not only work in a domain where their reproductive faculties are metaphorically emphasized by the reproduction and growth of their plant offspring, but they also highlight the peak of their fertility and reproductive capacities through the empirical nature of parturition. This fact is supported by the ancestral practice of giving birth in the garden, which is documented among other Amazonian peoples like the Achuar and the Tukano, for whom women's procreative abilities are closely associated with those of gardens (Descola, 1994: 217; Reichel-Dolmatoff, 1996: 74-75). If the biological fertility of women's bodies parallels that of gardens and this connection spans biosocial and cosmic domains, ancient human-plant interaction patterns may have significantly influenced kinship, fertility, growth, and reproduction concepts. Specifically, the consanguineal relationships that women form with manioc (see Descola, 1994, 2001; Taylor, 2001; Emperaire et al., 2012; Cardoso & de Arruda Campos, 2023) can be viewed as a distinct form of human-plant entanglement, where the primary importance lies in the conjunction of organismic kingdoms and their ontological interdependence. Behaviorally, human-manioc relationships may align with a definition of domestication that emphasizes coevolutionary and mutualistic interactions, where the domesticator's niche-constructing activities impact the survival and reproduction of the domesticate, which in turn provides resources for the former (Purugganan, 2022).

The Shuar frequently indicate that the reproduction and growth of tubers depend on specific nurturing abilities exhibited by their human "mothers," exemplified by women's sophisticated cognitive skills demonstrated in weeding, planting, tending, and harvesting behaviors, along

with elaborate gardening rites to care for and connect with tubers. Ritual behavior involves specific chants (*anent*) that emphasize the mythical connection with Nunkui, whose agential qualities benefit the growth and reproduction of cultivated plants. When asked why gardening activities require specific forms of care, participants straightforwardly replied that if not properly tended, manioc will refuse to grow and propagate; this would consequently lead to significant nutritional and social problems, as an infertile garden symbolizes women's failure in their reproductive and nurturing capabilities and responsibilities. These unique ways of caring for plants, coupled with a high level of bodily engagement, align with the practices of other Amerindian and Melanesian horticulturalists (Malinowski, 1935; Keesing, 1982; Godelier, 1986; Descola, 1994; Wiessner, 2005; Empeaire et al., 2012; Mentore, 2012; Maizza, 2017; Miller, 2016; Panoff, 2018; Daly, 2019).

The notion that cultigens possess agential traits such as volition, sensibility, and freedom of action has been reported among the Krahô of the Brazilian Amazon and the Maenge of Papua New Guinea. In these societies, tubers may relocate to other gardens if they are dissatisfied with the attention received from their nurturers (Morim de Lima, 2016; Panoff, 2018). Thus, the biological definition of domestication (Purugganan, 2022) used to elucidate the cultivation systems of Indigenous tropical horticulturalists is problematic, as it entirely overlooks Indigenous concepts of plant consciousness, cognition, and behavior. It could therefore be argued that these societies exhibit patterns of "antidomestication" (Carneiro da Cunha, 2019), wherein the active role of human niche construction in regulating tubers' fitness is reversed, leading to more balanced interspecies relations. Although the Shuar do not attribute tubers' volitional traits to the same extent as those seen with sweet potato among the Krahô (Morim de Lima, 2016) or taro among the Maenge (Panoff, 2018), they nonetheless attribute blood-feeding behavior to manioc. Notably, this belief is held only among older individuals; many community members were unaware of it. When elders were asked about the specific characteristics of manioc's blood-sucking habit, they clarified that primarily young children were the targets of this aggressive behavior. This description aligns with ethnographic records collected throughout the 20th century among the *Aents Chicham* ethnic group (see, e.g., for the Shuar, Harner, 1972: 75-76; for the Achuar, Descola, 1994: 204; for the Awajun, Aguaruna, Brown, 1986: 106). Nevertheless, even if the contemporary Shuar disregard manioc's vampire-like attributes, this notion may have significant implications for regulating trophic interactions and maintaining the biosocial and ontological interdependence between humans and manioc.

Human-manioc dynamics are divided into two reciprocal planes of trophic and ontological associations. First, the extraordinary devotion of women to their plant children in ensuring their propagation and growth is reciprocated by the latter's nutritional and social importance. Second, a subsequent level of reciprocation is evident in an inversion of feeding patterns, which involves a mechanism likely compensating for the cannibalistic tendency of humans, based on the hematophagous behavior exhibited by manioc, primarily toward their anthropoid siblings. Descola (1996: 94) reported that the Achuar believe, "The mother feeds on her plant-children, who in their turn take from her human offspring the blood they need for their own growth."

Although most women in the communities give birth in health facilities, knowledge regarding ancestral patterns of parturition remains widespread among community members. The Shuar are not confused when asked about their traditional childbirth practices and their apparent connection to blood and manioc. Notably, in line with other Amazonian peoples (Basso, 1973: 63; Kaplan, 1975: 38; Brown, 1986: 124; Reichel-Dolmatoff, 1996: 75), menstruating women are seen as polluting to the gardens since menstrual blood is detrimental to the plants and thus most staple crops they care for would be contaminated. Nevertheless, among the Shuar, the taboo surrounding menstrual blood does not carry an extremely negative connotation as it does in some Melanesian and Amazonian societies where women's seclusion is commonly practiced during their periods (Basso, 1973; Keesing, 1982; Albert, 1985). This, paradoxically, contrasts with the practice of giving birth in the garden, which involves the loss of women's blood and the exposure of their newborns, who could easily become victims of their hematophagous siblings. Keeping this in mind, we might view gardening as a form of reciprocal predation (Descola, 2001), wherein maternal nurturing abilities and exchanges of plant materials and bodily fluids illustrate the close connection between women and their human and plant children. These cross-kingdom interactions may indicate ancient patterns of familiarizing predation (Fausto & Neves, 2018) in which plants' nutritional properties, behaviors, and cognitive capacities have been integrated into the indigenous socio-ecological system. As a result of these entanglements with plant life, the Shuar's behavioral and conceptual frameworks were likely shaped gradually following the biosocial reproduction and well-being of both humans and cultigens; current ecological, social, and cognitive systems likely emerged from forms of human-plant coevolution.

The active role of manioc has been a key factor in shaping behaviors and modes of thought that highlight the biosocial and ontological interdependence of biological kingdoms. The Shuar attribution of a soul (*wakan*) to manioc (see also Descola, 1996, p. 92) is not merely a matter of symbolic associations. However, it likely arises from deeply embodied and embedded coevolutionary processes between intentional agents. If reciprocal relations with the environment characterize the extended cognition of plants, realized through complex growth patterns, behavioral plasticity, and biochemical exudates (Marder & Parise, 2024), then it is unreasonable to dismiss the possibility that such complex behavioral and cognitive qualities may shape patterns of human-plant interaction within horticultural activities. Based on this, the Shuar mythological and ritual structure may illuminate the significance of cross-species interactions and the intercommunication between ontological realms (humans, plants, and mythical beings) that inform growth and reproduction patterns within the garden domain.

When metaphysical and mytho-cosmological principles meet practical activities

The mythical narrative suggests that before the Shuar learned about tubers, they consumed the raw leaves of *Calathea lute*. Only with the arrival of Nunkui, who provided abundant tubers, could their starvation finally end. However, as some children mistreated Nunkui by throwing ashes in her eyes, the production of staple crops began to decline significantly until it ceased altogether. Nunkui then chose to leave humans by merging into the stem of Kenku (*Guadua* spp.), which, at that time, was a hollow tubular structure. Before fleeing to the chthonian realm, she created the nodes of the *Guadua* bamboo while regularly defecating the seeds of wámpakar (*Pytholacca rivinoides*), a curse that compelled humans to work hard in the gardens to eliminate these weeds and thus secure their food. Although this is a condensed version of the myth the informants recounted, it nonetheless highlights the key principles regarding the origins of horticulture.

The implications of the mythical narrative are threefold. Firstly, it denotes that the ancient Shuar exhibited a particular trophic behaviour by eating the raw leaves of *Calathea lute*. Participants, in fact, relentlessly indicated that *Calathea lute* leaves are generally used as food wrapping and therefore are not considered edible. In Brazil, among the Kalapalo (Basso, 1973, p. 30) as well as among the Ramkokamekra-Canela (Miller, 2015, pp. 385–90), the myths suggest that before the emergence of cultigens, humans ate roots¹ and rotten wood.

Secondly, the emergence and abundance of edible tubers were attributed to the intervention of Nunkui, a mythical being that parallels the figure of Cassava Mother/Mama among the Makushi (Rival, 2001; Daly, 2019), the Pemon (Lewy, 2023), the Waiwai (Mentore, 2012), and the *mãe da roça* (mother-of-the-field) among the Baré (Cardoso & de Arruda Campos, 2023). The key point is that tubers emerged from an entity's intentionality; without the agential qualities of the female child Nunkui, the Shuar would have continued with their low-quality diet. This aligns with the mythical repertoire of other horticultural societies that emphasize the reproductive capacities of a given female subject (Wiessner, 2005, pp. 125-6; Cardoso & de Arruda Campos, 2023: 7; Mentore, 2012: 147). These mythical narratives may suggest a spatio-temporal scale of pre-domestication and the intimate relationship between women's bodies/generative capacities and tubers.

Thirdly, when Nunkui was mistreated, the abundant production of tubers immediately stopped. The myth then continues that before escaping to the underworld through the hollow *Guadua* bamboo (Kenku), Nunkui formed the nodes in the stem while excreting the seeds of wámpakar (*Pytholacca rivinoides*), thus encouraging humans to strive for their subsistence. The defecation behavior and the *Pytholacca rivinoides* weeds are themes that can be further linked with other Amerindian myths about the emergence of manioc (Mentore, 2012, p. 147). The myth of Nunkui seems to reshape the nature and context of defecation. Thus, in contrast to Cassava Mother's defecating behavior, which benefited humans by providing a processed plant material (manioc flour), Nunkui excreted *Pytholacca rivinoides*, which, according to the Shuar, is considered a nuisance for horticultural activities. The excretion of *Pytholacca rivinoides* was, therefore, a direct response to humans' disrespectful and insolent actions. Informants often expressed concern about the harmful effects of *Pytholacca rivinoides* on traditional horticulture and the exhausting tasks of weeding and burning to eliminate these weeds.

It is also worth noting that, aside from defecating the seeds of *Pytholacca rivinoides*, Nunkui transformed Kenku (*Guadua* spp.) from a hollow tubular structure into its current morphological condition, i.e., a bamboo stem with nodes. This transformation has important implications for cross-species communication within the Shuar ontological and cosmological systems. Like the vine that connected heaven and earth in mythical times (see Descola, 1994: 69; Karsten, 2000 [1935]: 370-1), the hollow cylindrical structure of *Guadua* served as the connector between the terrestrial and chthonian realms (Lévi-Strauss, 1988, p. 20); for a

discussion of tubular structures in Amazonian mythology (see also Hill, 2009; Hill & Chaumeil, 2011; Wright, 2013; S. Hugh-Jones, 2017). These species of the *Plantae* kingdom acted as axis mundi (Ugalde & Kuhn, 2024), mythical bridges, and primary mediators for the interconnection between cosmic and ontological planes. However, by creating the nodes in the stem and transforming the primordial morphological structure of *Guadua*, Nunkui blocked the tubular passage that enabled intercommunication between realms. This, in turn, has shaped post-mythic subsistence patterns and prompted the Shuar to intimately engage in both the socio-ecological and ritual dimensions of horticultural practices.

For the Shuar women, gardening activities involve a profound connection with their plant children and Nunkui. This is underscored by a series of gardening rituals highlighting women's essential role in the growth and reproduction of cultigens. Interestingly, this contrasts with the behavioral patterns observed among Melanesian horticulturalists such as the Trobrianders (Malinowski, 1935), the Umeda (Gell, 1975), the Kwaio (Keesing, 1982), the Baruya (Godelier, 1986), and the Maenge (Panoff, 2018), who see men as the primary figures in the magical formulae and operations that ensure garden productivity. Furthermore, there are ritual chants performed exclusively by women during horticultural activities, emphasizing their close association with Nunkui and the production of staple crops (see also Harner, 1972; Brown & Van Bolt, 1980; Brown, 1986; Descola, 1994). Similar ritual chants sung by women for the reproduction, growth, and protection of cultivated plants have also been documented among other Amazonian horticulturalists like the Quichua (Whitten, 1976, p. 72), the Cashinahua (Kensinger, 1995, p. 19), the Yekuana (Guss, 1989, p. 36), the Arakmbut (Gray, 1996, p. 50), and the Krahô (Morim de Lima, 2017). However, it is important to note that among the Shuar communities, the knowledge of these formulae appears to be limited among younger and adult women and is primarily held by older adult women. This limitation is mainly attributed to schooling (see e.g., Boster, 1984 for similar effects of the introduction of schools on horticultural knowledge among the Awajun/Aguaruna) and wage labor, which now occupies much of women's time. In this context, most informants expressed concern about the negative impacts of acculturation and the market economy on cultural transmission patterns, emphasizing that traditional horticulture is a complex subsistence activity that requires extensive knowledge of local ecology and the related mythical and ritual frameworks.

Moreover, in contrast to the socio-ecological, symbolic, ritual, cosmological, and ontological significance of the peach palm (*Bactris gasipaes*) among Amazonians (S. Hugh-Jones, 1979; Rival, 1993; Chaumeil, 2001), as Virtanen et al. (2022) argue, the importance of *Guadua* spp. has been overlooked. This oversight is not surprising among the Shuar, as Uwí (*Bactris gasipaes*) plays a crucial role in ritual activities, epitomizing male principles of life and death (Mader, 2021). Thus, the peach palm (Uwí) serves as a masculine metaphysical postulate that represents the biological pattern of nature's abundance through its fruits and a model of warfare via its hard trunk, along with the spiritual energy (arutam) (Stirling, 1933: 139, 1938: 116) that saturates the spears. Kenku (*Guadua* spp.), in contrast, is seen as an androgynous entity and the essential connector of earth and the underworld in the female domain of the gardens. Additionally, according to informants, *Guadua* acts as a fertilizer, as its close association with Nunkui indicates the presence of fertile soil, a statement also confirmed by their Achuar neighbors (Descola, 1994: 196). Virtanen et al. (2022) have likewise reported that the Apurinã and Manxineru of the Brazilian Amazon associate *Guadua* with fertile soil ideal for swidden cultivation and attribute cosmological and ontological significance to it. Interestingly, among the Matsigenka of the Peruvian Amazon, particular *Guadua* species are envisioned as animate beings, particularly those thought to contain poison and used as arrow points that cause profuse bleeding in humans and animals and serve as good indicators of soil type and disturbance regimes (Daly & Shepard, 2024).

It may be assumed that the association between *Guadua* and fertile soil reported among Amazonian peoples likely corroborates the empirical studies indicating that *Guadua*-dominated forests coincide with eutrophic haplic cambisol and luvisol soils (de Carvalho et al., 2013); types of soils characterized by high nutrient concentrations according to Amazonian standards (Virtanen et al., 2022). Although the Shuar live in the Upper Amazon, the correlation between *Guadua* and fertile soils is more evident given the geographic location (Descola, 1994: 196). The primary point is, nonetheless, that concepts of growth, fertilization, and reproduction within traditional horticulture may have emerged from complex coevolutionary interactions between humans and plants. This is unsurprising since the mytho-cosmological and ontological significance of plants depends on the biosocial and cognitive properties attributed to them. From manioc's blood-feeding behavior to *Guadua*'s fertilizing qualities, gardening practices are deeply embedded in the mythological and ritual structure that underpins elemental ecological processes.

The ritual behavior exhibited by the Shuar women illustrates how complex forms of embodiment and cognition are necessary to negotiate with mythical entities that regulate the growth and reproduction of tubers. Besides the ritual chants, informants noted that other gardening rites have almost completely disappeared in the communities. One example of these rites was the use of powerful stones (*nantar*) that women buried in the gardens to enhance production (Harner, 1972, p. 72; Brown, 1986, pp. 115-122; Descola, 1994, pp. 206-209). A similar practice can also be found among the Makushi, who use potent plants, known as *bina* (e.g., *Eleutherine bulbosa*), to encourage the growth and yield of the staple crop bitter manioc (Whitaker et al., 2024). Given that *nantar* stones are believed to be closely associated with Nunkui, informants asserted that very few women possess them.

Planting after the full moon appears to be another ancestral horticultural tradition no longer practiced among the Shuar communities; informants often highlighted the positive influence of this lunar phase on the growth of staple crops (e.g., Beeson, 1946). According to the informants, planting purple yam (*Dioscorea trifida*) in the past required specific proprioceptive skills. Specifically, as described and enacted by the Shuar, this practice involves a woman preparing the soil and then squatting to hit the purple yam seeds with her buttocks. Therefore, the primary significance of women hitting the soil and the seed with their buttocks is to encourage *Dioscorea trifida* to grow large. This belief stems from the strong association that informants made between women's large buttocks and fully grown purple yams. A parallel with the Sambia people studied by Herdt (1981) is evident here, as in both societies, keystone plant species provide an empirical foundation to form symbolic associations infused with sexual connotations.

Given this ethnographic evidence, one might be tempted to speculate that there is an implicit connection between the full moon and women's buttocks. These physical attributes are indicators of rapid growth and sound production in staple crops. Interestingly, Conklin (2001: 153) reported that among the Wari' of the Brazilian Amazon, the physical growth and sexual maturation of pubescent girls are believed to be influenced by the special relationship they establish with the moon. On the other hand, among the Shuar, there appears to be an underlying pattern of bio-cosmic associations and ontological interdependence between women's bodies, the full moon phase, and the growth of tubers. Growth, fertility, and reproduction patterns

within traditional horticulture thus depend on complex relationships among organismic kingdoms, celestial bodies, immaterial beings, and inorganic matter.

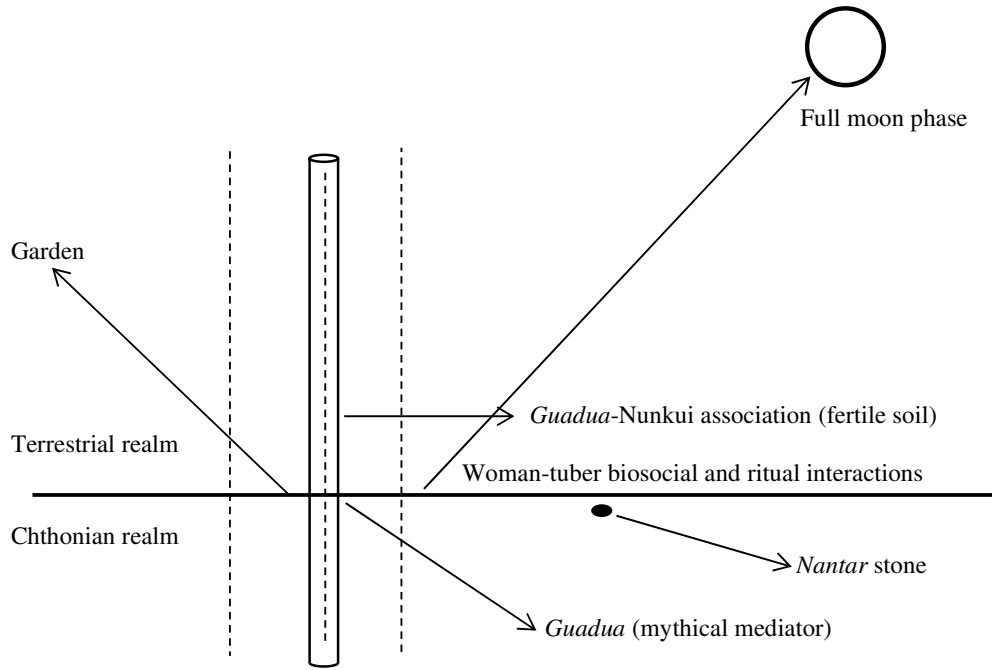


Fig. 1 Ancestral patterns of tuber growth and reproduction

It has been observed that some Amazonian peoples explicitly conceive the reproductive biology of manioc as a conjunction of female and male agencies embodied in the biological and morphological properties of the plant. For these societies, morphological and biological characteristics such as stem and root starches contain both female reproductive capacities and a semen-like substance derived from the fertilizing attributes of the sun (Reichel-Dolmatoff, 1971; C. Hugh-Jones, 1979; Rival, 2001). Although the Shuar do not overtly make any connection between these female and male principles, their traditional horticultural practices strongly indicate patterns of growth and reproduction that arise from the connection of a wide variety of agential forces. For instance, Guss (1989: 34) reported that the Yekuana conceive gardens as female and metaphysical spaces linked to Heaven and the supernatural powers essential to manioc growth. As illustrated in Fig. 1, the fertilizing and generative processes within Shuar gardens are determined by the concatenation of mythical connectors, cosmic

forces, and the agential qualities of biosocial beings and inorganic matter. Overall, the association between the biosocial, ecological, cognitive, mytho-cosmological, and ontological qualities of garden entities is likely well-embedded in human-plant coevolutionary interactions.

Conclusions

Traditional horticulture is crucial in providing carbohydrate-rich food crops and fostering social relations among Shuar communities. Shuar women exhibited high levels of physical and cognitive engagement during the processing of tubers, particularly in transforming manioc into a fermented beverage. These biosocial connections with tubers, especially manioc, imply complex forms of kinship, concepts of gender, and plant agency. Although ideas of gender and plant agency, kinship relationships, and specific rituals involving tubers are lost, mainly or only preserved by older adults, a comprehensive understanding of ancestral gardening practices emerged from the informants' narratives. This was further highlighted by comparing Shuar cultivation systems with the ethnographic realities of other Indigenous tropical horticulturalists.

The female domain of the gardens may have functioned as an ecological niche where biosocial, mythical, cosmic, and ontological associations between biological kingdoms informed growth patterns, fertility, and reproduction. These associations, in turn, emphasize relational processes filled with sensory experiences; in other words, plants' morphological, biological, behavioral, and cognitive properties are perceived in all their nuances and complexities. From the conception of *Guadua* as a fertilizer (likely supported empirically) to the notion of manioc's hematophagous behavior, Shuar horticulture revolves around elements of the plant kingdom infused with soul, consciousness, and intentionality. Therefore, plants' agential qualities are crucial in shaping the ritual and mytho-cosmological structure underpinning gardening activities.

Despite the acculturation processes and the relentless infiltration of the capitalist mode of production that have significantly undermined both the practical and theoretical knowledge of Shuar cultivation systems, this society exhibits remarkable behavioral plasticity in response to various environmental and socio-economic pressures. During the outbreak of COVID-19, the Shuar managed to navigate the precarious economic and health system by relying on their ancestral ecological knowledge. Traditional horticulture proved essential, providing the Shuar

with medicinal and starch-rich plant foods (Abad Espinoza, 2022a, 2024). For this reason, preserving Indigenous ecological knowledge is paramount, as it represents profound connections with the physical world and the meaningful qualities that emanate from it amid the destructive forces of the Anthropocene. From both evolutionary and cognitive perspectives, traditional horticulture is deeply rooted in ancient patterns of human-plant interactions that may have laid the groundwork for developing empirically and philosophically sound concepts of plant behavior, cognition, and consciousness. Plant life's biological, cognitive, and metaphysical properties have significantly influenced Indigenous socio-ecological, mytho-cosmological, and ontological systems. The ongoing disruption and collapse of these integrated thought patterns and behaviors pose significant threats to the valorization and preservation of Earth's ecosystems.

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Competing Interests

The authors declare no competing interests.

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Notes

¹ Although manioc is a root, the Kalapalo myth states that “before human beings knew about manioc, they lived on roots which they found in the cerrado” (Basso, 1973: 30). So, even if the myth is not clear about the roots the Kalapalo used to consume, it is likely that these roots are not associated with cultivated plants.