

Sensory ecologies, plant-persons, and multinatural landscapes in Amazonia¹

Glenn H. Shepard, Jr. and Lewis Daly

Abstract: Seeking to generate a deeper methodological and theoretical dialogue between botanical science and anthropology, this paper summarizes interdisciplinary approaches to human–plant interactions we have described as “sensory ecology” and “phytoethnography”, applying these concepts to vital questions about human–plant relations in Amazonia. Building on this work, we broaden the scope of our investigations by considering their relevance to the field of historical ecology. In particular, we discuss Eduardo Viveiros de Castro’s concept of “multinaturalism” and explore how it can be applied to understanding management and domestication of forest landscapes in Amazonia by Indigenous Peoples.

Key words: Amazonia, ethnobotany, ethnopharmacology, historical ecology, landscape domestication, perspectival multinaturalism.

Résumé : Cherchant à générer un dialogue méthodologique et théorique plus profond entre la science botanique et l’anthropologie, cet article résume les approches interdisciplinaires des interactions humain-plantes que les auteurs ont décrites comme « écologie sensorielle » et « phytoethnographie », en appliquant ces concepts à des questions vitales sur les relations humain-plantes en Amazonie. En s’appuyant sur ces travaux, ils élargissent la portée de leurs recherches en considérant leur pertinence pour le domaine de l’écologie historique. En particulier, ils discutent du concept de « multinaturalisme » d’Eduardo Viveiros de Castro et explorent comment il peut être appliqué à la compréhension de la gestion et de la domestication autochtones des paysages forestiers en Amazonie. [Traduit par la Rédaction]

Mots-clés : Amazonie, ethnobotanique, ethnopharmacologie, écologie historique, domestication des paysages, multinaturalisme perspectif.

Introduction: What kind of plants are people?

I already knew that the Matsigenka consider some plants as having human-like souls, but Romulo’s answer still surprised me. We sat in the shade of a palm-thatched hut overlooking the muddy expanse of the Manu River after finishing up an interview about the health improvements brought by a new water and sanitation project in his community, Tayakome². I continued chatting with Romulo Oyeyoyeyo, a respected Elder, and on a whim, I asked him a question about a topic that had long intrigued me.

“Uncle Romulo, what kind of plants are people?”

The Matsigenka generally don’t consider plants to belong to the grammatical category of “animate” beings,

defined by possessing a human-like essence, referred to as “suretsi” and translated as “soul”. While plants live, grow, multiply, and contain a “life essence” (“ani”), they don’t show willful locomotion, and hence are mostly considered “inanimate” beings (Shepard 2018). By contrast, animals as well as the sun, the moon, stars, planets, and diverse anthropomorphized beings show willful motion and agency, and hence are considered “animate” and possessing of a soul. A few exceptional plants are said to possess human-like souls or spirit owners, especially psychoactive plants like tobacco (*Nicotiana tabacum* L.), ayahuasca (*Banisteriopsis caapi* (Spruce ex Griseb.) Morton), and “tohé” or “floripondio” (*Brugmansia suaveolens* (Willd.) Sweet). Latex-containing plants like rubber (*Hevea*

Received 7 June 2021. Accepted 31 October 2021.

G.H. Shepard, Jr. Human Sciences Division, Museu Paraense Emílio Goeldi, Av. Perimetral 1901, Belém, PA 66077-830 Brazil; Anthropology Division, American Museum of Natural History, 200 Central Park West, New York, NY 10024-5102, USA.

L. Daly. Department of Anthropology, University College London, 14 Taviton Street, London WC1H 0BW United Kingdom.

Corresponding author: Glenn H. Shepard, Jr. (emails: gshepardjr@gmail.com; gshepard@museu-goeldi.br).

¹This article is part of a Special Issue entitled “Ethnobotany and Ethnopharmacology of the Americas”.

²The interview was carried out in April 2014 as part of the follow-up studies to the community water, health, and sanitation initiative led by Rainforest Flow. See rainforestflow.org and <https://www.youtube.com/watch?v=WY-ZTNKzF4o>.

© 2021 The Author(s). Permission for reuse (free in most cases) can be obtained from copyright.com.

brasiliensis (Willd. ex A.Juss.) Müll.Arg.) and “chicle” (*Castilla ulei* Warb.) are also said to have souls because of their freely running sap and elastic resins. Finally, certain cultivated plants like yam (*Dioscorea* sp.) and sweet potato (*Ipomoea batatas* (L.) Lam.) were once human and able to speak but lost this ability through a series of tragi-comical episodes related in Matsigenka myths.

Yet none of this prepared me for Romulo’s answer. After considering my question for a few moments, he replied, “Maempe”, the Matsigenka word for *Hura crepitans* L., a species of Euphorbiaceae with highly caustic sap, known regionally in Peru as “catahua”.

“Maempe’ is very caustic. If the latex gets in your eye, it will blind you”.

He reflected a while longer and continued, “Kapiro”, the Matsigenka word for the spiny bamboo species *Guadua weberbaueri* Pilg., which is used for making arrow tips.

“Kapiro’ is very painful. We use it to make arrows. It really hurts. If we carve arrow points when our wife is pregnant, the soul of the plant will take revenge and cut the umbilical cord and she will bleed and lose the baby”.

Romulo’s answer reminded me of the complexity of Indigenous concepts about substance, spirit, and personhood, and how difficult it can be to translate a word like “person” or “soul” across languages and cultures. For Romulo, the spiritual essence and human-like agency of plants is closely linked to noxious properties and a capacity for inflicting harm. The caustic sap of *Hura crepitans* can be used medicinally to remove rotten teeth and treat snakebite. *Hura* sap is dripped on the body of a poisonous snake that has inflicted a bite to dissolve its flesh and reduce the spiritual potency of its venom in the victim. Sorcerers also apply *Hura* sap to the clothing or hair of their victims to cause illness.

Bamboo is the epitome of pain and lethal power in Matsigenka botany, whittled to razor sharp points for arrowheads used in daily hunting activities (Fig. 1). Matsigenka hunters claim that bamboo contains a poison that makes animals (and people) bleed profusely. A rarer form of bamboo, “shinkerokota” (*Guadua* sp.), has an even more powerful hemorrhagic poison (Shepard et al. 2001). As recently as the mid-1980s, some of my Matsigenka friends have felt the painful sting of bamboo-tipped arrows fired at them by their traditional enemies, the Nahua people, or watched their loved ones die of arrow injuries during those conflicts. Bamboo is covered in sharp spines and tiny urticating hairs that can cause a severe itching reaction. For the Matsigenka, this collection of dangerous physical and chemical properties animates bamboo with human-like agency.

Despite a rich history of ethnobotanical research in the Amazon (Posey 1985; Schultes and Raffauf 1990; Balée 1994), plants remained at the margins of mainstream anthropological theory until quite recently (Rival 2012, p. 69). Anthropologists working in Amazonia and other tropical

Fig. 1. Bamboo is the epitome of pain and lethal power in Matsigenka botany, whittled to razor sharp points for arrowheads. [Colour online.]



forest regions have examined the practical uses and symbolic associations of plants in ritual, agriculture, and ethnomedicine (e.g., Turner 1967; Hugh-Jones 1980; Herdt 1981; Rival 2001). Medical anthropologists and ethnobotanists in particular have studied the complex interweaving of social, nutritional, and pharmacological rationales in medicinal and dietary plant usage (Wilbert 1983; Browner et al. 1988; Etkin 1988; Johns 1990; Moerman 1991; Brett 1998). Yet such biocultural insights into human–plant interactions have largely been overlooked in the emerging sub-field of multispecies ethnography and “anthropology beyond the human”. In Amazonia, anthropological understandings of non-human beings have focused on human–animal interactions (Kohn 2013; see Daly 2015). Only recently have cultural anthropologists begun to explore the botanical world in earnest (Daly 2015; de Oliveira 2016; Myers 2017; Daly and Shepard 2019; Hartigan 2019; de Oliveira et al. 2020; Schulthies 2021; Kawa 2021).

Interspecies relations involve the flow of signs across species boundaries (Kohn 2013; Tsing 2015; Swanson 2017). As Hornborg (2001, p. 127) notes, “Even biochemical processes have a semiotic dimension. . . , not to mention the

various visual, auditory, olfactory, and tactile communication systems of human and non-human organisms". Our research on plant-human interactions in Amazonia has revealed how sensory experience permeates Indigenous "logics of substance" and concepts about etiology, efficacy, and agency (Shepard 2004, 2018; Daly 2015, 2019, 2021; Daly and Shepard 2019). Such sensory underpinnings of Indigenous knowledge were alluded to in Claude Lévi-Strauss's concept of the "science of the concrete", and especially in his essay, "The Fugue of the Five Senses" (Lévi-Strauss 1969). But as we have argued (Shepard 2004, 2018; Daly and Shepard 2019), standard anthropological methods and theories are inadequate for apprehending the unique forms of self-organization (Gottlieb and Borin 2005), communication (Witzany 2008; Gagliano 2018), and intelligence (Trewavas 2003, 2016) found in plants. At the same time, mainstream botanists and ecologists have encountered methodological, theoretical, and epistemological challenges in acknowledging the sociocultural processes that have shaped forest landscapes in some regions of Amazonia (Franco-Moraes et al. 2019).

Seeking to generate a deeper methodological and theoretical dialogue between botanical science and anthropology, we summarize these approaches and show how they have been applied to understanding human-plant relations in Amazonia. Building on this work, we broaden the scope of these investigations by considering their relevance to the field of historical ecology. We discuss Brazilian anthropologist Eduardo Viveiros de Castro's ontological concept of "multinaturalism" (Viveiros de Castro 2002, 2004a), and explore how it can be applied to understanding the management, modification, and domestication of forest landscapes in Amazonia by Indigenous Peoples.

From sensory ecology to phytoethnography: What kind of people are plants?

Indigenous hunters, gatherers, and horticulturists of Amazonia are deeply intertwined with the tremendous diversity of botanical varieties, species, and landscapes that surround and sustain them. These entanglements and exchanges encompass empirical, social, historical, ecological, sensorial, and cosmological dimensions of human-plant relationships. As Gilbert Herdt observed among tropical forest peoples of New Guinea, plants offer more than just nutrients, medicines, and raw materials for subsistence: the morphology, reproductive biology, and sensory properties of keystone tree species provide essential metaphors to understand the ritual and sexual symbolism of the Sambia people (Herdt 1981). The living trees provide the physical context, intellectual framework, and emotional disposition for Sambia ritual life. Rappaport (1967) examined the "ritual regulation of environmental relations" among the Tsembaga people of New Guinea. In Amazonia, Reichel-Dolmatoff (1976, 1981) highlights synergies between Indigenous

concepts and ecological and neurophenomenological processes, while Århem (1996) describes a "cosmic food web" where ecology and cosmology become fused. In a dramatic illustration of the crucial role of biodiversity to Indigenous worldview, Yanomami shaman Davi Kopenawa elucidates his own visionary experiences and philosophical concepts through an encyclopedic concatenation of plant and animal species, individually named (Kopenawa and Albert 2014).

Amazonian Indigenous Peoples have altered forest landscapes through itinerant agriculture and agroforestry management for centuries, if not millennia (Posey 1985; Balée 1989; Shepard and Ramirez 2011; Clement et al. 2015; Levis et al. 2017). Amazonian ideologies about plant and animal life highlight the theme of diversity (Rival 2001; Heckler and Zent 2008; Carneiro da Cunha 2017). For the Matsigenka of the Peruvian Amazon, the dizzying variety of plants and animals in the forest and the ongoing maintenance of agrobiodiversity in swidden gardens all depend on the transformative powers of primordial and current shamans (Shepard 1999). The Makushi people of Guyana cultivate hundreds of folk-varieties of bitter manioc (*Manihot esculenta* Crantz), and celebrate diversity as a fundamental principle of their ecology and cosmology (Daly 2015). Swidden fallows, agroforestry systems, and secondary forests in various states of succession are dynamic spaces of inter-specific sociability, in which humans, plants, and animals interact in intimate, symbiotic, and multisensory ways (Daly and Shepard 2019).

Addressing the subjectivity of non-human beings has been among the most important contributions of Amazonian ethnology to contemporary anthropology, especially via the intellectual currents of "animism" (Descola 1994) and "perspectivism" (Viveiros de Castro 1996). Anthropologists working among diverse Amazonian peoples have encountered relational and "highly transformational" cosmological systems (Rivière 1994) in which human and non-human persons of various kinds interact, exchange, compete, and sometimes metamorphose. In myths, ritual and shamanic contexts, as well as in everyday life, personhood for Amazonian peoples is not restricted to human beings.

The personhood of wild animals is especially important in the theoretical construction of perspectivism. Indigenous People throughout Amazonia consider that each animal species sees itself as a person, with a human body and culture. The bodies of other species are perceived according to each one's "cosmological perspective" as determined by predatory relationships: the peccary sees itself as human, but regards the human hunter as a predatory jaguar; the jaguar sees itself as human, but regards humans as peccaries to be hunted and consumed (Viveiros de Castro 2002). In this "cosmos-as-ecosystem", hunting is a fundamental metaphor structuring mutual exchanges, both ecological and cosmological, between

humans, animals, and the spirit world (Reichel-Dolmatoff 1976; Århem 1996; Fausto 2007).

Despite the centrality of non-human personhood in contemporary anthropological theory of Amazonia, the plant world has played a marginal role. As Rival (2012, p. 69) wrote less than a decade ago, “There is a shortage of works on the symbolism of plants”. The predominance of the perspectival paradigm, with its focus on symbolic elaborations of predation, has proven less effective at elucidating plant perspectives. Even the influential work of Eduardo Kohn — and despite its suggestive title, *How Forests Think* (Kohn 2013) — ends up getting carried away by what Daly (2015, p. 67) characterizes as a “faunal bias” — “In purporting to explore ‘how forests think’, [Kohn] fails to adequately take into account perhaps the most ‘iconic’ living selves found in the rainforest: *plants*” (ibid.).

We have outlined the concept of phytoethnography as a remedy for this faunal bias in Amazonian anthropology (Daly and Shepard 2019). Phytoethnography elevates plants to the status of ethnographic subjects in their own right at varying scales, from house yard gardens to swiddens, managed successional fallows, mature agroforests, and the wider forest realm. By directing anthropological attention to plants, this approach seeks to highlight the centrality of botanical beings, plant substances, and forest landscapes in Amazonian lifeways.

The body for Indigenous peoples of the Amazon is not given, but rather constructed (Seeger et al. 2019; Vilaça 2005). Substances of plant origin play a major role in mediating vital transfers between different bodies and subjectivities (Shepard 2004; Zent 2005, 2009; Wright and Taylor 2009; Santos-Granero 2012; Daly 2015; Daly and Shepard 2019). The idea of “substance sharing” is found in many Amazonian cosmologies: substances perpetually flow between bodies and beings of different kinds. Human-plant interactions often take the form of substance transfers, in which qualities, capacities, and subjectivities of non-human beings are acquired by bodily incorporation (Santos-Granero 2012). In these transfers, notions about substance, soul, and body merge to the point of being nearly indistinguishable. As Luis Eduardo Luna writes of Peruvian mestizo shamans, “It is with the help of the spirits of some of these plants, which I have called ‘plant teachers’, that the shaman is able to acquire his powers” (Luna 1984, p. 140).

Considering this evidence, we were driven to ask, how exactly do Indigenous Amazonian peoples relate to plants, and what role do sensory experience, phytochemistry, ecology, and plant intelligence play in mediating these relationships? We bring to this investigation our independent ethnographic and ethnobotanical field studies among the Matsigenka people of Peru (Shepard 1998, 2004, 2018) and the Makushi of Guyana (Daly 2015). Though geographically separated by thousands of kilometres, and culturally and linguistically unrelated, the two groups showed remarkable similarities in their conceptions

about plant agency, botanical substance exchanges, and the healing power of plants.

The Matsigenka live in the Amazon headwaters in southern Peru. They currently number 13 000 people throughout the Urubamba, upper Madre de Dios, and Manu River basins. Matsigenka is an Arawakan language, closely related to Ashaninka (Campa). The term “matsigenka” means person, which also refers to the human essence of non-human beings. The Matsigenka plant sweet manioc, plantains and bananas, maize, sweet potatoes, cotton, annato, beans, peanuts, chili peppers, and a variety of other crops in swidden gardens (Johnson 1983). Fish, game, fruits, and other wild foods are essential in their diet. While the Matsigenka exhibit little in the way of elaborate public rituals, a closer examination reveals frequent ritual and practical interventions in the private family sphere, often involving plants. Since the 1980s, oil and gas prospecting activities have increasingly affected communities in the lower Urubamba region (Izquierdo and Shepard 2003).

Toxicity is fundamental to the Matsigenka’s understanding of illness and healing, as encapsulated in the concept of “kepigari”. The word is derived from the verb root “-piga-” (to return, turn around, spin), which by extension means to feel dizzy, nauseous; to be intoxicated or poisoned; to go insane. “Kepigari” refers to toxic, narcotic, and psychoactive substances as well as lethal poisons. Plants that are “kepigari” are often bitter (“kepishiri”), painful and (or) pungent (“katsi”), or have an intoxicating odor (“kepigarienka”). The Matsigenka seek out bitter, pungent, and other noxious plants as medicines because their toxic properties are said to hurt, kill, and expel intrusive pathogenic objects, agents, or spirits (Shepard 2004). Matsigenka shamans obtain their special healing and divining powers by consuming psychoactive and other toxic substances.

The Carib-speaking Makushi people live in the north Rupununi region of southwestern Guyana, a biologically diverse mosaic of savannahs, forests, and wetlands located on the northern fringes of Amazonia. Numbering 12 000 people in Guyana, with another 35 000 in Brazil, the Makushi have endured a long and tumultuous history of contact with European colonists. Despite significant socio-cultural and religious transformations, the conceptual system centered on shamanism and the proliferation of spirits (“imawari”) in the living environment remains vibrant, framing processes of cultural change (Daly 2015).

The Makushi are expert horticulturalists and place a high value on the botanical and phytochemical diversity of cultivated plants. The staple crop bitter manioc (“kîse”) is a keystone species that holds the dual status of life-giving foodstuff and cyanide-containing poison. As the Chief of Yupukari village told Daly, with palpable passion, “We are scientists! Did you know that? We turn poison into food!” The concept of poison (“kawi”) is also central to Makushi cosmology and shamanism. Poisonous plants

Fig. 2. The more painful the tobacco, the more powerful the shaman. [Colour online.]



and venomous creatures such as ants, spiders, and snakes are important in origin myths (“panton”). Snakes (“kii”) are closely tied to the mythical origins of poisonous plants. Shamanic ritual centers around the use of toxic, emetic, and bitter plants, and shamans are intimately associated with the anaconda (“tinki”), considered the most dangerous snake of all.

Much of the Makushi pharmacopoeia expresses a substance-based logic, whereby potent or otherwise powerful substances flow between plant and human bodies. Plant medicines are ingested as tea-like infusions, bathed on the body, rubbed into the skin, or dripped into the eyes, and the curative power of plants depends on these substance transfers. Many medicinal plants are toxic, poisonous, irritating, astringent, or bitter (“mai”), and their efficacy or strength (“merunti”) resides in these extreme chemosensory reactions. Chemosensory properties, in turn, are entangled with the personhood of plants.

The Makushi consider plants to be persons (“pemon”) and shamanic plants are especially powerful persons. Certain food crops like manioc are considered to be children (“imun”) of their gardener “mothers”, and appear in myths as familial characters, an example of what Raramuri ethnobotanist Enrique Salmón has termed “kin-centric ecology” (Salmón 2000). Shamanic plant-charms are more ambiguous, considered either helper spirits or dangerous enemies depending on one’s point of view. Plant-charms constitute primary tools and allies of shamans (“pia’san”) as well as sorcerers (“kanaimà”). Certain particularly powerful plants are considered “plant-shamans” in their own right, botanical equivalents of their human counterparts.

Personhood is determined by possession of a vital essence (“ekaton”), which literally means that which brings life to things but is typically translated as soul, a concept thus integrating plants, animals, and humans into a unified cosmic web. The soul “infuses” the substance or body (“esak”) of the plant with specific sensory properties that transmit curative or toxic powers. Makushi

shamanic training involves the consumption of potent plant substances, notably tobacco (“kawai”), taken in copious quantities, either smoked or taken nasally as a viscous liquid known as “pia-juice” (shaman-juice). The shaman becomes a master (“esak”, the same word for body) of plants, such that the person’s body becomes infused with plant substances and subjectivity (Daly 2015; Daly and Shepard 2019).

For the Matsigenka, some, but not all plants, are people. As noted in the introduction, Matsigenka grammar treats most plants as inanimate beings, with exceptions for latex-containing plants, plants that were mythological persons, and toxic or psychoactive plants imbued with spirit “masters” or “owners” (Shepard 2018). The Matsigenka word for soul or spirit, “suretsi”, can also refer to the heartwood of a tree or the pith of an herbaceous plant without necessarily implying a human-like essence. Similar to the Makushi concept, “suretsi” also refers to the pharmacological principles of medicinal, toxic, and psychoactive plants as manifest through specific sensory properties. When a plant is heated in water, its soul contaminates or infuses (“okitsitinkake”) the herbal brew with these properties, which in turn infuse the patient’s or healer’s body.

The Matsigenka, like the Makushi, consider tobacco as fundamental to shamanism. Indeed, tobacco and shamanism are synonymous in Matsigenka: the shaman is “seripigari” (meaning the one intoxicated by tobacco) (Baer 1992). The spiritual power of tobacco is judged by how painful (“katsi”) it is: the more painful the tobacco, the more powerful the shaman who prepared it (Fig. 2). Apprentice shamans receive their special shaman’s soul (also “suretsi”) by ingesting a wad of extremely bitter tobacco quid (“opatsa seri”) that has been first swallowed and regurgitated by a master shaman. This shaman’s soul is conceived of as Brother (“Ige”), a spirit twin living in the parallel invisible world of the spirits who switches places with his human counterpart during shamanic rituals involving psychoactive plants

(Shepard 1998). The tobacco-soul is also referred to as a “seed” (“okitsoki”) that the master shaman “sows” (“ipankitakero”) in an apprentice’s body (ibid.), a further instance of shamanic plant symbolism.

For both the Makushi and Matsigenka, shamans might be described as part plant, owing to their copious ingestion of powerful plant agents. Such human–plant substantiality permeates Amazonian shamanism. The Matsigenka and other Indigenous Peoples of western Amazonia consume the hallucinogenic plant brew ayahuasca, consisting of *Banisteriopsis caapi* and *Psychotria* species among other plant admixtures. Ayahuasca is conceived as a “plant teacher” that imparts knowledge directly to the apprentice shaman (see Luna 1984). Just as shamans can be part plant, plants too can be shamans themselves, capable of teaching, transforming, and healing their human apprentices and allies.

The routine use of medicinal and charm plants by non-shamans also involves the exchange of substances and subjectivities with botanical beings. One fourth of the Matsigenka pharmacopeia consist of plants used to improve men’s aim and hunting skill (Shepard 2002). A man loses his aim (“kovintsari”) when he violates behavioral, dietary, and sexual taboos: allowing wounded animals to die in the forest, eating spoiled or improperly cooked meat, eating the brain or head-meat of an animal he has killed, having sex the night before a hunt, or having any contact with menstrual blood. When a man violates these norms, his body begins to reek with carrion odor (“anigarienka”) associated with the spirit of the vulture, which offends the game animal masters who proceed to hide the animals from the man so he won’t “waste their bounty”.

Hunting medicines include purgative, emetic, and psychoactive plants that physically rid hunters’ bodies of the rotten odor associated with ritual impurities while opening channels of spiritual communication with game animal masters. Purgative preparations, including the toasted seeds of a highly caustic *Dieffenbachia* species (Araceae), rid the hunter of spiritual and bodily impurities through violent bouts of diarrhea. Matsigenka hunters also apply the painful (“katsi”) leaf juice of numerous plant species (mostly Rubiaceae) to their eyes to clarify vision and replace the carrion-smelling vulture soul with the sharp-eyed harpy eagle (Shepard 2002). The eye-drops cause intense stinging as the soul of the plant infuses the man’s eyes, head, torso, arms, and hands, as well as his bow and arrow.

Such substance transfer can also work in reverse when human body substances are applied to plant tissue. When the Makushi fall ill from a curse (“taren”), they may place a few drops of their own blood into a hole made in the stem of an omen plant (“paani”), such as *Dieffenbachia*, causing the enemy shaman to be revealed in a dream. The clairvoyant capacity of the plant is related to its caustic properties. Among the

Fig. 3. The Makushi category of charm plants (“bina”) revealed unexpected synergies between their phytochemistry and the phenomena of shamanism (“pia”) and necromancy (“kanaima”). [Colour online.]



Matsigenka, a similar procedure involves putting hair, clothing, dirt from a footprint, or other personal possessions of a victim into contact with the caustic sap of *Dieffenbachia* or *Hura crepitans* to inflict an inflammatory sorcery illness.

Our collaborative investigation of Makushi charm plants (“bina”; Fig. 3) revealed unexpected synergies between their phytochemistry and the phenomena of shamanism (“pia”) and necromancy (“kanaima”). Makushi shamans and necromancers alike gain power by absorbing invisible, crystalline darts, known as “waawī”, from “bina” charm plants. Many “bina” plants belong (like the *Dieffenbachia* species noted above) to the Araceae, whose tissue, curiously, contains high concentrations of microscopic, needle-like crystals of calcium oxalate. Known as raphides, these sharp crystals puncture the skin, facilitating the passage of other toxins and causing severe inflammation of the soft tissues and mucus membranes, an important symptom of “kanaima” sorcery. While other anthropologists have studied the social, bodily, and historical symbolism of Makushi shamanism, sorcery, and necromancy (Colson 2001; Whitehead 2002), we were the first to point out the metaphorical and literal associations of raphide phytochemistry with these concepts (Daly and Shepard 2019). This example highlights the defining role of phytochemistry, chemosensation, and native substance logics in some cosmological concepts, and illustrates the power of phytoethnography in addressing the agency of shamanic and medicinal plants in their full biocultural richness.

Plants are sophisticated communicators, transmitting information to each other and to the animal world via visual and taste signals, scents, hormones, and biochemical impulses (Witzany 2008). The most important chemical compounds in animal–plant interactions, alkaloids, polyphenols, and terpenoids, are “messenger molecules”

whose primary function appears to be, not chemical defense, as was long thought, but rather transmitting information across cell membranes (Gottlieb and Borin 2005). According to Trewavas (2003, p. 3), “the set of molecules used in the transduction of biochemical signals is totally similar between nerve cells [of animals] and plant cells”. In other words, bioactive compounds produced by plants (including shamanic and medicinal substances of plant origin) feed a kind of biospheric nervous system, transmitting information within and between plant cells, among different organisms, and into the biospheric level (Shepard 2018). Recent scientific research suggests that plants have sui generis forms of intelligence (Trewavas 2016), echoing Indigenous concepts about the notion of “plant teachers” in Amazonian shamanism (Luna 1984).

Plants live in intimate symbiotic associations with fungi, forming vast underground communication networks that shape the character of entire forest landscapes (Tsing 2015). Large-scale deforestation disrupts this complex ecosystem of communication between plants, animals, fungi, and the biosphere, leading to climatic disturbances on a continental and even global scale (Lovejoy and Nobre 2018). Indigenous People have their own theories about the substance transfers and spiritual pathologies connecting environmental devastation, climatic instability, cosmological imbalances, and epidemic illnesses (Kopenawa and Albert 2014; Lagrou 2020). Indigenous Peoples are increasingly seen as key allies in the defense of tropical forests (Chapin 2004; Stevens et al. 2014), and their lands serve as effective barriers against deforestation (Nepstad et al. 2006).

Multinatural landscapes of Amazonia

How do wider forest landscapes in Amazonia intersect with Indigenous conceptions about non-human personhood? Virtanen and Saunaluoma (2017) have argued that extensive geoglyphs (ancient earthworks recently made visible by deforestation) in the Brazilian state of Acre might represent an extension of Indigenous Amazonian practices of body ornamentation: these forest landscapes may have been marked as social bodies amplified to the macroscale. Like human and plant bodies, forest landscapes are permeated by substance flows and transformations among biological and spiritual beings. As in our discussion of plant teachers and messenger molecules, the multiscale quality of these interactions may give them a fractal character, with patterns repeating at varying scales from individual human and plant bodies to the biospheric and cosmological level.

Drawing on a perspectival understanding of Amazonian metaphysics, Viveiros de Castro (2004a) has described the “multinatural” character of Indigenous Amazonian ontologies. In the Western philosophical tradition, the biological body is seen as a universal structure on which human cultural variations alternate superficially, like costume changes: a “multicultural” ontology. According to Amerindian concepts, by contrast, many living beings are fundamentally human, sharing a universal human culture. It is

the “natural” biological form — the body, defined according to predatory relations and cosmological perspective — that varies: to wit, a “multinatural” ontology. In contrast to the Western scientific viewpoint, which postulates a single, all-encompassing universal “natural world”, multinaturalism implies multiple, variable, perspectival natures that are determined by the unique lifeways of different animal and plant species and human cultural groups. In this sense, Viveiros de Castro and other authors involved in the so-called “ontological turn” (Kohn 2015) apply insights from ethnographic investigations of non-Western cultures towards a deep-reaching ontological critique of Western metaphysics.

The nature–culture dichotomy is a fundamental axiom of Western science and philosophy, dating back to the Enlightenment era and beyond (Descola 2013). Mind–body dualism, asserted in the notorious Cartesian “*cogito, ergo sum*”, is the foundation for what Latour (1993, p. 12) refers to as “the Great Divide” between the human (Culture) and non-human (Nature) realms that characterizes modern Western thought. In contrast, Indigenous conceptual systems and attendant lifeworlds are predicated upon a more fluid ontology that incorporates “natures” and “cultures” into an integrated, relational whole. And yet, by inverting the nature–culture dichotomy and swapping “multiculturalism” with “multinaturalism”, Viveiros de Castro appears to have recreated the problematic Cartesian divide from the other side of the looking glass, as it were (Shepard 2018, p. 78). The entanglements of biochemistry with cosmology implicit in Matsigenka hunting medicines and Makushi necromancy defy Cartesian dualism and the disciplinary boundaries between anthropology and botanical science.

In our comparative examination of Indigenous Amazonian plant medicines and shamanism, we were both struck by the crucial role of phytochemical substances and their associated chemosensory properties in mediating deeply entangled ontological conceptions about body, soul, and personhood. Viveiros de Castro (2004b, p. 8) warns about the dangers of “silencing the Other by presuming a univocity — the essential similarity — between what the Other and We are saying”. Especially within the discipline of ethnobiology, with its comparative methods and intercultural dialogue between Indigenous and biological ways of knowing (see Berlin 1992; Hunn 2006), it is important not to reduce or misconstrue Indigenous concepts to match those of the dominant scientific epistemology (Furlan et al. 2020). And yet, treating Indigenous cosmologies as abstract metaphysical systems severed from the living, murmuring, pungent, rank, cacophonous multitude of species involved in all that relating and predating and transforming is to engage in a different form of “silencing”. We reiterate the point we made in the introduction: the challenges of a truly multispecies “anthropology beyond the human” are

methodological as well as theoretical; biochemical as well as metaphysical.

When moving from the scale of individual plant medicines to the anthropogenic forest landscapes that surround many Indigenous communities, we also argue that the quantitative methods of floristic community analysis and historical ecology, as much as ethnography and cosmology, are essential to understanding human–plant interactions. Just as Indigenous conceptions about botanical substance sharing and plant personhood subvert the Cartesian dichotomies of mind–body and matter–spirit, so do Indigenous agroforestry practices — resulting in measurable alterations of entire forest landscapes without disrupting otherwise “natural” ecological functions and biodiversity — challenge traditional scientific as well as anthropological understandings of the Nature–Culture divide. As a case in point, studies of Matsigenka ecological knowledge have revealed a richly detailed system of habitat classification based on geomorphological features, flooding regimes, soil types, human disturbance histories, and indicator species that are, in turn, inextricably linked with mythical places, cosmological beings, oral histories, seasonal cycles of resource use, and a collective sense of territorial identity (Shepard and Chicchon 2001).

The engagement of Indigenous peoples with the Amazonian botanical universe is part of a long cultural history, until recently underappreciated, of management, modification, and domestication (Shepard and Ramirez 2011; Clement et al. 2015; Levis et al. 2017; Franco-Moraes et al. 2019). As Hornborg (2001, p. 127) notes, “Amazonia provides us with remarkable evidence for the extent to which human, cultural behaviour can be constitutive of ecosystems”. Due to the presence of vast expanses of intact and apparently untouched forests in the Amazon when European settlers and explorers first arrived, a persistent, but largely misguided presumption emerged that much of pre-colonial Amazonia was uninhabited or was little impacted by Indigenous People: what Denevan (1992) dubbed the “pristine myth”. According to the predominant 20th century archeological theories about Amazonian cultural history, ancient Indigenous societies would have been mostly semi-nomadic hunters or itinerant farmers surviving within a challenging and nutrient-poor ecosystem, leaving few lasting traces in the landscape (Meggers 1971).

It is now clear that vast tracts of “pristine” Amazonia are in fact anthropogenic. More recent archeological research has revealed densely settled societies in some regions that altered the landscape through earthworks, soil enrichment, and agroforestry management (Erickson 2006; Heckenberger et al. 2008), resulting in lasting changes in floristic composition (Levis et al. 2017). These processes increased the productivity of forests for human needs and, therefore, represent a form of landscape domestication (Clement et al. 2015). Likewise, ethnographic research by historical ecologists has

demonstrated that landscape transformations by contemporary Indigenous Peoples are widespread across the Amazon basin (Posey 1985; Balée 1994; Rival 2006; Kawa 2016). These new insights and discoveries from archeology and historical ecology have revolutionized our understandings of human history in South America, overturning orthodox models of cultural evolution and environmental history focused on the centrality of agriculture (Shepard et al. 2020). Amazonian food production and environmental management reveals cultivation without domestication and domestication without agriculture, a syndrome that has been referred to as “counter-domestication” (Aparício 2019, p. 108) or “anti-domestication” (Carneiro da Cunha 2019). It was high mortality from exotic diseases brought by Europeans, more than any inherent ecological factor, that led to the perception of the Amazon as a largely uninhabited and “pristine” environment (Clement 1999).

Recent studies have pointed to persistent floristic legacies left by the management practices of pre-colonial and historical Indigenous Peoples (Shepard and Ramirez 2011; Lins et al. 2015; Franco-Moraes et al. 2019; Levis et al. 2017). Amazonian Indigenous Peoples invested their domestication efforts both in domesticated species in gardens as well as wild populations of plants in actively managed agroforests (Clement et al. 2015). The result was the transformation of many Amazonian landscapes into human-influenced spaces that appeared “natural” to the eyes of the colonizer, but that in fact are cultural in origin. These cultural or “ancestral” forests (Franco-Moraes et al. 2019) represent social spaces domesticated (in the sense of Clement et al. 2015) for human purposes without excluding the multitude of other species, thus maintaining their ecological functions largely intact.

Juliano Franco-Moraes, one of Shepard’s graduate students, analyzed soil features and floristic composition of interfluvial forests located in the Içana River basin, northwestern Amazonia, traditional territory of the Baniwa people (Franco-Moraes et al. 2019). Prior remote sensing and climate studies predicted that this region was unlikely to bear lasting imprints of ancient human habitation (Bush et al. 2015). However, working with the Baniwa people to locate ancient village sites, abandoned centuries ago, Franco-Moraes was able to identify “ancestral forests” with as much as 57% of the tree biomass composed of fruit trees managed by the Baniwa, compared to only 10% of such species in old-growth forests with no memory of management or habitation in Baniwa oral tradition. Baniwa management also appears to have improved soil fertility in this acidic, sandy region through the addition of charcoal. Yet structural analysis of ancestral forests reveals them to be nearly indistinguishable from old-growth forests with no memory of Baniwa habitation: to an ecologist or botanist, they would appear to be “natural” and pristine. If anything, these cultural forests have slightly greater forest biomass and more evenly distributed

biodiversity than comparable old-growth forests, owing to increased soil fertility resulting from past Baniwa management. Participatory mapping and direct observations revealed ancestral forests to be widely distributed throughout the region, whereas old-growth forests are rare.

It is in this sense that we propose to reinterpret Viveiros de Castro's (2004a) essentially metaphysical conception of "multinaturalism" as a tangible, concrete property of anthropogenic forest landscapes in Amazonia. Domesticated forests in the Amazon are not the pristine, "natural" environments perceived by early naturalists, and some ecologists and conservationists to this day; rather, they are cultural spaces, built by centuries-long management and domestication processes of Indigenous Peoples (Levis et al. 2017). Such processes of landscape domestication also highlight the unique features of lowland South American farming and agroforestry, which have overturned orthodox archeological theories about agriculture and human cultural evolution (Shepard et al. 2020).

Juliana Lins, also a student of Shepard's, brings an additional nuance to the multinatural approach to Indigenous landscape domestication. Her floristic studies of anthropogenic dark earth sites on culturally distinctive archaeological horizons in the central Amazon reveal measurably different floristic compositions of spontaneous plant species native to Amazonia (Lins et al. 2015). Even when controlling for soil characteristics, distance, and other ecological features, the factor that correlated most strongly with site-to-site variation in floristic composition was the ancient cultural context, even though these archeological sites were abandoned as much as a millennium ago. In other words, cultural diversity in the distant past, acting through variable social habits, management practices, and food preferences, was capable of leaving behind distinctive botanical signatures in the landscape that have persisted for centuries. The multinatural paradigm is manifest, not only in cosmological terms, but also in the lived physical world: different cultures have created measurably different "natures". When introduced species are included in the floristic analysis, however, the statistically significant differences in species composition vanish: a floristic analog of the homogenization and outright annihilation of the diverse, multinatural processes, and lifeways of Indigenous Peoples that were overwhelmed by European colonization.

Despite being social and humanized spaces, which vary according to the preferences and cultural habits of the different peoples who domesticated them, such cultural forests preserve the ecosystem services necessary for maintaining Amazonian biodiversity. Within these "multinatural landscapes", each human group, and each biological species, contributes to the construction of its niche or "domus" according to its position — its multinatural perspective — in a complex social, ecological, and cosmological web composed of multiple species, forces,

and beings. The multinatural perspective also helps de-center the anthropocentric viewpoint by incorporating Indigenous understandings of forest landscapes that are "owned" or "planted" by different non-human beings (de Oliveira 2016), thus contributing a diversity of multinatural interventions and relations.

While the concept of multinaturalism comes from anthropological theory, its application to landscape-scale phenomena, in their full, multispecies, relational character, requires the use of ethnobotanical, ecological, and historical as well as ethnographic methods, in an intense collaboration between the human and natural sciences and local knowledge systems. In this way, multinaturalism brings Indigenous ontologies, predicated on other-than-human personhood and trans-specific relationality, into dialogue with parallel scientific understandings. This synthesis can be applied to phenomena ranging across multiple scales from the micro (e.g., particular human-plant engagements in specific ethnographic contexts) to the macro (e.g., the dynamics of the rainforest biosphere at large).

Conclusion

"Schultes grappled with the unsettling clash between the cosmology of his Amazonian informants and that of his own modern science, a world view that prevented him from understanding the plants on the Amazonians' own terms" (Sheldrake 2020, p. 365).

Relatively late in his long and productive career, ethnobotanist Richard Evans Schultes became intrigued by what he described as the "enigma" of how Indigenous Amazonian people could identify and distinguish closely related botanical varieties of certain wild plants, consistently and at a distance, that he himself was unable to differentiate using all the tools of taxonomic science (Schultes 1986). In his recent discussion of "Schultes' dilemma", Merlin Sheldrake draws on Viveiros de Castro's (2002, 2004a) work to reflect on the epistemological and ontological chasm between Indigenous and scientific ways of knowing: "In proposing that what is 'natural' for us may be 'cultural' to Amazonians, [Viveiros de Castro's] perspectival multinaturalism suggests that people differ in their nature as well as their culture. The very basis of reality is at stake" (Sheldrake 2020, p. 364).

In a similar vein, Furlan et al. (2020) draw on Viveiros de Castro's (2004b) conception of "controlled equivocation" — a playful parody on the "method of controlled comparison" in 20th century ethnography — as a tool for enriching the field of ethnobiology. Both Sheldrake (2020) and Furlan et al. (2020) call for a more symmetrical dialogue between Indigenous and scientific viewpoints, while highlighting the possibility of epistemic and ontological incommensurability. Given the political, economic, and power relations inherent in encounters between the knowledge systems of Indigenous Peoples and European colonist-settlers, it is only right that this dialogue should reverse historical asymmetries. Yet, by insisting that the dialogue begin with

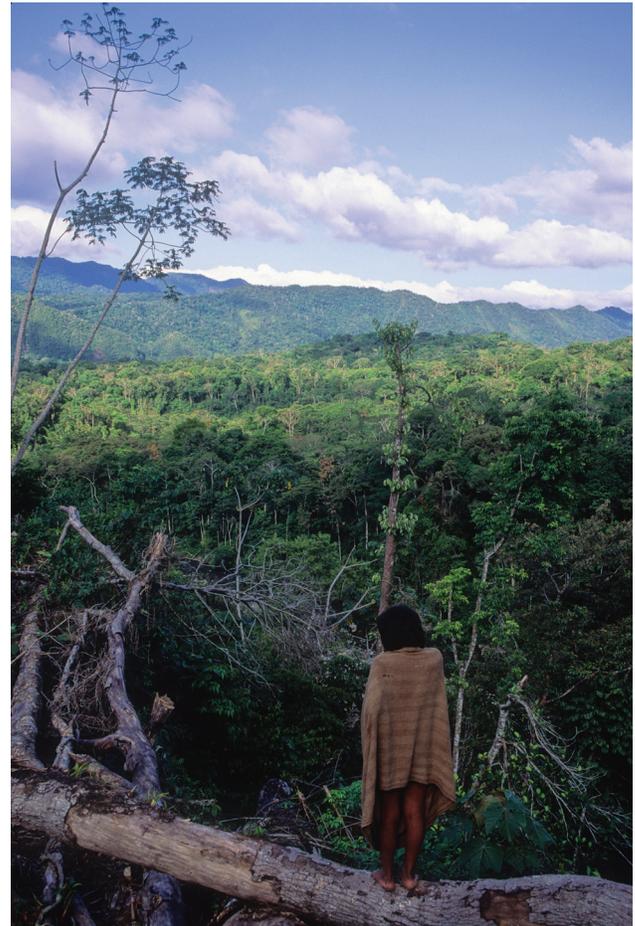
botanists and ethnobiologists becoming more familiar with anthropological theories about Indigenous Amazonian peoples, neither author considers the reverse possibility: that anthropology in Amazonia could be enriched by botanical and ethnobiological methods and theories.

In considering Schultes' perplexity at how Amazonian Indigenous People could identify certain "wild" plant varieties from a distance, [Sheldrake \(2020, p. 351\)](#) notes, "If particular plant individuals were cultivated and already known to the local inhabitants, this would not be extraordinary". And yet, as pointed out above, the process of domestication in the Amazon can be entirely independent from cultivation and the Old World agricultural paradigm. As the methods of historical ecology have revealed for important plant species like Brazil nut ([Shepard and Ramirez 2011](#)) and many others ([Levis et al. 2017](#); [Franco-Moraes et al. 2019](#)), the distinction between wild and cultivated plants in Amazonia is not always clear cut, and the very concept of domestication has to be rethought at the level of entire landscapes, rather than just cultivated fields ([Clement et al. 2015](#)).

As [Sheldrake \(2020, p. 365\)](#) himself observes, "It is precisely the lack of clear knowledge about the nature of the actors, *both plant and human*, that form the subject matter of the enigma" (emphasis added). If anthropology can contribute to understanding the nature of plant actors, why couldn't botany also contribute to understanding the human actors? Indigenous Peoples have incorporated ecological realities like predation into the heart of their cosmological conceptions ([Reichel-Dolmatoff 1976](#); [Århem 1996](#)). Emerging scientific understandings of phytochemical communication, biosemiotics, and plant intelligence also seem to have synergies in certain Indigenous concepts ([Daly and Shepard 2019](#)). While it is important not to conflate Indigenous and Western philosophical notions, especially in ways that erase, misconstrue, or "equivocate" the former ([Viveiros de Castro 2004b](#)), perhaps the two are not so utterly incommensurable as they might seem at first glance. Indeed, Schultes and many other ethnobotanists throughout the history of the discipline have been consistently impressed with the detail and sophistication of Indigenous knowledge about plants and other elements of the landscape, often surpassing the knowledge of scientific botanists not to mention anthropologists (see [Shepard et al. 2001](#)). If Schultes' enigma is a "postcard from the limits" of ethnobotany (*ibid.*, 365), it is also a postcard from the limits of cultural anthropology.

The challenges faced by so-called "multispecific ethnography" ([Kirksey and Helmreich 2010](#)), or what we have described here as "multinatural landscape ecology", are theoretical as well as methodological. How can ethnographic research be carried out with botanical partners? Ethnographic and ethnobiological theory can enrich one another in a truly interdisciplinary dialogue. Although they are a step in the right direction, recent

Fig. 4. The socio-environmental processes that create "cultural forests" in Amazonia run in both directions, creating a kind of "forested" human culture. [Colour online.]



contributions such as those by [Sheldrake \(2020\)](#) and [Furlan et al. \(2020\)](#) feel more like a one-sided harangue. People-plant relationships are intrinsically sensory and often mediated by chemosensory experiences related to specific phytochemical compounds ([Shepard 2004](#); [Daly and Shepard 2019](#)). Biosemiotics and emerging scientific understandings of "plant intelligence" reveal unexpected synergies with shamanic concepts ([Shepard 2018](#); [Daly and Shepard 2019](#)). Moving from the level of individual human-plant interactions to the landscape scale, several recent studies have documented how the lifeways of Amazonian peoples give rise to mature forest environments that are as much the product of cultural as of natural forces. The socio-environmental processes that create "cultural forests" in Amazonia run in both directions, creating a kind of "forested" human culture ([Franco-Moraes et al. 2019](#)), as revealed in the fundamental role of biodiversity and ecological concepts in Amazonian cosmology ([Fig. 4](#)). These multispecies and multinatural forest landscapes have been managed and used by humans for centuries without excluding the multitude of other species and ecological

processes that make the region crucial to conservation and global climate stability.

Here, we have synthesized the results from these diverse research enterprises to suggest a methodological outline for further research in phytoethnography and multinational landscape ecology. Methods from the human sciences, including linguistics and archeology as well as cultural anthropology, are of course fundamental to this endeavor. However, scientific results of botanical, phytochemical, ecological, and even atmospheric studies can sometimes yield unexpected insights into the deep and complex engagements of Indigenous Peoples with tropical plants and forests (Daly and Shepard 2019). This multidirectional and intercultural dialogue is especially important in the collaborative research arrangements between Indigenous Peoples, scientists, and anthropologists that have been implemented in different parts of Amazonia (Shepard et al. 2001; Carneiro da Cunha et al. 2002; Hutukara Association 2015). Such transdisciplinary dialogue is essential to documenting, and ultimately maintaining, the increasingly threatened cultural forests and multinational landscapes that safeguard global biodiversity and climate stability.

Epilogue

As I chatted with Romulo about plant-persons and non-human intentions on that hot afternoon in 2014, I was reminded of my first encounter with what might be called a “multinatural equivocation” many years before during my first fieldwork expedition to Tayakome in 1987. Romulo’s son-in-law had pursued a herd of white-lipped peccaries and killed several with his arrows and sent back word for help carrying them to Romulo’s hamlet. I went with Romulo and a few other relatives to haul the heavy carcasses from the distant kill site. Being slower than the rest, I was the last to pass through the recently felled swidden by Romulo’s house. High in the wall of forest along the swidden’s edge, I caught sight of a troupe of six or seven spider monkeys vocalizing and swinging among the tree branches. I dropped the gutted peccary and ran to Romulo’s house.

“Uncle Romulo, grab your arrows, there are spider monkeys by your garden!”

Romulo laughed:

“No, those are pets! No one hunts them! My son-in-law killed their mothers long ago and my daughter raised them like babies. When they grew up, they went back to the forest, but they return sometimes to visit. They call out to us from the garden just the way visitors call from a distance to let us know they are arriving”.

“They’re just like people! Their hands, just like humans. The way they grab tree branches, the way they hold their hands out to ask for food. So we don’t bother them. They call their friends from the distant forest for us to hunt, and they plant *Pouteria* seeds for us to eat, just like we plant our gardens”.

Acknowledgements

We thank the editors of this special issue, Alain Cuerrier, John Arnason, and Myron Smith, for the kind invitation to participate in a rich interdisciplinary dialogue. We greatly appreciated the detailed comments and suggestions for revisions and expansion provided by two anonymous reviewers, which substantially improved the final manuscript. Shepard acknowledges funding from the Wenner-Gren Foundation, the National Science Foundation, the Leverhulme Foundation, and the Brazilian Research Council (CNPq Proc. 312037/2018-0) throughout different phases of research and writing, and thanks the Manu National Park administration and Peru’s National Protected Areas service (SERNANP) for research authorization and support. He also thanks Nancy Santullo of Rainforest Flow (rainforestflow.org) for supporting research travel and much needed health interventions for Indigenous communities in Manu. Daly acknowledges funding and support from the Economic and Social Research Council (ESRC) (grant reference number: ES/I903887/1), the Royal Anthropological Institute, and the Association of Social Anthropologists of the United Kingdom, and thanks Guyana’s Ministry of Amerindian Affairs and Environmental Protection Agency. Finally, we express our deep thanks to the Matsigenka people of Tayakome and Yomibato and the Makushi people of Yupukari and Rewa for their friendship, collaboration, and generosity.

References

- Aparício, M. 2019. A planta da raiva. Timbó e envenenamento nos Suruwaha do Purus. In *O Uso das Plantas Psicoativas nas Américas*. Gramma/NEIP. Edited by B.C. Labate and S.D. Goulart. São Paulo. pp. 107–124.
- Århem, K. 1996. The cosmic food web: Human-nature relatedness in the Northwest Amazon. In *Nature and Society: Anthropological Perspectives*. Edited by P. Descola and G. Pálsson. Routledge, London and New York, pp. 185–204.
- Baer, G. 1992. The one intoxicated by tobacco: Matsigenka shamanism. In *Portals of Power: Shamanism in South America*. Edited by J. Matteson-Langdon and G. Baer. University of New Mexico Press, Albuquerque. pp. 79–100.
- Balée, W. 1989. The culture of Amazonian forests. In *Resource management in Amazonia: Indigenous and folk strategies*. Edited by D.A. Posey and W. Balée. New York Botanical Gardens, New York. pp. 1–21.
- Balée, W. 1994. Footprints of the forest—Ka’apor Ethnobotany: The historical ecology of plant utilization by an Amazonian people. Columbia University Press, New York.
- Berlin, B. 1992. Ethnobiological classification: Principles of categorization of plants and animals in traditional societies. Princeton University Press, Princeton.
- Brett, J. 1998. Medicinal plant selection criteria: The cultural interpretation of chemical senses. *J. Appl. Bot.* 72: 70–74.
- Browner, C.H., Ortiz de Montellano, B.R., and Rubel, A.J. 1988. A methodology for cross-cultural ethnomedical research. *Curr. Anthropol.* 29: 13–32.
- Bush, M.B., McMichael, C.H., Piperno, D.R., Silman, M.R., Barlow, J., Peres, C.A., et al. 2015. Anthropogenic influence on Amazonian forests in pre-history: An ecological perspective. *J. Biogeogr.* 42: 2277–2288. doi:10.1111/jbi.12638.

- Carneiro da Cunha, M. 2017. Traditional people, collectors of diversity. In M. Brightman & J. Lewis (Eds.), *The anthropology of sustainability: beyond development and progress* (pp. 257–272). London: Palgrave MacMillan.
- Carneiro da Cunha, M. 2019. Antidomestication in the Amazon: Swidden and its foes. *HAU: J. Ethnogr. Theory*, **9**: 126–136. doi:10.1086/703870.
- Carneiro da Cunha, M., Almeida, M., and Barbosa de, M. 2002. *Enciclopédia da Floresta: O Alto Juruá: Práticas e conhecimentos das populações*. Companhia das Letras, São Paulo.
- Chapin, M. 2004. A challenge to conservationists. *World Watch*, **17**(6): 17–31.
- Clement, C.R. 1999. 1492 and the loss of Amazonian crop genetic resources. I. The relation between domestication and human population decline. *Economic Botany*, **53**(2): 188–202. doi:10.1007/BF02866498.
- Clement, C.R., Denevan, W.M., Heckenberger, M.J., Junqueira, A.B., Neves, E.G., Teixeira, W.G., and Woods, W.I. 2015. The domestication of Amazonia before European conquest. *Proc. R. Soc. B Biol. Sci.* **282**(1812): 20150813. doi:10.1098/rspb.2015.0813. PMID: 26202998.
- Colson, A.B. 2001. Itoto (kanaima) as death and anti-structure. In *Beyond the visible and the material: the Amerindianization of society in the work of Peter Rivière*. Edited by L. Rival and N. Whitehead. Oxford University Press, Oxford. pp. 221–233.
- Daly, L. 2015. The symbiosis of people and plants: Ecological engagements among the Makuxi Amerindians of Amazonian Guyana. Ph.D. Dissertation, Department of Anthropology, University of Oxford, Oxford, U.K.
- Daly, L. 2019. The nature of sweetness: An indigenous fermentation complex in Amazonian Guyana. In *Alcohol and humans: a long and social history*. Edited by K. Hockings and R. Dunbar. Oxford University Press, Oxford.
- Daly, L. 2021. Cassava spirit and the seed of history: On garden cosmology in indigenous Amazonia. *Anthropol. Forum*. [In press.] doi:10.1080/00664677.2021.1994918.
- Daly, L., and Shepard, G.H., Jr. 2019. Magic darts and messenger molecules: Toward a phytoethnography of human-plant engagements in Amazonia. *Anthropol. Today*, **35**: 13–17. doi:10.1111/1467-8322.12494.
- Denevan, W. 1992. The pristine myth: The landscape of the Americas in 1492. *Ann. Assoc. Am. Geogr.* **82**(3): 369–385. doi:10.1111/j.1467-8306.1992.tb01965.x.
- de Oliveira, J.C. 2016. *Mundos de roças e florestas*. Bol. Mus. Para. Emílio Goeldi. Ciênc. Hum. **11**(1): 115–131. doi:10.1590/1981.81222016000100007.
- de Oliveira, J.C., Amoroso, M., Morim de Lima, A.G., Shiratori, K., Marras, S., and Emperaire, L. (Editors). 2020. *Vozes Vegetais: Diversidade, resistências e histórias da floresta*. Ubu Editora, São Paulo.
- Descola, P. 1994. *In the society of nature: A native ecology in Amazonia*. University of Cambridge Press, Cambridge.
- Descola, P. 2013. *Beyond nature and culture*. Translated by J. Lloyd. University of Chicago Press, Chicago.
- Erickson, C.L. 2006. The domesticated landscapes of the Bolivian Amazon. In *Time and complexity in historical ecology*. Edited by W. Balée and C.L. Erickson. Columbia University Press, New York. pp. 235–278.
- Etkin, N.L. 1988. Cultural constructions of efficacy. In *The context of medicines in developing countries*. Edited by S. van der Geest and S.R. Whyte. Kluwer Academic Publishers, Dordrecht. pp. 299–326.
- Fausto, C. 2007. Feasting on people: Eating animals and humans in Amazonia. *Curr. Anthropol.* **48**: 497–530. doi:10.1086/518298.
- Franco-Moraes, J., Baniwa, A.F.M.B., Costa, F.R.C., Lima, H.P., Clement, C.R., and Shepard, G.H., Jr. 2019. Historical landscape domestication in ancestral forests with nutrient-poor soils in northwestern Amazonia. *For. Ecol. Manage.* **446**: 317–330. doi:10.1016/j.foreco.2019.04.020.
- Furlan, V., Jiménez-Escobar, N.D., Zamudio, F., and Medrano, C. 2020. Ethnobiological equivocation' and other misunderstandings in the interpretation of natures. *Stud. Hist. Philos. Sci. Part C Stud. Hist. Philos. Biol. Biomed. Sci.* **84**: 101333. doi:10.1016/j.shpsc.2020.101333.
- Gagliano, M. 2018. *Thus spoke the plant: A remarkable journey of groundbreaking scientific discoveries and personal encounters with plants*. North Atlantic Books, Berkeley, Calif.
- Gottlieb, O.R., and Borin, M.R.de.M.B. 2005. Insights into evolutionary systems via chemobiological data. In *Ethnopharmacology: Encyclopedia of life support systems*. Edited by E. Elisabetsky and N.L. Etkin. UNESCO/Eolss Publishers, Oxford. pp. 25–70.
- Hartigan, J., Jr. 2019. Plants as ethnographic subjects. *Anthropol. Today*, **35**(2): 1–2. doi:10.1111/1467-8322.12491.
- Heckenberger, M.J., Russell, J.C., Fausto, C., Toney, J.R., Schmidt, M.J., Pereira, E., et al. 2008. Pre-Columbian urbanism, anthropogenic landscapes, and the future of the Amazon. *Science*, **321**: 1214–1217. doi:10.1126/science.1159769. PMID:18755979.
- Heckler, S.L., and Zent, S. 2008. Piara manioc varieties: Hyperdiversity or social currency? *Hum. Ecol.* **36**: 679–697. doi:10.1007/s10745-008-9193-2.
- Herd, G.H. 1981. *Guardians of the Flutes: Idioms of masculinity*. McGraw-Hill, New York.
- Hornborg, A. 2001. Vital signs: An ecosemiotic perspective on the human ecology of Amazonia. *Sign Syst. Stud.* **29**: 121–151. doi:10.12697/SSS.2001.29.1.09.
- Hugh-Jones, C. 1980. *From the Milk River: Spatial and temporal processes in northwest Amazonia*. Cambridge University Press, New York.
- Hunn, E. 2006. Meeting of minds: how do we share our appreciation of traditional environmental knowledge? *J. R. Anthropol. Inst.* **12**(S1): S143–S160. doi:10.1111/j.1467-9655.2006.00277.x.
- Hutukara Association. 2015. *Manual of traditional Yanomami remedies*. Hutukara Associação Yanomami, Boa Vista.
- Izquierdo, C., and Shepard, G.H., Jr. 2003. Matsigenka. In *Encyclopedia of medical anthropology: Health and illness in the world's cultures*. Edited by C.R. Ember and M. Ember. Kluwer Academic/Plenum Publishers, New York. pp. 823–837.
- Johns, T. 1990. *With bitter herbs they shall eat: Chemical ecology and the origins of human diet and medicine*. University of Arizona Press, Tucson.
- Johnson, A. 1983. Machiguenga gardens. In *Adaptive responses of Native Amazonians*. Edited by R. Hames and W. Vickers. Academic Press, New York. pp. 29–63.
- Kawa, N.C. 2016. Amazonia in the Anthropocene: People, soils, plants, forests. University of Texas Press, Austin.
- Kawa, N.C. 2021. Plants that keep the bad vibes away: Boundary maintenance and phyto-communicability in urban Amazonia. *Ethnos*, **86**: 228–244. doi:10.1080/00141844.2020.1765830.
- Kirksey, E., and Helmreich, S. 2010. The emergence of multispecies ethnography. *Cult. Anthropol.* **25**: 545–576. doi:10.1111/j.1548-1360.2010.01069.x.
- Kohn, E. 2013. *How forests think: Toward an anthropology beyond the human*. University of California Press, Berkeley.
- Kohn, E. 2015. Anthropology of ontologies. *Annu. Rev. Anthropol.* **44**(1): 311–327. doi:10.1146/annurev-anthro-102214-014127.
- Kopenawa, D., and Albert, B. 2014. *The falling sky: Words of a Yanomami shaman*. Belknap Press of Harvard University, Cambridge.
- Lagrou, E. 2020. Nisun: A vingança do povo morcego e o que ele pode nos ensinar sobre o novo coronavírus, por Els Lagrou. Blog BVPS, 13 April 2020. Available from <https://blogbvps.wordpress.com/2020/04/13/nisun-a-vinganca-do-povo-morcego-e-o-que-ela-pode-nos-ensinar-sobre-o-novo-coronavirus-por-els-lagrou/>.

- Latour, B. 1993. We have never been modern. Harvard University Press, Cambridge.
- Levis, C., Costa, F.R.C., Bongers, F., Peña-Claros, M., Clement, C.R., Junqueira, A.B., et al. 2017. Persistent effects of pre-Columbian plant domestication on Amazonian forest composition. *Science*, **355**: 925–931. doi:10.1126/science.aal0157. PMID:28254935.
- Lévi-Strauss, C. 1966. The savage mind. University of Chicago Press, Chicago.
- Lévi-Strauss, C. 1969. The fugue of the five senses. In *The raw and the cooked: Mythologiques I*. Harper & Row, New York. pp. 147–163.
- Lins, J., Lima, H.P., Baccaro, F.B., Kinupp, V.F., Shepard, G.H., Jr., and Clement, C.R. 2015. Pre-Columbian floristic legacies in modern homegardens of central Amazonia. *PLoS ONE*, **10**: e0127067. doi:10.1371/journal.pone.0127067. PMID:26030879.
- Lovejoy, T.E., and Nobre, C.A. 2018. Amazon tipping point. *Sci. Adv.* **4**(2): eaat2340. doi:10.1126/sciadv.aat2340.
- Luna, L.E. 1984. The concept of plants as teachers among four mesizo shamans of Iquitos, northeastern Peru. *J. Ethnopharmacol.* **11**(2): 135–156. doi:10.1016/0378-8741(84)90036-9. PMID:6492831.
- Meggers, B.J. 1971. Amazonia: Man and culture in a counterfeited paradise. Aldine-Atherton, Chicago.
- Moerman, D.E. 1991. Poisoned apples and honeysuckle: The medicinal plants of Native America. In *The anthropology of medicine*. Edited by L. Romanucci-Ross, D. Moerman, and L.R. Tancredi. Bergin & Garvey, New York.
- Myers, N. 2017. From the anthropocene to the planthropocene: Designing gardens for plant/people involution. *Hist. Anthropol.* **28**: 297–301. doi:10.1080/02757206.2017.1289934.
- Nepstad, D., Schwartzman, S., Bamberger, B., Santilli, M., Ray, D., Schlesinger, P., et al. 2006. Inhibition of Amazon deforestation and fire by parks and indigenous lands. *Conserv. Biol.* **20**: 65–73. doi:10.1111/j.1523-1739.2006.00351.x. PMID:16909660.
- Posey, D.A. 1985. Indigenous management of tropical forest ecosystems: The case of the Kayapó Indians of the Brazilian Amazon. *Agrofor. Syst.* **3**: 139–158. doi:10.1007/BF00122640.
- Rappaport, R.A. 1967. Ritual regulation of environmental relations among a New Guinea people. *Ethnology*, **6**(1): 17–30. doi:10.2307/3772735.
- Reichel-Dolmatoff, G. 1976. Cosmology as ecological analysis: A view from the rain forest. *Man*, **11**(3): 307–318. doi:10.2307/2800273.
- Reichel-Dolmatoff, G. 1981. Brain and mind in Desana shamanism. *J. Lat. Am. Lore*, **7**(1): 73–98.
- Rival, L. 2001. Seed and clone: the symbolic and social significance of bitter manioc cultivation. In *Beyond the visible and the material: The Amerindianization of society in the work of Peter Rivière*. Edited by L. Rival and N.L. Whitehead. Oxford University Press, Oxford, U.K. pp. 57–80.
- Rival, L. 2006. Amazonian historical ecologies. *J. R. Anthropol. Inst.* **12**(S1): S79–S94. doi:10.1111/j.1467-9655.2006.00274.x.
- Rival, L. 2012. Animism and the meanings of life: reflections from Amazonia. In *Animism in rainforest and tundra: Personhood, animals, plants, and things in contemporary Amazonia and Siberia*. Edited by M. Brightman, V.E. Grotti, and O. Ulturgasheva. Berghahn Books, Oxford. pp. 69–81.
- Rivière, P. 1994. WYSINWYG in Amazonia. *J. Anthropol. Soc. Oxford*, **25**(3): 255–262.
- Salmón, E. 2000. Kincentric ecology: Indigenous perceptions of the human-nature relationship. *Ecol. Appl.* **10**(5): 1327–1332. doi:10.2307/2641288.
- Santos-Granero, F. 2012. Beinghood and people-making in native Amazonia: A constructional approach with a perspectival coda. *HAU J. Ethnogr. Theory*, **2**: 181–211. doi:10.14318/hau.2.1.010.
- Schultes, R.E. 1986. Recognition of variability in wild plants by Indians of the Northwest Amazon: An enigma. *Journal of Ethnobiology*, **6**(2): 229–238.
- Schultes, R.E., and Raffauf, R.F. 1990. The healing forest: Medicinal and toxic plants of the northwest Amazon. Dioscorides Press, Portland.
- Schulthies, B. 2021. Phytocommunicability and cross-species sociality. *Ethnos*, **86**(2): 199–206. doi:10.1080/00141844.2020.1765834.
- Seeger, A., Da Matta, R., and Viveiros de Castro, E.B. 2019. The construction of the person in indigenous Brazilian societies. *HAU J. Ethnogr. Theory*, **9**(3): 694–703. doi:10.1086/706805.
- Sheldrake, M. 2020. The ‘enigma’ of Richard Schultes, Amazonian hallucinogenic plants, and the limits of ethnobotany. *Soc. Stud. Sci.* **50**: 345–376. doi:10.1177/0306312720920362. PMID:32375597.
- Shepard, G.H., Jr. 1998. Psychoactive plants and ethnopsychiatric medicines of the Matsigenka. *J. Psychoactive Drugs*, **30**: 321–332. doi:10.1080/02791072.1998.10399708. PMID:9924838.
- Shepard, G.H., Jr. 1999. Shamanism and diversity: A Matsigenka perspective. In *Cultural and spiritual values of biodiversity*. Edited by D.A. Posey. United Nations Environmental Programme and Intermediate Technology Publications, London. pp. 93–95.
- Shepard, G.H., Jr. 2002. Primates in Matsigenka subsistence and worldview. In *Primates face to face: The conservation implications of human and nonhuman primate interconnections*. Edited by A. Fuentes and L. Wolfe. Cambridge University Press, Cambridge, U.K. pp. 101–136.
- Shepard, G.H., Jr. 2004. A sensory ecology of medicinal plant therapy in two Amazonian societies. *Am. Anthropol.* **106**: 252–266. doi:10.1525/aa.2004.106.2.252.
- Shepard, G.H., Jr. 2018. Spirit bodies, plant teachers and messenger molecules in Amazonian shamanism. In *Ethnopharmacologic search for psychoactive drugs II: 50 years of research (1967–2017)*. Edited by D. McKenna, G.T. Prance, B. De Loenen, and W. Davis. Synergetic Press, Santa Fe. pp. 70–81.
- Shepard, G.H., Jr. and Chicchon, A. 2001. Resource use and ecology of the Matsigenka of the eastern slopes of the Cordillera Vilcabamba. In *Biological and Social Assessments of the Cordillera de Vilcabamba, Peru*. Edited by L.E. Alonso, A. Alonso, T.S. Schulenberg and F. Dallmeier. Conservation International, Washington, D.C. pp. 164–174.
- Shepard, G.H., Jr., and Ramirez, H. 2011. “Made in Brazil”: Human dispersal of the Brazil nut (*Bertholletia excelsa*, Lecythidaceae) in ancient Amazonia. *Econ. Bot.* **65**: 44–65. doi:10.1007/s12231-011-9151-6.
- Shepard, G.H., Jr., Yu, D.W., Lizarralde, M., and Italiano, M. 2001. Rainforest habitat classification among the Matsigenka of the Peruvian Amazon. *J. Ethnobiol.* **21**: 1–38.
- Shepard, G.H., Jr., Clement, C.R., Lima, H.P., Mendez, G., de Paula Moraes, C., and Neves, E.G. 2020. Ancient and traditional agriculture in South America: Tropical lowlands. In *Oxford encyclopedia of agriculture and the environment*. Edited by R. Hazlitt. Oxford University Press, Oxford. doi:10.1093/acrefore/9780199389414.013.597.
- Stevens, C., Winterbottom, R., Springer, J., and Reyntar, K. 2014. Securing rights, combating climate change: How strengthening community forest rights mitigates climate change. World Resources Institute, Brighton, U.K.
- Swanson, H.A. 2017. Methods for multispecies anthropology: Thinking with salmon otoliths and scales. *Soc. Anal.* **61**: 81–99. doi:10.3167/sa.2017.610206.
- Trewavas, T. 2003. Aspects of plant intelligence. *Ann. Bot.* **92**: 1–20. doi:10.1093/aob/mcg101. PMID:12740212.
- Trewavas, T. 2016. Plant intelligence: An overview. *Bioscience*, **66**: 542–551. doi:10.1093/biosci/biw048.
- Tsing, A. 2015. The mushroom at the end of the world: On the possibility of life in capitalist ruins. Princeton University Press, Princeton.

- Turner, V. 1967. *The forest of symbols*. Cornell University Press, Ithaca, New York.
- Vilaça, A. 2005. Chronically unstable bodies: reflections on Amazonian corporalities. *J. R. Anthropol. Inst.* **11**: 445–464. doi:10.1111/j.1467-9655.2005.00245.x.
- Virtanen, P.K., and Saunaluoma, S. 2017. Visualization and movement as configurations of human–nonhuman engagements: Precolonial geometric earthwork landscapes of the upper Purus, Brazil. *Am. Anthropol.* **119**: 614–630. doi:10.1111/aman.12923.
- Viveiros de Castro, E. 1996. Os pronomes cosmológicos e o perspectivismo ameríndio. *Mana*, **2**: 115–144. doi:10.1590/S0104-93131996000200005.
- Viveiros de Castro, E. (Editor). 2002. Perspectivismo e multinaturalismo na América indígena. In *A Inconstância da Alma Selvagem e Outros Ensaios de Antropologia*. São Paulo. pp. 347–399. doi:10.1590/S0104-93132003000100015.
- Viveiros de Castro, E. 2004a. The transformation of objects into subjects in Amerindian ontologies. *Common Knowl.* **10**: 463–472. doi:10.1215/0961754X-10-3-463.
- Viveiros de Castro, E. 2004b. *Perspectival anthropology and the method of controlled equivocation*. *Tipiti: J. Soc. Anthropol. Lowland South Am.* **2**(1): 1.
- Whitehead, N. 2002. *Dark Shamans: Kanaimà and the poetics of violent death*. Duke University Press, Durham & London.
- Wilbert, W. 1983. Warao ethnopathology and exotic epidemic disease. *J. Ethnopharmacol.* **8**: 357–361. doi:10.1016/0378-8741(83)90075-2. PMID:6645585.
- Witzany, G. 2008. The biosemiotics of plant communication. *Am. J. Semiot.* **24**: 39–56. doi:10.5840/ajs2008241/34.
- Wright, R.M., and Taylor, B. 2009. The religious lives of Amazonian plants. *J. Study Relig. Nat. Cult.* **3**: 5–8.
- Zent, E. 2005. The hunter-self: Perforations, prescriptions, and primordial beings among the Hodi, Venezuelan Guayana. *Tipiti: J. Soc. Anthropol. Lowland South Am.* **32**: 35–76.
- Zent, E. 2009. “We Come from Trees”: The Poetics of Plants among the Joti of the Venezuelan Guayana. *Journal for the Study of Religion, Nature and Culture.* **3**(1): 9–35.