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Multispecies learning with the Amazon rainforest: thinking with ant gardens[1]

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ABSTRACT

This text germinates from encounters, crossings, and uneasiness with the Amazon. Write with the forest: let yourself be affected by astonishment and enchantment. We sought to think of the forest as a multispecies sympoietic collective, whose entangled relationships create and sustain worlds. The field diary that is interwoven with the text experiments with and cultivates attention to these entangled worlds without reducing their complexity. Questions arise about the encounter with an Ant Garden: a living composition arising from mutualistic relationships between ants and plants. Multispecies relationships write complex, intricate stories situated in space-time. Learning from storytelling, with forests as thinking partners, perhaps helps us *unpredict* the end of the world.

KEYWORDS: Amazon forest. Attentivity. Multispecies relationships. Ant-gardens.

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Aprendizagens multiespécies com a floresta amazônica: pensar com jardins de formigas

RESUMO

Este texto germina a partir de encontros, atravessamentos e inquietações com a Amazônia. Escrever com a floresta: deixar-se afetar pelo assombro e pelo encantamento. Buscou-se pensar a floresta como coletivo simpoiético multiespécie, cujas relações emaranhadas criam e sustentam mundos. O diário de campo que se entrelaça ao texto experimenta e cultiva a atenção para esses mundos emaranhados, sem reduzir sua complexidade. Abrem-se questões acerca do encontro com um Jardim de Formigas: uma composição viva que se dá a partir de relações mutualísticas entre formigas e plantas. Relações multiespécies escrevem histórias complexas, intrincadas e situadas no espaço-tempo. Aprender com a composição de histórias, ter as florestas como parceiras de pensamento, propicia, quem sabe, *imprever* o fim do mundo.

PALAVRAS-CHAVE: Floresta amazônica. Atentividade. Relações multiespécie. Jardins de formigas.

Aprendizaje multiespecie de la selva amazónica: pensar con jardines de hormigas

RESUMEN

Este texto germina a partir de encuentros, cruces y preocupaciones con la Amazonía. Escribir con el bosque: dejarse afectar por el asombro y el encanto. Intentamos pensar en el bosque como un colectivo simpoiético multiespecie, cuyas relaciones entrelazadas crean y sostienen mundos. El diario de campo que se entrelaza con el texto experimenta y cultiva la atención hacia estos mundos enredados sin reducir su complejidad. Se plantean preguntas sobre el encuentro con un Jardín de Hormigas: una composición viva que surge de las relaciones mutualistas entre hormigas y plantas. Las relaciones multiespecies escriben historias complejas e intrincadas situadas en el espacio-tiempo. Aprender de la narración de historias, teniendo a los bosques como compañeros de pensamiento, tal vez nos ayude a *impredecir* el fin del mundo.

PALABRAS CLAVE: Selva amazónica. Atentividad. Relaciones multiespecies. Jardines de hormigas.

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The Amazon is not a place where we carry our body, this sum of bacteria, cells, and subjectivities that we are. It is not so. The Amazon jumps into us like an anaconda boat, strangles the backbone of our thinking, and mixes us into the marrow of the planet. We no longer know who the selves are. People continue to call us by our names, we answer, apparently we have our identities intact, but what we are, we no longer know. What we have become has no name. Not because he doesn't, but because we don't know his language.
Eliane Brum (our translation)

Preamble in fragments

Who has ever felt something like what Brum describes in this passage from the second page of her masterful "*Banzeiro Òkòtó*" (2021) and which is so difficult to describe with words: the astonishment in front of the Amazon Rainforest. Entering the Forest causes profound mutations but talking like this seems like a cliché if we don't use Brum's powerful words. Not least because we do not intend to generalize the experiences: we want to speak in the first person. Even so, we write in the first person about a Forest that is something immeasurably greater than people: existences, words, and texts. We let the Forest inhabit writing. We remember that who writes is a body— more than one, in the case of this text. A body that entered the Forest: heard, looked, felt, acted… And it was crossed by the Forest in its multiple dimensions[4].

Writing is necessary to maintain the awe and the proliferation of sensations and experiences that are impossible to record in a coherent way. It is a writing that seeks, but does not always succeed, to escape from anthropocentric traps, crystallization, classification. Thus, it is a writing moved by curiosity, affected by encounters and that wants to make the Forest reverberate in texts, in classes, in conversations, is cultivated.

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[4] It is important to mention that these crossed bodies of writers are white bodies, who were not born or inhabited the Amazon for a long time, and, as much as they have affection and respect for it, they came and inhabit the Southeast of Brazil.

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A meeting that starts from a student of Biological Sciences, who returned from the Amazon after navigating in speedboats through the rivers of the Forest in collections of the fieldwork of her master's degree in Botany[5], and a professor who, 26 years ago, in the last year of her graduation, participated for a month in actions of the Solidarity University Program in riverside communities in the State of Amazonas[6]. Experiences that are very different from each other and very distant in time. Carried away by the recent experience, the student wants to address the multidimensionality of the Amazon, raise people awareness about its importance, and denounce the threats that put something so precious at risk. By understanding—and sharing—the rapture, the professor suggested reading Eliane Brum's book, a contemporary manifesto in defense of the Amazon.

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The viewpoint in the Serra do Divisor National Park changed me forever. After an eight-hour journey in a speedboat up the Rio Moa, a white-water river that rises in Peruvian territory and flows into the Juruá River, we arrived in the extreme west of the country, Acre, on its border with Peru. The state does not have many mountains; its highest altitude is 400 meters above sea, but in this region, there is a high point with a trail to a viewpoint. Under a scorching sun, blue sky, and few clouds, on one side I could see Peru, with mountains and more mountains making up its territory, and on the other, Acre, Brazil, with no mountains, only forest as far as the eye could see, and beyond. As much as I knew that there are limits, the feeling was of an endless forest, which never ends. A forest the size of the sky, with plant constellations, waterways, and supernovae of life[7].

[5] It should be noted that she already had the titles of bachelor and master, being in a second link with the aforementioned course to obtain the title of licensee.
[6] The communities were in the Tefé region, as well as in the Mamirauá Extractive Reserve.
[7] Throughout the text, excerpts from a personal field diary are mixed with the discussion, always highlighted in italics.

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The Forest and its Entanglements

In the first week I spent in the Serra do Divisor Park, we set up a collection routine: wake up around 6 am, drink coffee, pack the materials, and, at 7 am, enter the motorboats upstream. Every day, we advanced a little further along the way; Every day, we looked for different trails to enter and collect. A standardized behavior, but with a feeling that, every day, we learned more from the forest. I began to recognize the curves of the river, some rocky walls, the location of flowering trees, others in fruiting, the ravines, the fallen trunks, and the hanging herbaceous plants. Eventually, we could see some of my trees from afar, with a characteristic branch growth, even many meters away, and it was possible to see them. I started referring to two of them as "the twins" because they are so close and stand out just after a bend in the water.

Largest tropical forest in the world: more than 6 km² in extension. 50 million years of creation. It houses an extraordinary network of connections between the most diverse beings. Its rivers are part of the largest mixed-regime river basin in the world. It holds the greatest biodiversity known to science. With an estimated population of 38 million people, with more than 400 indigenous peoples, and more than 300 languages (IBGE, 1977; 2023). We are inevitably faced with this information that stresses the immensity of the Amazon, its superlative importance to the world, its riches, as well as the serious threats associated with, above all, agribusiness, mining, large infrastructure projects, and climate change... How do we talk about something so immense and complex? Maybe by starting to perceive the Amazon through small bundles, filaments of stories, partialities, small things...

The Forest is not a green and homogeneous wall, but a proliferation of lives and connections. Different experiences and encounters form the mosaic of a multiple Amazon. Its wide and long rivers, with crystalline springs that join the white and black waters. Its tall trees, with different crowns and

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foliage, with different saps and resins, herbaceous trees that cover the ground and grow under the trunks. Flowers and fruits of different shapes, colors, and smells. Fungi that create fruiting bodies with the most curious patterns, in the most unexpected corners. Its animals, with unique sounds and movements. Susana Dias (2020, p. 8, our translation) points out that:

> A forest is interesting because it is a living laboratory of what can become a being together, a living together. What can an experience of being together do when pushed to the edge, by bringing together different ways of living, feeling, and thinking, and letting them coexist, promoting aberrant relationships, unthinkable kinships. In a forest, one realizes that life is not only in beings, things, and supernatures, but among them, since a living world is a world of bridges, connections, synapses. For this reason, a forest claims a thought not around individuals, but rather about populations, systems, networks, flows of matter and energy, and passages between becomings.

Taking the Forest as a given system, which self-regulates with its theorized dynamics and interpreted functions, and whose rhythm is transformed only by disruptive agents of destruction, is to consider it a closed system. Donna Haraway (2023) points out that sympoiesis refers to living systems that are constantly expanding and changing, with ties and connections that create and recreate those that compose them at all times; they are complex, dynamic, responsive, situated, and historical. This concept contrasts with autopoiesis, which concerns autonomous systems that produce themselves, are self-sufficient, and whose interactions with the environment trigger only internal responses. When considering the Forest composed of thousands of species, it is possible to see the autonomy of the so-called “individuals”, their bodies and metabolic processes, but the dynamics are built by the vast network of interactions

between beings, as highlighted by Dias in the aforementioned quote. The Forest's history was written by several hands, branches, leaves, wings, paws, stones, rhizomes, flagella, hyphae, rivers…

Perhaps, then, in the face of the green immensity that haunts and fascinates, it is also interesting to look at multispecies entanglements that participate in the joint creation of worlds in the Forest, or rather, in the creation and continuity of the Forest itself. Regarding this, van Dooren, Kirskey, and Münster (2016, p. 42, our translation) explain how the multispecies approach

> focuses on the multitudes of animate agents that lead them to be in the midst of entangled relationships that include, but always also exceed, dynamics of predator and prey, parasite and host, researcher and researched, symbiotic partner, or indifferent neighbor.

The authors also highlight that cultivating arts of attentiveness requires practices that allow getting to know the other intimately and, at the same time, ways of responding to this other in an ethical and sensitive way, contributing to the making of worlds oriented to mutual flourishing.

Multispecies alliances in an ant garden

Feeling the slight sway of the speedboat, the roar of the engine, and the running of the Moa River permeating the air, cutting plant branches to press and assemble exsiccates, I heard, "we have to collect those there". On the other bank of the river, there was what looked like a ball suspended by a vine, but as we got closer, we could see better what it was. What a curious sight: a hanging ball. Curious, indeed. We got close and saw the proliferation of life, with subtle movements of what appeared to be two species of ants. Observe the green and purple epiphytes erupting through

the brown, smooth texture of the leaves compared to the irregularities of the earthy surface. It's a garden. A garden? About 20 centimeters in diameter. After a brief battle and several (deserved) ant bites on the whole team, we managed to take part of the plants with us.

But how did they all get there? The ants, the plants, the seeds? How did that round community grow so large, suspended on a vine? The ants probably climbed up and down the tree in which the vine was wrapped, but what a long way to set up "an anthill"! And did the two ant populations arrive at the same time, or did one invite itself to compose along with the other? And the plants? Were their seeds sown at the same time, or added as the garden grew?

Our encounter with this association between different living beings triggered many questions about what that animal-plant tangle was and mobilized research to try to better understand what happened there, in that "ball full of life". The so-called ant gardens are an association exclusive of Brazil, of the Amazon. These gardens are formed by communities of ants of one or sometimes two or three species, which build a suspended anthill and carry some seeds of epiphytic plants inside, which germinate and become part of this community. How are they formed? Which plant families are most common? Do these plant species sprout, grow, and flourish only in this type of association, or are they found in a "solitary" way? Which species of ants participate in these relationships? Are they of a single or multiple genders? What are the ecological relationships between them? Do they occur only in the Amazon or in other tropical forests around the world?

The formation of the Ant Garden was first reported in a paper by Ernst Heinrich Georg Ule[8] in 1901, who coined the name *Ameisen-gärten*, which can be translated exactly as "Ant Garden". The naturalist hypothesized that such an ecological relationship would be highly

[8] For botanists, the name of this naturalist is greatly familiar, whether for analyzing and working with his collections, coming across nomenclatural tributes in plants species and genera, or even for deciphering his signature and calligraphy in German.

specialized and essential for the ant and angiosperm species involved (Madison, 1979). More than 10 botanical families have been recorded in the different tropical forests, such as *Araceae*, *Bromeliaceae*, *Cactaceae*, *Gesneriaceae*, *Orchidaceae*, among others, with more than 20 species, which may or may not be restricted to gardens (Davidson, 1988; Yu, 1994). As for ants, there are a little more than 10 species that participate in this ecological relationship, divided between the *Azteca*, *Camponotus*, *Crematogaster,* and *Solenopsis* genera. They may present different patterns of behavior and routines, such as *Crematogaster levior*, which forages at night, and *Camponotus femoratus*, during the day, but both can make up the same garden (Orivel; Leroy, 2011; Paula; Lopes, 2013; Paolucci *et al*., 2016; Vicente *et al*., 2020; Morales-Linares *et al*., 2021a, 2021b).

Later, entomologists Wheeler (1921) and Weber (1943) began to argue that the relationships that took place in ant gardens were casual and opportunistic, that ants transport various types of organic matter into their colonies indiscriminately, and that the plants found were only in suitable conditions to germinate and remain in the substrate of the garden. The formations would take place through a series of chance events, without having a significant connection between the species involved, without mutual choice. They also argued that the benefits the association provided, such as the herbivore defense and the colony's sustenance, were just coincidences.

Currently, the theory proposed by Ule (1901) has been confirmed in different ways. According to it, the relationships between plants and ants are specialized and the species involved actively participated in it. It is confirmed, for example, by the physical structuring of the community, protection against herbivory, sharing of floral resources, feeding of the larvae by consuming part of the seeds without harming their germination process, and by the plants producing such specific volatile compounds that attract the ants to the seeds. Regardless of whether these relationships are developed exclusively or not, the connection these species have today in ant gardens is the result of an evolutionary process spanning thousands of years.

A clash of hypotheses is not uncommon in academia. Papers that disagree with and discuss previously presented ideas are an important part of science. Formulating hypotheses in a reasoned way, which guides research and projects in a responsible way, is highly desired. In this case, what drew attention was the presence of some terms used by Wheeler (1921) and Weber (1943) to develop these arguments, such as "greedy and acquisitive" and "aggressive" to adjectivize ants, the statement that gardens fit more like a composite nest than a mixed colony, and that plants were taken by ants only by chance, not chosen. Of course, we cannot ignore the possibility of casual or opportunistic ecological relationships, or that the behavior of some ants may be more territorial.

Even though he mentions at the end of his paper that more robust results require a longer research period, why did Wheeler seem so firm in characterizing the ant species involved as individualistic? Furthermore, he suggested "that it is advisable at the present time to suspend judgment on the provenance and meaning of plant elements in the biocenosis[9] of the Ant Garden of tropical America"[10] (Wheeler, 1921, p. 102, our translation). How much is lost when studying a community with several species when we despise fundamental members of it? Why limit our understanding to the sterilized functionality of different relationships (whether they are harmonic or disharmonious), regardless of how much we actually learn from and about them?

Writing and thinking with ant gardens ended up taking on contours never imagined at a time when the main concern was avoiding ant bites. A discreet event, an encounter with a tangle of tiny life in front of the forest grandeur, unfolded possibilities for thought and writing, like a multispecies experiment that took place long after the trip to the Amazon. Whether leading us to reflect on how this small web of interactions is treated as a problem or

[9] From the Greek *bios*, life, and *koinos*, common, it refers to the set of species that inhabit the same environment.
[10] Free translation of our responsibility.

as something to be protected, how the relationships there can be read as a conflict of individualities or as companion species with intertwined agencies. Would it be possible to fabricate an Ant Garden? In what ways are they explained or known by residents of the region? Why are the images of these living compositions so rare?

I believe that, in order to deal with multiplicity, with diversity, with the world makings that branch out from this ecological association, we cannot start from an exercise of equivalences and analogies. I will never understand what it is like to be part of an Ant Garden, because I am not an ant or a plant, and I am even less this affective relationship (why not?) between them and other possible beings that have become tangled up in their bodies and stories. But I believe that I can (can!) know more; we can let ourselves be crossed, create with, exercise other perspectives, cultivate sensibilities from my encounter with them. Arts of attention.

In ecology, ant gardens are described as a specialized, mutually beneficial, interspecific relationship with an evolutionary history shared for thousands of years. We could describe the diversity of taxa involved, how this community forms, and how water, luminosity, and climate can influence this dynamic. However, we chose to think from multispecies studies, and, with them, we can ask other questions and make reflections. Thinking with Biology, and beyond it—weaving other connections. "Multispecies relationality attentive to temporal and semiotic registers evidences an animate world in which being is always becoming, in which becoming is always a becoming-with" (van Dooren; Kierskey; Münster, 2016, p. 41, our translation).

Ants, capable of traveling long paths and carrying loads far greater than their own weight, with such active energy; are they the ones who choose, or are they chosen by plants? Plants often placed as supporting actors but are so intensely and directly connected to the Earth that made life possible for so

many other beings millions of years ago. How do articulated legs and jaws join rhizomes, roots, and leaves to shape a small world full of life? What communication happens between ants and plants? Do they meet and choose each other based on some odor? How is the relationship between different species of ants that cohabit in the same garden? How is the spherical shape created and maintained by these beings together?

The Amazon is a region of expressive sizes, with millions of human beings and more-than-humans who weave their worlds together, and, if we are to mention a forest carpet, it is made of different lines, techniques, and materials, which create the most diverse patterns. Exercising sensitivity to multispecies life involves improving what Tsing (2022) calls the "art of perceiving" existing connections and being open to new ones. Multispecies relationships write complex, intricate stories situated in space and time, a plot with multiple protagonists and different behaviors, metabolisms, languages, affinities, and aversions. "Species involve intergenerational dances where entangled agents twist each other in continuous loops of intra-action multispecies" (van Dooren; Kirskey; Münster, 2016, p. 49, our translation). Writing these stories is not a simple task, as it involves immersive ways of understanding and being with other beings, and paying attention to how they create life and share worlds. Thus, the authors emphasize that:

> Striving for better worlds requires learning to take others seriously in their otherness, finding ways of confusing that avoid the fantasy of universal translation or a singular criterion—usually "ours"—of evaluation or verification. It also requires learning new ways of taking into account other enigmatics who cannot be—or perhaps do not want to be—represented or even made knowable or practical within any available mode of understanding (van Dooren; Kirskey; Münster, 2016, p. 51, our translation).

Thinking with ant gardens is thinking with a complex knot; it is to observe the medullary rhizome of epiphytes that support soil particles meters above the ground, which sprout and bloom. It is to notice the different ants that are part of the same community and build internal tunnels that enable an ingenious cohabitation. It is to see how the history of this unique formation, with different possible sets of plant and ant species, is described through the poetic term "Ant Garden". To be suspended in company, not in the sense of interruption or pause, but of being upright, held high, with the risk, but not the certainty of a fall.

Learning from gardens also involves dealing with the uncertainty of falling, which can cause agony, frustration, and fear. The worry that precedes it, like having butterflies of being suspended, is not superfluous; It considers real risks and possibilities. But it can also open a range of possibilities. To deal with the sympoiesis of living systems, the importance of alliances between different species and knowledge in world making, which can *unpredict* a certain fatality, a unique significance. Multispecies alliances can participate in this unpredictability, helping us walk different paths and build colorful parachutes. As stated by Ailton Krenak (2019, p. 30, our translation), "thinking of space not as a confined place, but as the cosmos where we can fall".

Studies by Schmit-Neuerburg and Blüthgen (2007), Morales-Linares *et al.* (2021a; 2021b), and Dejean *et al.* (2022) explored possible responses of ant gardens to climate change, based on forecasts for the coming decades, considering factors such as droughts and rising average temperatures. Losses of colonies and individuals were found, and there were some changes in their distribution patterns, but something that several reported was a greater resilience of the species when in the garden formations compared to them separately.

Mutualistic relationships may be more vulnerable to extinction because of the deep connection between species, as the absence of one triggers a disruptive ripple effect. The effects that one species causes on the other(s),

the pressures, and their dynamics are completely altered, leaving deep marks of what was once a history written together. However, mutualistic relationships cannot be seen only for their vulnerabilities, as a weakness, or as being subject to greater risk; with them, partnerships are also formed, sensibilities and new ways of being in the world are cultivated. Especially because, as Haraway reminds us, no being preexists their relationships; "Co-constitutive companion species and coevolution are the rule, not the exception" (Haraway, 2021, p. 42, our translation).

Mystery will always be painted around...

> *What emerges from the dark depths of the forests and rivers of the Amazon if not the feeling that these mysteries must continue to exist?*
> Uýra Sodoma

The phrase of the *activist-performer* Uýra Sodoma, who is also a biologist and holds a master's degree in Ecology, resonates in many ways throughout this journey of thinking and writing with the forest and its relationships. The curiosity aroused by an encounter with an Ant Garden during a research immersion in the Amazon Rainforest triggered a process of writing, study, and enchantment, open to unexpected encounters. A cartographic arrangement that would not be possible during the master's degree and development of a dissertation in Botany. At the same time, meeting Donna Haraway and the multispecies studies made it possible to visualize other things, in other ways, with Amazon's biodiversity and scientific knowledge.

Understanding the work of thinking and writing with scientific papers as an experimentation also allows us to rethink the idea, often mobilized in science, that it would be necessary to fill "gaps in scientific knowledge" about the Amazon. Filling in the gaps as a means to eliminate mystery. We like to think of such "black holes" of knowledge not as an absence in the accumulated knowledge about the region, as empty spaces,

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but as a cosmic power that moves us to always learn from the Forest. The mystery does not need to and cannot be unraveled: it is an immanent condition of the forest. Dialoguing with this, what Dias says about having a Forest as a companion is very beautiful:

> Thus, having a forest as a companion of thought and creation requires not only gestures of preserving and protecting, but also paying attention to the point of view of a living and creative matter, prone to becomings. And becomings are always a matter of passages, of "passing between, of being between, intermezzo" (Deleuze; Guattari, 1997, p. 69). They give an opportunity to escape from dualities, to sympathize with interval gestures, capable of populating and multiplying the possibilities of the in-between. (…) Having forests as partners in thought and creation involves taking a perspective of systems in motion and constant formation, in which matter acquires new properties, increases its order and complexity, where fluctuations and instabilities play an essential role (…) (Dias, 2020, p. 9, our translation).

Having forests as partners in thought and creation, as happened in this paper, even moved our own matter. Being crossed by the forest when you meet it in person is inevitable; it rains in your mind, flows through your pores, sows by capillarity. It puts you face to face with millions of beings, their world making, and their entanglements. When it really enters you and spills your body beyond it, it is difficult to go back to your old conformation; you wonder whether you really want to go back.

However, back to the phrase of Uýra Sodom, it is necessary to affirm, to exclaim, that these mysteries must continue to exist. Exist literally. In the case of the Amazon, there are destruction projects, which have received many names and have been sustained by different discourses throughout the history of Brazil, and always aim to devour the

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Forest—to use a verb often used by Ailton Krenak. And, in this case, science and scientists also play a fundamental role, which obviously does not consist in "knowing before it no longer exists".

Alyne Costa (2020) mentions how, in the face of ecological collapse, science must move from a position of enunciator of truth and become one of the agents that participate in its construction. She says that what the scientist does is "propose a truth in which a myriad of non-humans (and many other humans, of course) already participate; but it also needs to be built together with those on whom the weight of this truth may fall" (Costa, 2020, p. 7, our translation).

Making shared worlds, the sensitivity and recognition of all beings involved in this process, oppose the world makings of the Anthropocene and the Capitalocene. Marked by individualism, immediacy, capital accumulation, and excess productivity, they go far beyond a mere time interval; they shape the way human beings relate to one another. They establish a transactional focus with other humans and more-than-humans, ignore other ways of building knowledge, connections, communities, and affections. The destruction of the forest is part of this world making, of a colonial project, which is presented as the only and definitive one, but it is only a possibility, not a certainty. As Haraway (2023, p. 93, our translation) mentions, "the Capitalocene is also terran; it does not need to be the last biodiverse geological epoch that includes our species as well. There are still many good stories to tell and many netbags to spring, and not just by human beings".

Working with and about the Amazon is about engaging with its biodiversity, grandeur, cultural diversity, relationships and connections, biotic and abiotic elements, as well as deforestation, mining, pollution, and political issues, and how all these factors are part of the region. We start with Eliane Brum and end with her:

> The battle for the Amazon, the reforestation of the self, the Amazonization of the world is a movement to overthrow the hegemony of Western, patriarchal, white, male and binary thought that has dominated the planet for the last millennia—and exterminated, silenced or pushed to the peripheries all other ways of perceiving oneself in the world, for the world and with the world. The battle for the Amazon is for the reforestation of the worlds—those outside and those inside (Brum, 2021, p. 51, our translation).

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